Successful Implementing Digital Networking

on the Shop Floor in the Tool and Die Industry

2018

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WBA WERKZEUGBAU AKADEMIE

WZL | RWTH AACHEN UNIVERSITY

WBA Tooling Academy Aachen

The WBA Tooling Academy Aachen develops industry-specific solutions for the sustainable competitiveness of the tool making industry in a network of leading companies. Its activities focus on industrial consulting, further education, industry solutions as well as research and development. Its own demonstration tool shop enables the WBA to test innovative approaches in the laboratory and quickly make them accessible for its partner companies. Key issues are further addressed in the current studies. These provide information about market and competition trends and developments.

Laboratory for Machine Tools and Production Engineering (WZL) of RWTH Aachen University

Across the world, the Laboratory for Machine Tools and Production Engineering (WZL) of RWTH Aachen University, with its 900 employees, stands for successful and forward-thinking research and innovation in the area of production engineering. Active in four different fields, WZL research activities not only relate to fundamental theories and findings, but also to the application of findings in an industrial context. Furthermore, practical solutions are developed to optimize production. The WZL covers all sub-disciplines of production technology with its four chairs of Production Engineering, Machine Tools, Metrology and Quality as well as Manufacturing Technology.

Imprint

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Spotlight

The tool and die industry is facing far-reaching changes. The fourth industrial revolution is promising an abrupt rise in productivity based on smart networks for manufacturing resources. The foundation for this is the use of networked digital devices on the shop floor. Similar to other industries, the system-wide use of data offers a chance for the improvement of transparency and efficiency increase. This can be realized by an optimal utilization of capacity and use of existing resources in the tool and die industry. Learning effects also promise an improved mastery of the continuously increasing complexity in tool shops. The present study gives an overview of the status quo of digital networking on the shop floor in the tool and die industry and shows concrete courses of action as well as solutions.

29,139 €

... are invested on average in tool shops every year for digital networking measures

31%

... of tool shops are actively engaged in the implementation of digital networks

1.6

... tool shop-specific mobile applications (apps) are used on average in tool shops

3

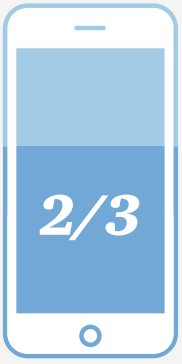
... tablet computers are available per 100 employees in a tool shop

Initial Situation

The smartphone that changed the world: with the market launch of the iPhone in 2007, the path was cleared for the digital networking of private life. Nowadays it is taken for granted that we can communicate with friends and business partners wherever possible accessing current news and information or streaming one's favorite music. In 2015, about two thirds of all German citizens possessed a smartphone, compared to only 10% five years earlier. However, the use of digital technologies is not only restricted to the today's smartphone. Under the banner of the smart home, many connected and remote-controlled devices are already moving into households, offering a higher quality of life while also dealing with the increased need for safety and ecological compatibility.
The rising degree of digital networking not only profits private life. The industry has also recognized that modern information and communication technologies can be used to explicitly address key performance indicators such as costs, quality and time. An example is the logistics branch, where time is particularly critical. In order to increase productivity and reduce the influence of disturbances, the sector was an early adopter of the integration of modern information and communication technologies into work processes.

The Container Terminal Altenwerder (CTA) was opened in the port of Hamburg in 2002. Its hallmark is the high degree of automation paired with a clear layout in which a complex IT-system takes control over nearly the entirety of logistics processes. 95 completely autonomous electric transport vehicles, weighing up to 70t, are guided to their destination by 19,000 transponders on the ground. The vehicles plan their charging cycles themselves, taking into account fluctuating electricity prices throughout the day. Furthermore, 300 sensors at intersections, roads and bridges control the traffic flow in the loading zone and a multilingual mobile app grants long-haul truck drivers real-time access to traffic information as well as parking reservation. This enables highly efficient loading and unloading of large container ships. With its permanent access to information anywhere and user-friendly handling, this system demonstrates the enormous potential of digital networks. In order to utilize the resulting potential and remain competitive, it is also of particular importance for companies from other industries to deal with fields of activity in digital networking early on. To this end, the impact on the spectrum of goods offered needs to be investigated and possibilities derived for tool shop processes. Parallel to the potential of the digital networks, it is still important for companies to look at the challenges they present.

The Laboratory for Machine Tools and Production Engineering (WZL) of RWTH Aachen University and the WBA Tooling Academy Aachen have been investigating the topic of digital networking for several years, both in batch production and in single and small batch manufacturing. The WZL has contributed significantly to the progression of digital networking in the manufacturing industry with numerous publications, studies, research projects as well as dissertations. This knowledge was used to identify the potentials relevant to the tool and die industry. The present study describes recommended courses of action, which tool shops can take into consideration for the design of their shop floors with contemporary digital networks.



of all Germans possessed a smartphone in 2015

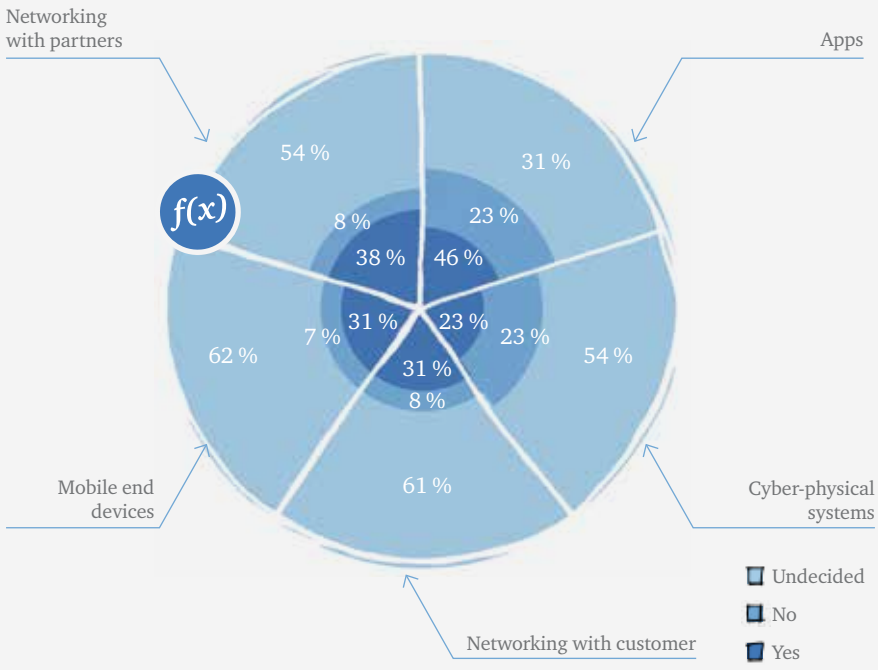

Digitization
Tool shop portal
Intranet
INTELLIGENT
TABLET
WEB APPLICATIONS
Systems
Workplace
Industry 4.0
Smartphone
Networks
Automation
MINING
smart
APP
AUGMENTED REALITY
Wiki
Tracking
Flexibility
CYBER-PHYSICAL SYSTEMS
Processes
REAL-TIME DATA
NETWORKING
Future
Industry
IT
Sensors
ICT
Toolmaking
digital
Shop floor
Tool
TEAM WORK
PLATTFORM
Information
Big data
COLLABORATION
Transformation
Workflows
mobile
Data integration
Machine
EXTRANET
Cloud
Internet

Potentials of Digital Networking in the Tool and Die Industry

In the general sense, the concept of digitization is the recording, processing and saving of data. Digital data are already widely used in manufacturing environments, for example in milling machines with digital controls or shop floor boards with touch screens. In particular, large potentials are opened up as soon as there exists digital network for products, machines, people and processes and hence enabling a system-wide use of data. This system-wide use of data can increase transparency and utilized capacity while reducing errors in equal measure. This will lead to tool shops having a much better command over the rising complexity on the shop floor as well as increasing efficiency.

