Digitization in the Sheet Metal Working Industry

Digitization, networking, virtualization are concepts that we encounter more and more frequently, also in the business world. What do they mean in concrete terms? And what implications do they bring to the shop floor? Digitization plays a crucial role from the process level up to the factory network, as we can see in small and large companies in sheet metal working. As with many ideas around Industry 4.0, the goal is higher machine utilization, higher product quality, or quite simply a productivity boost.

In the production of the future, the traditional world of production processes will be connected and optimized via intelligent software. To accomplish this, companies will record data from processes, machines and products, from order acceptance to production all the way to delivery. This transfer of data from the real world into the virtual world is what we call digitization.

According to Gartner digitization is “the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business.”

As a part of digitization, virtualization describes how the individual processes are mapped in a computer in detail. Thanks to sophisticated software, data and measured values from processes and products can be compiled and complete processes simulated. Physics, engineering and business management are combined to achieve different goals: Even before actual production, variants of the processes and products can be tested and optimized. Later, in the virtual world, processes are tracked and evaluated on a large scale in order, on the one hand, to have up-to-date data on production and, on the other, to calculate trends for the future as precisely as possible.

An important model in this context is the digital twin. This concept describes the virtual image of a real product (or process, machine, service). The digital twin of a component is assigned the respective measurement data of the real component during all production steps. This results in a data set (coupled with a digital name tag of the component) that enables detailed traceability.

When process data and product data are combined, the processes can then be monitored and optimized. In the event process values deviate from defined target values, it is possible to react immediately and to change individual process parameters accordingly. These process parameters may have been previously defined; coupled sets of product and process parameters are then stored.

Horizontal networking refers to the mapping of a complete production line with all its processes and data. In contrast, vertical networking refers to networking from the individual process to the machine, to the production cell, to the production hall and finally to the factory network. To give just one example: If a process has to be corrected due to changed material parameters, in vertical networking
the corresponding data set can be exchanged on all machines that carry out the same process on the same material batch in the factory network.

**Digital transformation** is the process of change that occurs when digital technologies are introduced. In the process, completely new business models can develop, such as purely digital business models and digital value creation networks.

**Digitization on All Levels**

Digitization in the industry is closely linked to the concept of Industry 4.0 because this concept is about the “comprehensive digitization of industrial production.” It is used to detect deviations in production more quickly and to find solutions to them. In addition, digitization supports the industry in optimizing its manufacturing processes through virtualization and further standardization.

To take full advantage of digitization, it is recommended to introduce it on all levels of manufacturing: It starts with order processing and continues through the actual manufacturing where all process data is collected and each process can be tracked, for each part. The aim is to optimize productivity as well as the traceability of each individual production step for each part. The optimization can also be automated, so that processes regulate themselves.

But digitization also has clear advantages beyond the boundaries of the factory. As mentioned in vertical networking, factory networks can derive new benefits from standardization and their economies of scale. In addition, plant manufacturers can monitor the operating data of their machines at the customer's site (“condition monitoring”) and help remotely if maintenance is needed, or predict expected maintenance for the customer by means of parameter trends (“predictive maintenance”).

A good example of the possibilities of digitization in industry can currently be observed in the field of 3D printing. There, product development and production are often completely separated, with the pure production sold as a service. Dassault Systèmes offers a software environment in which not only simulation and virtual testing of the products are possible; evaluated suppliers can also be contracted for production on their 3DExperience platform. The individual steps are modularized, but continuous digitization on a uniform platform nevertheless enables efficient and profitable economic activity.

**Full Control in the Welding Process**

At the International Laser Technology Congress AKL’18, Michael Ungers from Scansonic MI GmbH explained how digitization works at process level. “From teaching to seam inspection, we can document every weld on every component on video and with a complete dataset.”
Scanson builds laser processing systems for laser soldering and welding. With their SCEye camera system, they offer an integrated solution for process control, both for soldering processes with tactile wire guidance and for remote welding. For each component the software records both process parameters (laser power, wire feed, etc.) as well as the movement of the swivel axis (swivel axis position) or the pressing force of the wire. In addition, the joining zone is recorded on video.

The camera images taken before and after the actual process are edited in real time. For example, such images can be used to identify obstacles before the process begins or dropouts during joining. After the process ends, the camera also monitors the cooled seam and can clearly identify seam defects (for example, pores).

There is a lot of know-how packed into the software. For this, Scanson analyzes large amounts of test data sets. With the help of machine-learning approaches, it then generates and optimizes the algorithms for the respective application. The user receives the algorithms as a software update and only needs to make the fine tuning by setting a reference track. As a result, material influences and product properties can be taken into account. The long-term goal here is further optimization in order to eventually generate a self-learning machine.

When testing the camera system, Scanson checked about 20,000 welds with a total of 69 defects (defects > 2mm). All errors were found reliably. The pseudo error rate of “false negative” was 1.1%. These are displayed errors, which are still acceptable.