Currently, the tool and die industry has recognized the possibilities that come along with digital networking and the use of information and communication technology. Only a handful of tool shops have tried to utilize these systematically and comprehensively so far. Surveys conducted by the WBA have confirmed the skepticism and sluggishness of German tool shops with regard to the implementation of digitization measures. In one survey, tool shops were asked what technological trends they would be addressing in the future. It was confirmed that the companies especially often identified networking with partners, the use of mobile devices, real-time data availability, information security and the ability to plan dynamically based on real-time data as the most important trends. Those trends were assigned with a high potential. However, only a much smaller share of the surveyed companies had correspondingly planned an introduction and implementation of these technology trends in the future. Another WBA survey shows that currently only 31% of tool shops are actively working on the implementation of digital solutions.

Planned Introduction of Digital Networks



31 %

of tool shops are actively working on implementing digital solutions

38% of tool shops pursue an active procuration of information regarding digitization and 68% a passive procuration of information (multiple answers permitted).

Moreover, it can be stated that the technological infrastructure of tool shops is not up to date. In the tool and die industry, most of the hardware consists of desktop computers, work stations with viewer licenses and laptops. Tablet computers, on the other hand, are very seldom used. Further, tool shops utilize software and IT systems with varying intensities. Computer-aided manufacturing (CAM) as well as computer-aided design (CAD) are used in all tool shops. Over two thirds of companies use PPS and ERP systems for manufacturing and resource planning. Furthermore, about half use IT solutions for product lifecycle management (PLM). Also, systems for capture manufacturing data are used by half of all tool shops. Thus, it can be concluded that the majority of tool shops have already implemented the basic systems. However, the software often is not interconnected, meaning the existing data cannot be used system-wide.

Currently, the tool and die industry is facing four main challenges. Firstly, shortened product lifecycles require an increasing integration of the industry into the product development process and reliably quick tool provision. Together with the trend towards individualization, this creates the challenge of quickly rising complexity for the tool and die industry. General societal developments also create even greater necessity to adapt. For example, the aging demography also affects the personnel of German tool shops, whose average apprenticeship share has sunk by 6.8 percentage points in the last ten years to 8.9 (2017). It is getting more and more difficult to enthuse young employees for the tool and die industry and purposefully qualifying them. The compensation of the impending knowledge loss that results from the retirement of older and more experienced employees and shortage of young people, creates a second decisive challenge. A third challenge results from the changing style of leading and motivating younger employees. The so-called “Generation Y”, born between 1980 and 1999, has significantly different demands with respect to work content, work environment and employers. These demands, which in particular include wishes for responsibility and variety, need to be fulfilled by the tool and die industry in order to continue to attract and hold qualified and motivated employees. Another important challenge is a result of globalization, which entails international interaction and cooperation between economic entities as well as markets coalescing. New market participants, especially from Asian and eastern European countries, are able to produce considerably cheaper, due to lower factor costs, and hence create an increasing cost pressure.

The described general challenges for the tool and die industry have large effects on the location where goods and services are rendered, namely the shop floor. With 77%, the large majority of employees still work on the shop floor. Therefore, the listed societal trends of aging and the associated knowledge loss as well as the changing demands for the workplace impact the shop floor in a particularly hard way. The pressure for reliable quick tool provision is also given on directly to manufacturing, which makes a reliable and plannable processing tremendously difficult due to the high complexity. Currently, the shop floor is characterized by scarce information availability and an inadequate information presentation. According to another study, nearly all employees working in manufacturing want a real-time availability of data and information on the shop floor.

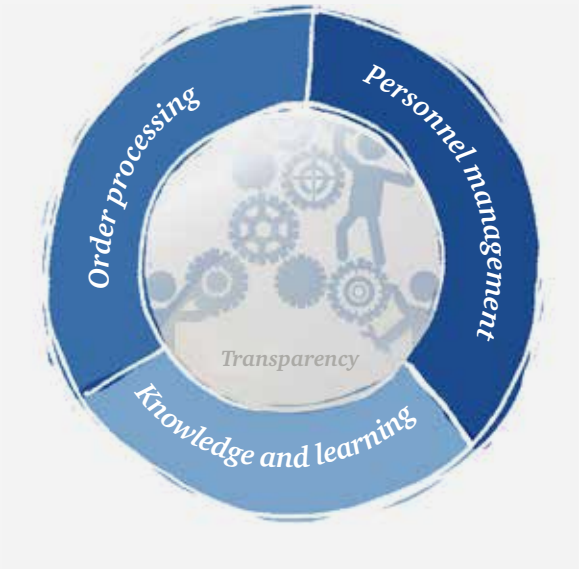
Furthermore, there is a wish to be informed about current news about the tool shop, the affiliation of a component with its tool, the current due date status of projects as well as the volume of work on a weekly basis.

A comprehensive digital networking of the shop floor can contribute to overcoming the central challenges tool shops face. The basic requirement for a digital network is the reation of transparency through near real-time recording and analysis of relevant data and information in order to properly handle the complexity as well as increase efficiency. The challenge of the increasingly complex toolmaking under both time and cost pressure can be met with a digitally-assisted order processing. The impending knowledge loss can be averted with digital knowledge management, which can give on the competences of older employees onto the next generation. Additionally, Generation Y can be motivated and led in a goal-oriented fashion via the use of modern digital media on the shop floor. Thus, the three crucial areas of activity for comprehensive digital networks on the shop floor in the tool and die industry are order processing, personnel management as well as knowledge and learning. In the following these activity areas are described and concrete solutions are introduced to address them.

77 %

of tool shop employees work on the shop floor

Application Areas for Digital Networking on the Shop Floor



Source: DFA Demonstration Factory Aachen

Order Processing

Order processing describes all activities surrounding the fulfillment of customer orders and thus represents the core of every enterprise. It includes all activities from project management, tool design, assembly, try out over to delivery of the finished tool to the customer. Evidently, this is a holistic process that includes all elements of rendering goods and services. An efficient order processing greatly influences the features with which tool shops differentiate themselves: adherence to delivery dates and processing time. Currently, according to the competition for “Excellence in Production” for tool shop of the year, about 24% of orders are delivered after the agreed date.

See study > Tooling in Germany 2018

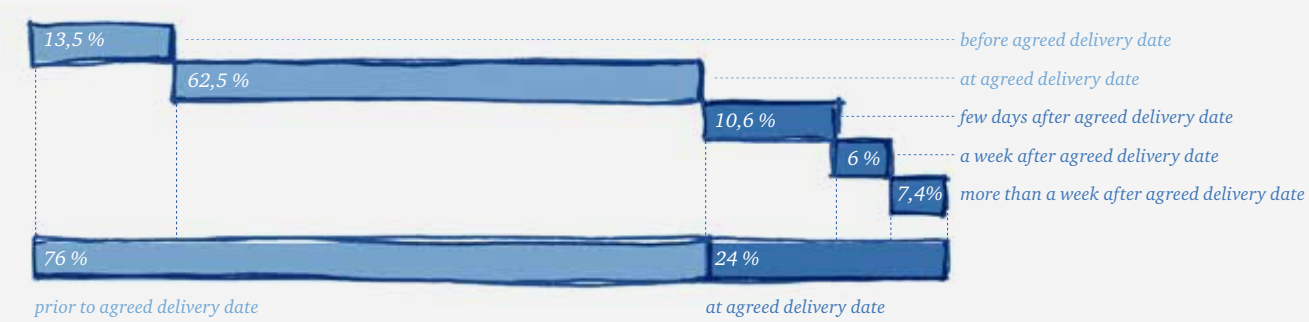
With regard to the current challenges facing tool shops, order processing has to be the focus of digital networking. In particular, the activities that directly create value, which are usually manufacturing and assembly on the shop floor, can be significantly optimized with digital networking. The creation of continuous transparency throughout the entire value creation and the entire value creation network offers various possibilities to simplify processes as well as make them more efficient.

In the following, three example solutions via digital networks in order processing on the shop floor are introduced. Through the implementation of these solutions the previously described increase in transparency in order processing can be reached. First, a possibility for digital component tracking is explained. Following that, approaches for prioritizing orders at work stations as well as digital assembly control are described.

24%

of orders are not delivered on time

Adherence to Delivery Dates in the Tool and Die Industry



Component Tracking

[Real-time component tracking creates transparency on the shop floor.]

Motivation

The course of activity in a tool shop has developed into an increasingly complex construct in the past. In order to do justice to the growing demands for the coordination of a number of different processes in manufacturing, an innovative approach is needed to handle this complexity. Foremost goal of such an approach must be to make the complexity visible in a structured manner by creating as much transparency as possible throughout all manufacturing processes.

Concept Description

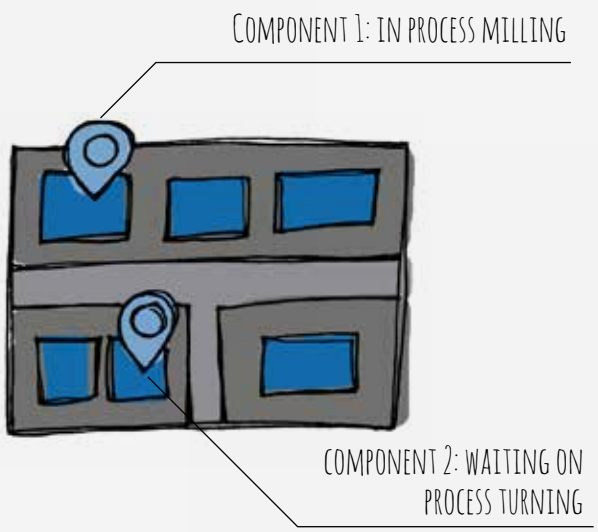
Most tool shops already possess ERP and/or manufacturing data capture systems, with which data can be reported regarding specific orders or even components. From this data, conclusions can be made about the status of a component. On the basis of these reported data, components can be traced if a process sequence was defined for the respective components and reports are sent after every process step. Further, due to the recording of data, a number of analyses of manufacturing processes can be carried out. These analyses can be used to optimize manufacturing. For example, time studies of transport, wait and manufacturing times at individual manufacturing technologies and machines can be carried out with a high degree of exactness and with a user-defined number of components. As well, a data-based evaluation can determine bottlenecks at machines, which transport ways are frequented most often and what other peculiarities appear in manufacturing. Based on these analyses, the optimization potentials, ranging from process optimization to new design of the layout to investment planning for manufacturing machines, can be implemented.

Through the use of modern information and communication technology it is now possible to realize the tracking of components in an even more precise and automated fashion. A promising approach is the use of automatic identification systems, e.g. radio-frequency identification (RFID) technology. Materials and components are identified and recorded in a database at their respective receipt at a processing station. This enables a complete transparency about the processing status and location of each component. Moreover, communication between the part and the machine is conceivable. For example, the component could automatically relay information to a machine, which then chooses suitable processing tools and programs.

Requirements

The requirement for the implementation of a component tracking system is an adaption of the IT infrastructure at the respective manufacturing facility as well as the installation of transceivers and scanning devices. In order to achieve an increase in the efficiency of manufacturing processes, the data needs to be compiled on the one hand, and evaluated and analyzed on the other. Suitable software and tools need to be developed and implemented for this purpose.

Digital component tracking



Application area *Manufacturing, Assembly*

Prioritization Assistance

[Prioritization assistance enables an efficient order control and relieves pressure on the responsible employee.]

Motivation

In contrast to the series production, tools are manufactured in single or small batch production. Due to the business nature, there are few repetition effects in manufacturing, which makes manufacturing planning and control an extremely complex task. Particularly the controlling of single components on the shop floor, i.e. the coordination of the manufacturing process and the determination of priorities at each processing station, often is carried out with simple aids or even just based on the experience of and permanent supervision by a master craftsman. Manufacturing control has a significant influence on the relevant key performance indicators in manufacturing:

- Short processing time of components
- Low variance of processing time of components
- High due date of components
- Low stock on the shop floor
- High efficiency and utilized capacity

With the help of a digitally networked prioritization, the controlling activities on the shop floor can be assisted and the manufacturing optimized regarding named key performance indicators.

Concept Description

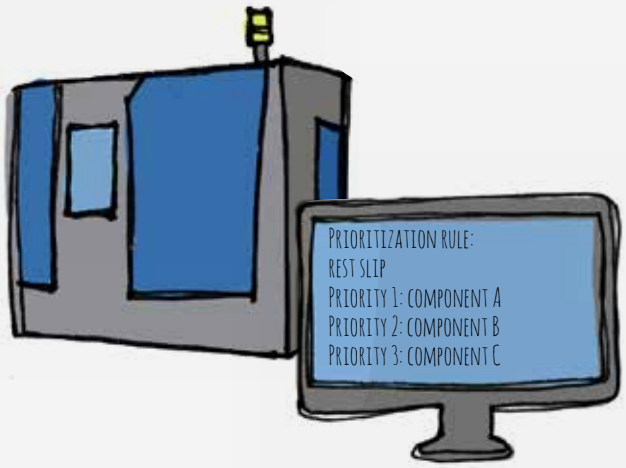
For the prioritization of components at each processing station, prioritization rules of varying complexity can be applied, with different effects on the listed key performance indicators. For example, the rule that follows the first-in-first-out (FIFO) principle has an especially positive effect on the variance of the processing time and the adherence to due dates. In contrast, the principle of equipping optimization, which is often preferred by the machine operators, has a positive effect on efficiency and utilized capacity as well as low stock but negatively affects the variance of processing time and the due date adherence. The application of the respective prioritization rules is associated with expenses, which can be simplified with digital prioritization assistance. In particular, the optimal prioritization rule for due date adherence, which is based on slack time (time until latest possible start date for processing a component), is extremely complex and requires constant reprioritization. Via a tablet or a screen directly at the machine, the employee is able to see which component should be processed next. The digital assistance makes it possible to visualize the tasks near real-time. Furthermore, it is possible to actively and flexibly change the prioritization rules as well as change processing sequence, with the effects on key performance indicators automatically being displayed. The employee is supported in this manner and pressure on the master craftsman is relieved.

Requirements

In order to reach the goal of digitally networked prioritization, e.g. through a digital prioritization board for individual

processing machines, it is necessary that the components waiting to be processed notify the respective machine. Further detailed target processing times, based on a work plan from manufacturing engineering, is needed. Finally, manufacturing control needs to be expanded so that it can fulfill the described functionality with this data and the prioritization assistance can be displayed on a screen at a processing station.

Digital Prioritization Board



Application area *Manufacturing*

Assembly Steering

[A digitally networked assembly steering enables a smooth assembly process.]

Motivation

In the tool and die industry, the assembly is the deciding process step for the guarantee of the proper functionality and quality of the tool in question. The final adjustments of tool components during assembly, especially of complex tools, require a lot of experience, skill and time. Errors in assembly lead to a lack of functionality of the tool to reach its demanded product quality. These errors are usually only noticed in downstream process steps, e.g. try out, and then need to be corrected in several cycles in manufacturing, assembly and try out. In practice, the assembly of a tool is often only started when all components on the bill of material have been procured and processed. Oftentimes it is not transparent when this exact point is reached, resulting in a considerable delay of the order fulfillment process. On the other hand, if the assembly process is started too early and components are still missing it needs to be interrupted and continued at a later point in time. This also results in lost time and inefficiencies.

Concept Description

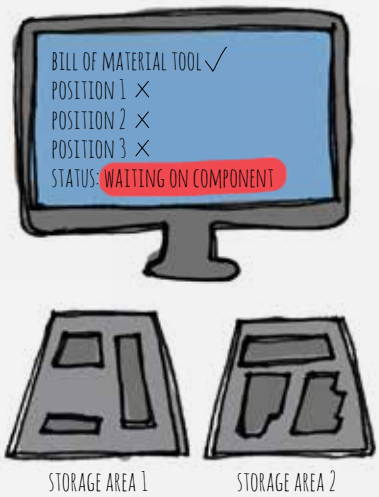
The goal of a networked assembly steering is to determine the exact and earliest possible time to start assembly and present this result transparently. Thereby, an optimal start and a smooth and effective assembly process can be guaranteed. First of all, the crucial time needed for the assembly of a tool has to be calculated. As soon as a component of the tool to be assembled is ready being processed and this status has been conveyed, it is registered as present on the bill of material. When all components needed for assembly are marked as ready or the remainder of their processing time is less than the time until they are needed in assembly, assembly is started. This process is visualized digitally by giving every ready or bought-in component for a specific tool an interim storage area until assembly start. This storage area is assigned to a tool via a tool number or symbol on a digital screen. As well, the status on the position of components for each tool is shown. As soon as assembly is triggered by the system, this is shown with a “traffic light” at the storage area and free assembly workers notified if applicable. Simultaneously, the tool to be assembled is assigned a free assembly workplace where the employees can immediately start with assembly. In this manner, it is ensured that there is no time lost in assembly and an assembly process, once started, does not have to be interrupted. Since there are no more pauses due to missing components, employees remain concentrated and do not have to refamiliarize themselves after a longer break. Thus, not only higher speeds but also an increased quality are achieved in assembly.

Requirements

A fundamental component of digitally networked assembly steering is the digital bill of material of the tool to be assembled. Manufacturing engineering needs to define in this bill of material which tool components are necessary for assembly

start and which are needed later on. For the parts that are needed later, the exact length of time after assembly start has to be provided. In order to implement the digitally networked assembly steering, e.g. through a digital “traffic light” showing the start of an assembly, corresponding software is to be developed and the information presented via a screen.

Digital Assembly Traffic Light



Application area *Assembly*

Source: WBA Tooling Academy Aachen

Personnel Management

Employees are the most important resource of a tool shop, especially on the shop floor. In order to guarantee the best possible assignment of employees, goal-oriented management is necessary. Personnel management determines the productivity of employees to a decisive degree and hence the efficiency of the entire value-creation process.

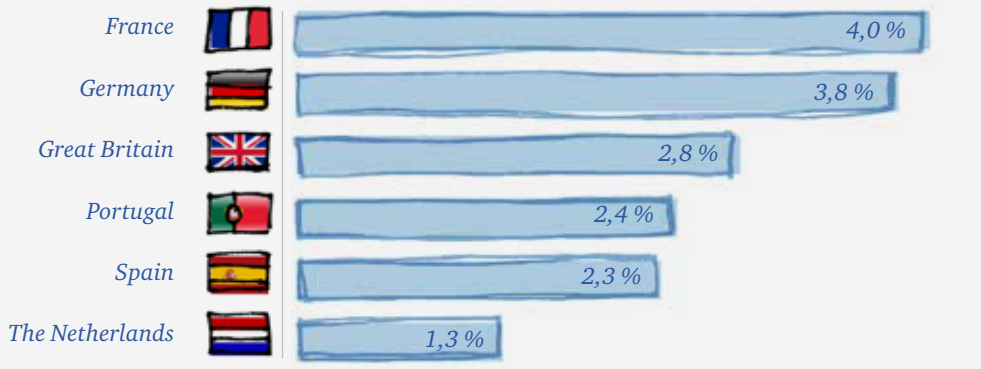
An employee needs to take on new tasks every day and react to a dynamic work environment. Also, an employee makes demands regarding work content, work environment and the employer. These demands, which include the wish for more responsibility and variety in the world of work, must be addressed by responsible people in tool shops. An assumption of responsibility requires an information base with which a well-grounded decision can be made. However, the current information availability is not sufficient according to a survey of employees working on the shop floor of tool shops conducted by the WBA. In total, 47% of employees are badly or very badly informed. Among other reasons, this is due to the scarce presentation and outdatedness of information on the shop floor. However, with the use of digital networking, near-real time information presentation as well as visualization enable for deviation to be recognized earlier on and necessary measures to be derived. Furthermore, the interaction with and between employees can be greatly improved with digital networks by defining and prescribing standardized workflows. Also, by improving the work condition, the satisfaction of employees can be increased. An increase in satisfaction among employees correlates strongly with a rise in productivity according to a study by the Cologne Institute for Economic Research.

In the following, three digitization solutions for personnel management on the shop floor are presented and explained. Apart from the presentation of information and workflow management, the flexibilization of the workplace is a central application of digital networking in the tool and die industry.

47 %

of employees on the shop floor are badly or very badly informed

Increase in Productivity per Increased Unit of Life Satisfaction



Information Presentation

[The availability of information is a basic requirement for employees taking on more responsibility.]

Motivation

Currently, employees on the shop floor of tool shops do not feel adequately informed as information and key performance indicators partly are not presented at all or not in the desired form. The majority of German tool shops utilize analog boards on the shop floor to present information and key performance indicators. Digital boards offer the possibility to update and properly present information and key performance indicators in near real-time. In this manner, the current scarce information availability on the shop floor can be counteracted and the task of information collection is eased in components for the employee, who can than focus more time on value-creating activities.

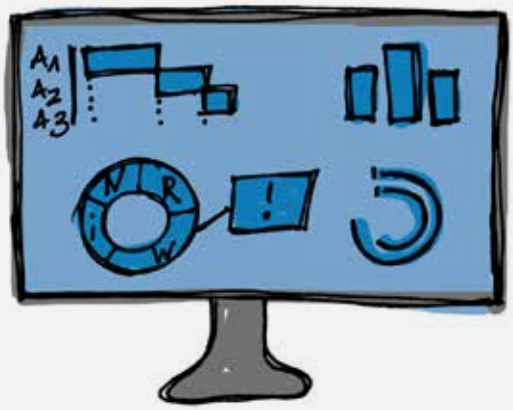
Concept Description

A digital solution of the shop floor board is a development of the analog board by adding an automatic and near real-time updating of information. Currently information that is to be presented on a shop floor board is often retrieved by hand, printed and placed on the board. This is wasting time and effort,while a digital board makes it possible to drastically minimize this labor input via continuous, computer-assisted updates and workflows. With regard to the layout on the board, information about process organization, productivity, quality, project status and continual improvement processes is fitting. An individual adjustment of shop floor board towards the required information of the respective tool shop and department is necessary to reach a maximal acceptance and use of the boards by employees. On the one hand, the board should ensure continuous information availability, while on the other hand also being utilized as a central element in meetings and votes. A passive information presentation on digital boards is pointless. Rather, there should be possibilities to actively adjust the board directly when needed.

Requirements

The data required for the design of a shop floor board often is already recorded by the ERP system. However, these data are neither evaluated properly nor presented. For the output of the data, interfaces have to be implemented so that it can be accessed and then automatically processed for information, which is then presented on the shop floor boards. It is the job of the tool shop to design the contents of the board and individually adapt it towards the demands of their shop floor. The use of one clear data source (“single source of truth”) is essential for guaranteeing the currency and consistency of the data. The inclusion of employees and continuous development are deciding in the design of shop floor boards.

Digital shop floor board



Application area *Manufacturing, Assembly, Indirect areas*

Workflow Steering

[Defined workflows enable the consistent realization of standard processes.]

Motivation

Numerous documented standard processes, checklists and guidelines exist in tool shops but are often not used by employees. As a result, there is an increase in the need for coordination as well as a loss in transparency of specific assignments. Through a digital network, it is possible to integrate workflows with digital assistance as well as standardize the process for assignment processing and make it transparent. For example, such workflow steering can be implemented in manufacturing for the creation of measurement reports or for tool approval and purchase in try out. Both for the preparation of measurement reports and try out documentation, the workflow steering guarantees the completeness of the necessary information by filling in given fields as well as a structured, predefined forwarding and storage of information in the form of a log.

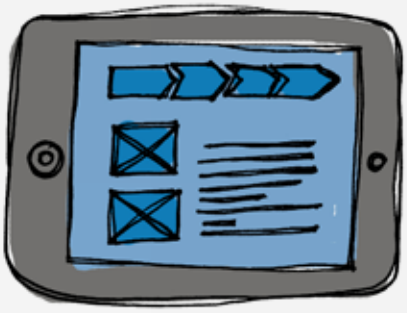
Concept Description

A concrete application of workflow control can be realized in the try out of tool shops. The try out of tool shops is a test run of a manufactured tool with the goal of configuring optimal process parameters and efficient reactions to disturbances. This process step is very significant as every further try out cycle is attached to significant costs. Therefore, the try out of a tool shop determines to a large degree the profitability of the entire toolmaking process. Currently, documentation of try out is mainly done with checklists that are only superficially evaluated due to the wealth of information as well as the nontransparent workflow. On the other hand, a digital workflow steering leads the employee through the process of try out documentation. Features and abnormalities that are recognized during the try out can immediately be recorded and targeted measures adopted, for example laid out in needs-based checklists, dropdown menus or text fields. Defined options can significantly reduce time-consuming completion of forms as well as guarantee standardized documentation. However, it should be noted that essential information must be present to continue with documentation. With analog try out documentation it is possible to skip documentation fields, resulting in information gaps that could result in more try out cycles, which usually means significant additional costs. Another deciding advantage of digital try out documentation is the possibility of accessing prior documentation as they were systematically archived. Following the digital try out documentation, a standardized model report can be and utilized for internal and external documentation.

Requirements

Digital try out documentation needs to be adapted to the given conditions as well as the respective tools. The selection of features asked about in the try out has to be made with relevance and efficiency in mind. A thorough definition of workflows secures a possibility for the standardized recording, storage and analysis of the try out process. Furthermore, time- intensive optimization can be reduced with a defined work process and by providing appropriate information of past documentations.

Digital try out documentation



Application area

Manufacturing, Assembly, Try out, Indirect areas

Flexibilization of Workplace

[The flexibilization of workplace is a possibility to grant an employee more decision-making freedom.]

Motivation

Within a WBA Study the employees on the shop floor assessed the employees satisfaction. The central result of this survey was identifying the employees' wishes for more responsibility as well as flexibilization of the workplace. Exactly these wishes need to be addressed by those responsible people in tool shops in order to increase the satisfaction of employees. In particular, digital technologies and their networking can create new possibilities for workplace design. A concrete digitization solution that grants employees the desired flexibility together with increased responsibility can be realized through the use of applications for monitoring important machine and process parameters.

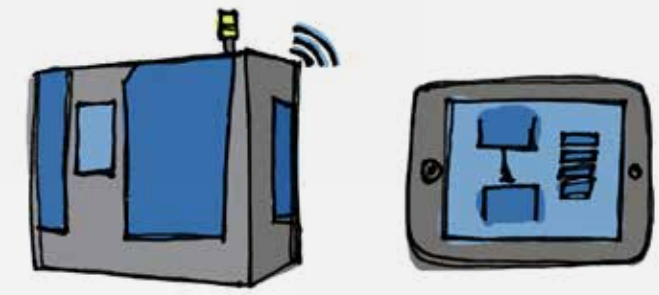
Concept Description

Via the interface of the machine, the employee should also have the possibility to be remotely informed about the status quo of processing tasks. If the processing tasks of a machine can run independently for longer periods of time and the presence of an employee is not necessary, that employee can pursue another task. With the help of camera systems, which are either already part of the processing machine or mounted later on, the state of processing can be followed live with an app. Further, vital processing parameters can constantly be shown and compared with target key performance indicators. Abnormalities in processing can immediately be recognized in this manner. Employees can be informed via push notifications in these cases. There is also the possibility of controlling the machine and its processing steps remotely and take necessary actions. This type of remote access to a machine leads to an increase in productivity due to simultaneous usage of multiple machines while also increasing the flexibility of employee. Likewise, the responsibility the employee also increases.

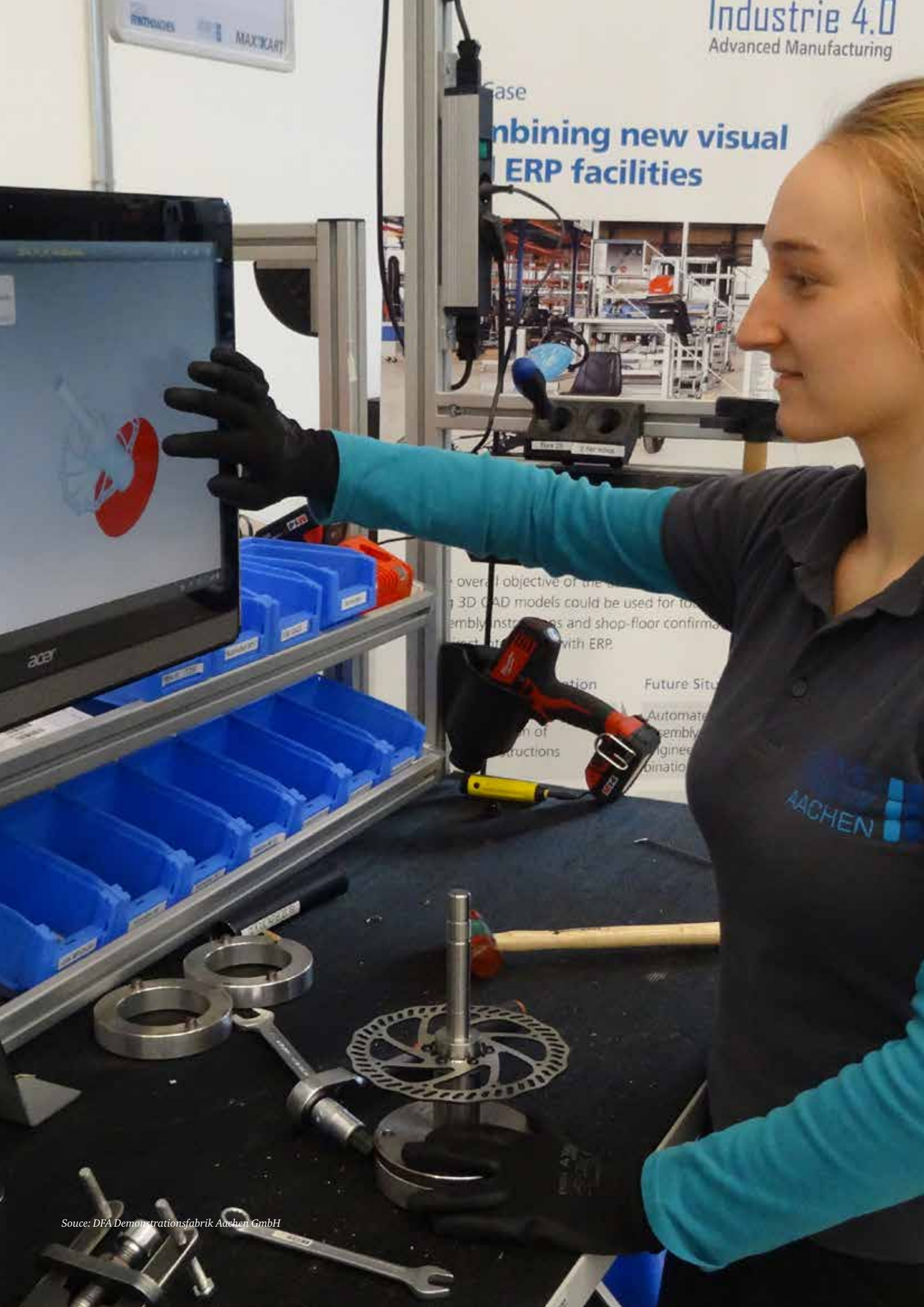
Requirements

Generally, it is relatively simple to extract required data from newer machines as interfaces are already standard. Older machines often do not have these functions. Also, camera systems are rarely already integrated, meaning that they have to be retrofit. This requires coordination with the manufacturer of the respective machines. Significantly more complex is installing a remote-control system for the machine. The decision of which functions should be remotely accessible has to be made with process safety and accident prevention in mind. Nevertheless, the use of digitization measures is relatively large as it leads to a considerable rise in employee productivity. With respect to cost positions, the main expenses can be identified in the hardware systems, as the interaction interface, as well as the corresponding software.

Remote-control of workplace



Application area *Manufacturing*



Souce: DFA Demonstrationsfabrik Aachen GmbH

Knowledge and Learning

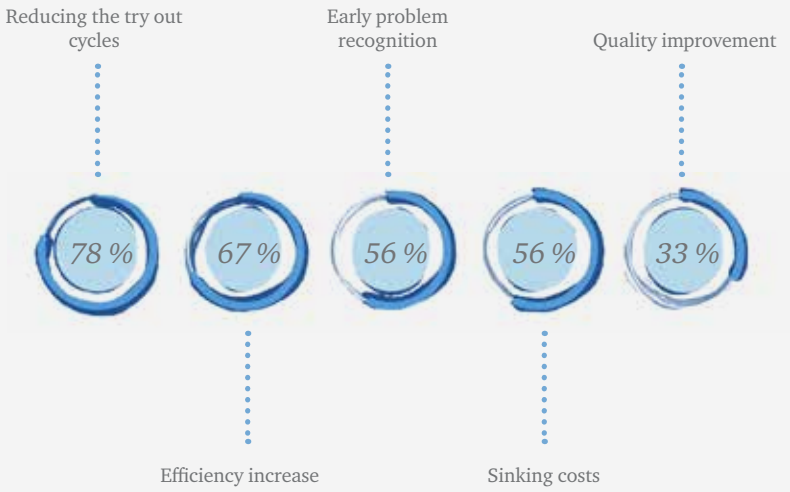
Knowledge and learning form the basis for the business success of the tool and die industry. It includes the safeguarding but also the forwarding of knowledge within the tool shop. The use of the gained knowledge is distributed among all the phases of tool making and allows increases in efficiency in all areas. Due to individualization and complexity of products, and thus also tools, the systematic handling of internal tool shop know-how is more important than ever. Additionally, the market demands quick reactions from tool shops due to short product cycles and thus a quick access to vital knowledge is important. Access to experience from completed projects offers large potential for tool shops. In particular, the experience and knowledge a tool shop has can be systematically recorded and made available through digital networks. When asked about the reasons for an improvement of the feedback system for try out, most companies see potential in the reduction of try out cycles (78%) and in the general rise in efficiency (67%). Respondents also mentioned cost reduction, early problem recognition, quality improvement and learning effects.

Through the digital networking of the shop floor, knowledge and learning processes can be managed more efficiently and effectively. The aspects of knowledge management, continual improvement process as well as individual learning were identified as basic starting points.

67%

of respondents name a general increase in efficiency as the concrete reason for the knowledge feedback from try out

Reasons for a necessary Improvement of Knowledge Feedback*



**multiple selections possible*

Knowledge Management

[Successful companies secure, expand and use their knowledge stock on a daily basis.]

Motivation

Tool shops generally employ highly qualified workers that provide specific, individual knowledge. Often, they are unable to make this individual knowledge available to all employees. If an employee were to leave or is unavailable, their personal, individual knowledge is not usable or even entirely lost for the tool shop in that situation. On an organizational level, this challenge can be met with successful knowledge management. Furthermore, the incorporation of new employees can be simplified with documented knowledge.

Concept Description

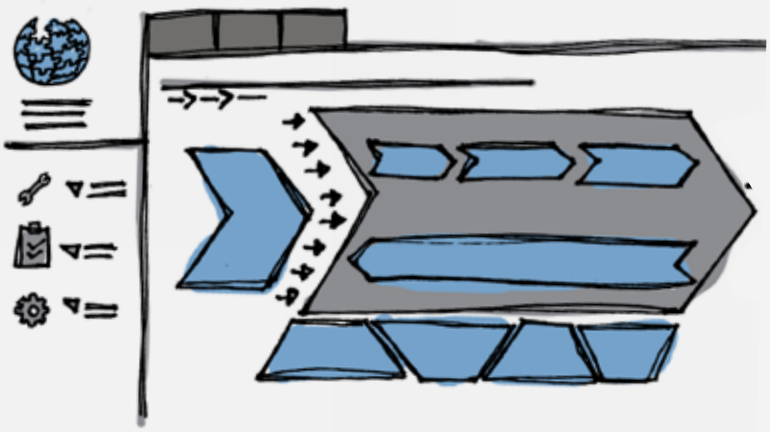
A modern possibility to gather individual employee knowledge and thus make it available to the entire tool shop is a so-called internal wiki, similar to Wikipedia, the online encyclopedia. In a wiki, which is derived from the Hawaiian word for "fast", employees and management store information within the tool shop network. This information can then be viewed and changed by colleagues. Hence, a very comprehensive knowledge record is created. This enables a transparent presentation of the history of an article by tracking what knowledge authorized users have added or changed. The benefits of individual knowledge management in digital networks can be seen in social media. Typical aspects of social media, such as short communication channels and quick dissemination of information, help to build up an internal tool shop network, which will improve the procurement of information within the tool shop. It is also possible to input current industry news or integrate training courses via interfaces, which will simplify the organization of personal learning processes for each employee. Another potential benefit is the inclusion of suppliers and customers into this system, as demonstrated with Facebook's project "Facebook at work".

Requirements

The fundamental requirement for introducing a wiki is the creation of an intuitive access to existing knowledge that is available everywhere in the form of a website as well as the associated knowledge database. Due to the diverse possibilities of such a IR database, the range of applications can go from simple recommendations for action and frequent causes of errors to multimedia content, e.g. videos of assembly steps. It is crucial for the success of a knowledge database to motivate the intended users to continually build up the wiki. The effort required to create an article can discourage employees from transferring their knowledge into a database. Therefore, the importance and potential that result from the general access to knowledge must be clearly communicated. Only then it can be guaranteed that individual knowledge is transformed into tool shop-wide knowledge and thus remain available when the respective employee is unavailable or leaves. The realization of a platform for communication and distributing information within

a tool shop and externally requires a similar infrastructure as for the implementation of a wiki, although a particular focus has to be kept on simple and quick communication. Due to the direct advantage for the user, significantly less inhibitions are expected when compared to a wiki. Nevertheless, it must be ensured that the system does not distract employees from their main tasks.

Internal tool shop Wiki



Application area *Manufacturing, Assembly, Indirect areas*

Digital Continuous Improvement Process

[Digital networking eases the recording, pursuit and implementation of improvement recommendations.]

Motivation

A constant aim of the tool and die industry is the improvement of tool manufacturing, the tools as well as the products to be manufactured. A valuable resource in this regard is the employee, whose experience needs to be incorporated within the framework of a continuous improvement process (CIP). The willingness of employees to participate is of eminent importance. Currently, possible improvements and errors have to be manually documented, evaluated and then relayed. The introduction of digital networks can lead to significant effectivity and efficiency gains in this area.

Concept Description

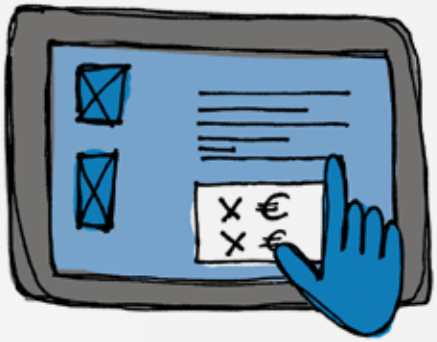
Continuous data availability is a core component of digital CIPs. Such a system consolidates all of the information and data collected in the tool shop with a minimum number of interfaces. With this joint data base, planned change measures can be simulated. Thus, the effects of planned changes can be predicted as exactly and comprehensively as possible. Furthermore, digital networking of data allows for the expansion of classical CIPs by adding automated error recognition. The existing data enables the recognition of discrepancies on the shop floor. For example, with the help of CAD data, modern software applications can identify variance in shapes or missing and wrong process steps for finished tools on the basis of photos and videos (Augmented Reality). Similarly, the automated comparison of planning data and real shop floor key performance indicators can find weaknesses in the order processing process. Another area of action is the submission of improvement recommendations by employees. Via the use of apps on mobile devices, the intuitive recording of recommendations is becoming possible, which can be submitted independent of time or location with multimedia data (picture, audio, video). Furthermore, a constant monitoring of the processing status of the submission can be implemented in order to give feedback to the employee and encourage further participation in CIP.

Requirements

A deciding factor in the implementation of digital CIPs is the connection of utilized systems into the existing IT landscape as well as the integration of upstream and downstream processes, creating a central database with general access. Additional software has to be employed for automated target comparisons. By dealing with disturbance factors in this manner, tool shops can significantly improve the order processing process and sustainably increase the effectivity. However, this necessitates a high initial investment. As well, automated error recognition needs both hardware, such as tablet computers or cameras, and software that analyzes the existing product data and shop floor key performance indicator.

The introduction of an application for the submission of employee ideas requires significantly less initial investment to be implemented. The WBA has already designed an app and web-based solution, which centralizes the submitted errors and improvement recommendations in a database where they can be evaluated. The necessary hardware is already present at most companies and for most of their employees.

Digital error recording app



Application area *Manufacturing, Assembly, Indirect areas*

Individual Learning

[Efficient processes and high-quality tools require a continuous development of all employees.]

Motivation

The individual learning process of an employee is an essential building block for securing a tool shop's competitive advantage, especially with respect to the increasingly shorter half-life of (expert) knowledge. However, this process is often associated with high personnel expense and time cost. Thus, it would be constructive to make learning more efficient and effective for employees by making it more realistic and appealing with the help of new concepts and digital technologies. The goal is to develop user-oriented and near-real-time methods for learning that enable the employee to overcome the rising number of demands.

Concept Description

Only a couple of years ago, learning consisted mainly of reading books and journals as well as visiting training courses. However, a new form of learning has established itself due to digitization. Today, it is common in many areas to educate oneself further via web-based or mobile training and Massive Open Online Courses (MOOCs). Information in various media forms are available digitally all the time in virtual learning spaces, allowing for a significantly more flexible and efficient design of individual learning processes. Furthermore, it is possible to integrate direct feedback for the learning progress and hence increase motivation further. Another way to facilitate use its individualized distribution of relevant information to employees.

Apart from the use as an entertainment medium, there also exist numerous potentials for data-based learning, in which information is displayed in the field of vision of the user, merging theory and practice even further. For example, while looking at a workpiece, error causes or assembly steps can be shown in the realistic work environment, which can dramatically shorten the initial training process. Similarly, the utilization of data glasses in employee training can reduce the downtime from e.g. ramp-up and training processes as well as lower the error rate during manufacturing.

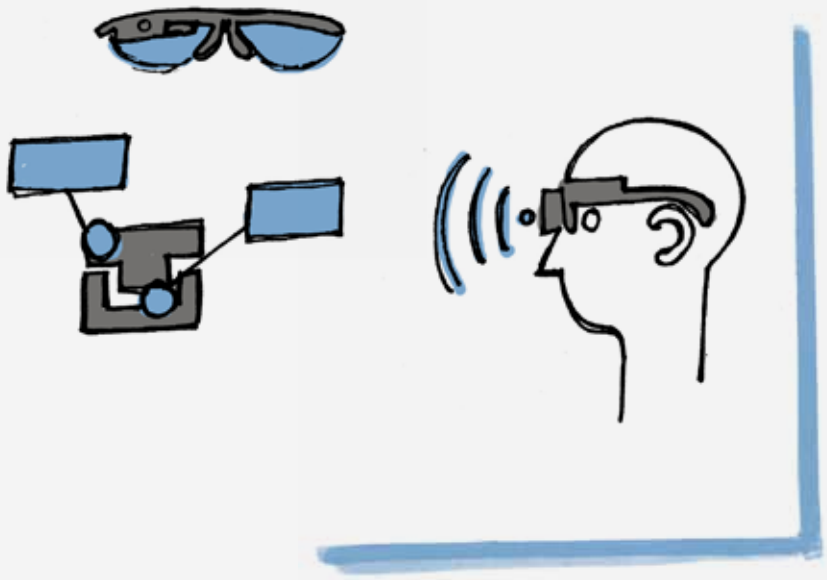
Requirements

The possibilities of digitally networked learning can already be used intensively in tool shops. An important requirement is the centralized provision of the introduced digital learning and information material by the tool shop. These learning materials and applications can be made available within the tool shop networks on specially created websites or databases. As well, individual information distribution can easily be arranged by matching keywords for materials and fields of activity with employees. Usually employees already have the necessary mobile devices, meaning that there is no additional overhead for the tool shop at this point.

By contrast, technology for Augmented Reality currently has several weak spots as it is not completely matured yet and is relatively cost-intensive. Additionally, the models for each tool have to be created by hand, which is not feasible with respect to the single and small batch manufacturing character of the industry and the resulting time required. Thus, Augmented Reality has hitherto been implemented in batch

production manufacturing, where e.g. the assembly positions of individual components are visualized. However, first prototypes for training purposes are currently being developed, which only require the designs of a few tool models. With the progress that can be expected as the technology matures in the near future, Augmented Reality will increasingly be focused on by tool shops.

Virtual assembly assistance



Application area *Assembly*

Outlook

Considering the increasing cost pressure in international competition as well as the simultaneous rise in quality requirements and shortened lifecycles, it is essential for the German tool and die industry to raise its performance level so that it can continue to offer high-quality and innovative tools on the market. Modern information and communication technologies create new opportunities for successfully realizing potentials. In order to implement information and communication technologies (ICT) as well as digital networking, transparency can be increased, capacity utilization improved and errors avoided. In this manner, the rising complexity can be mastered as well as efficiency sustainably increased. As the central location for value creation, the shop floor in particular has demonstrated itself as suitable for the application areas of order processing, personnel management as well as knowledge and learning.

With respect to digital networking, the overarching goal for tool shops should be to create the highest possible transparency along the entire value-creation. Weaknesses and optimization potentials can be identified through the digital recording and analysis of available data. Assembly control systems and prioritization assistance allow for a more efficient exploitation of all resources in manufacturing. In this situation, the question of interface and data security has special relevance, which can be met by making use of the competences of software providers. Furthermore, the individual employee can be addressed particularly well through digital networking. In times of demographic change and skills shortage, it will be ever more important in the future to bind employees with attractive work conditions and purposefully utilize the present knowledge. Modern ICT such as tablet computers, apps and virtual reality hardware can be used to make information available to employees as well as make workplaces more flexible. Further, databases allow for the centralized collection of existing knowledge and thus goal-oriented individual learning. In particular, it should be noted that there are different solutions for all application areas with varying amounts of initial investment required. This means that it is worthwhile for every tool shop to engage themselves with the topic of digital networking, no matter their starting position.

In order to sustainably secure competitiveness, tool shops should implement the following four recommendations for action that were identified in this study.

Main recommendations for action:

- Creating an awareness of the importance of digital networking
- Digitizing and merging all of the information and data of a tool shop through the use of modern ICT
- Creating end-to-end transparency along the entire value-creation chain through the analysis of data as well as revealing correlations
- Using the revealed relations via the introduced digitization solutions

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Our Studies – Strategic Development

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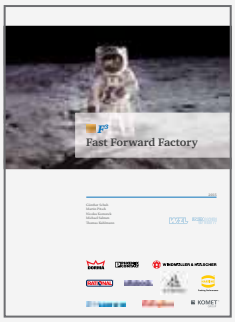

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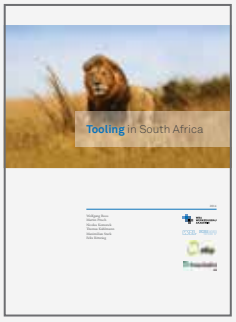

Tooling in South Africa
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