The monitoring of process and machine parameters is also interesting: The user sets warning and limit values for the manufacturing tolerances before processing. The control software then shows in real time whether the parts produced are within the tolerances (green), are in the warning range (yellow) or are unacceptable (red). Not only can the reject rate be precisely controlled, but the system can also identify process problems in real time. This way, greater damage to the processing machine can be prevented.
Image 1: Scansonic's SCeye® process monitoring system displays a live image of the process zone (top left), the seam guide (top center), the result of the seams (top right) as well as the recorded process parameters (bottom). (Image: Scansonic MI GmbH)

Sheet Metal Working of the Future

Trumpf in Ditzingen has been working on new concepts for sheet metal working for quite some time. At the plant, visitors can view the “Sheet metal production unit” in a manufacturing hall. One walks along the five stations – from receipt of order all the way to the delivery of the parts – and can find out more about the status of work on large screens. During a tour at the last INTECH in-house exhibition, one could see that they present real data: In the morning at 3am, a sheet metal part had obviously got stuck in the warehouse, so the machine had been stopped.
And that’s what digitization is all about in production: optimizing capacity utilization, detecting and eliminating disruptions in a timely manner. Even when planning the production unit, the company identified bottlenecks and optimized processes using simulation. “Our vision is the autonomous factory,” says Dr. Heinz-Jürgen Prokop, CEO of Machine Tools at Trumpf. “Our goal is the step-by-step automation of both order processing, which will be paperless and without media disruptions in the future, as well as the value chain, about which we require full transparency at all times.”

In production, Trumpf relies on continuous horizontal networking. For customers, some of whom are significantly larger than Trumpf, the Ditzinger-based company also provides extensive possibilities for vertical networking. Data acquisition starts at the very bottom of the process. At the higher levels, the data is increasingly aggregated. The aim is to optimize the process, even beyond the limits of the site. The customer decides which data is passed on to whom.

In most cases, process data remains in the respective company, while operating data of the individual machines can also go to the manufacturers, such as Trumpf. There, the data from as many machines as possible are compiled and evaluated. Changes in individual systems, but also in complete model series are being pursued as “condition-based services.” In the short term, companies can react to critical
conditions, to some extent even before they occur. In the long term, the experience can be used for the benefit of all users.

**Strategic Thinking at BMW Pays Off**

BMW AG in Regensburg has gained a great deal of experience with digital transformation in its lead plant in the sector of metal forming. Dr. Josef Meinhardt, from the Research and Innovation Center FIZ in Munich, has been accompanying the development as head of standards and innovations in the sector of sheet metal forming and mounted parts.

He sees digitization as an important aspect of the “on-site” strategy, which ensures the standardization of all pressing plant in terms of structure, technology and organization throughout the BMW Group’s entire sheet forming sector. Large parts, the “major parts,” are pressed on site using the same technology. The seven pressing plants of BMW have identical production technology with two servo lines each. They work everywhere with the same servo presses, which are very easy to adjust and control.

“All spotting and tryout presses are identical to the drawing stage of the servo lines and they have the same press stiffness,” says the expert. “In this way, we were able to set up a global pressing plant network to avoid overproduction thanks to on-site production.” BMW not only avoids overproduction, but also reduces space requirements, set-up times and transport costs. Vertical networking thus helps it use the economies of scale locally and globally.
Laser-marked body parts: Fine control of the presses, traceable body parts at any time

Steel rolls weighing up to 40 tons and around three kilometers long – so-called coils – are cut into blanks in the pressing shop and then formed into body parts. Plate thickness, firmness or the degree of oiling are not the same at every point of the coil, characteristics that can lead to cracks during forming in the case of particularly stressed body parts. This is where a Smart Data Analytics application in the BMW Group in Regensburg works. It marks each blank by laser with its own ID code.

In the future, this ID will allow the press to be fine-tuned to the blank's characteristics: If required, the ID could include a control command that triggers additional lubrication of the blank prior to forming in the press, for example.

Thanks to clear marking, the blank can be identified at any time. Each body part is thus assigned information that remains available through the following manufacturing steps to the finished car body.
The planning specialists of the BMW Group are already using the traceability of all parts in order to optimize the process using additional algorithms.

Thus, by taking into account the measured properties of each body part, the company can optimize the gap dimensions of the finished body even further, or match the paint application better to the surface of the individual body. Already today, the fine adjustment of the press parameters has a clear effect on the properties of the blank: The number of rejects has dropped significantly; the degree of material utilization of a coil has continued to rise. This way, system downtime required for defect analyzes can be reduced.

Christian Patron, Head of Innovations and Digitalization in the Production System at BMW says, “With Smart Data Analytics, we are setting new standards in our production system. We combine the experience of our employees with the new possibilities of efficiently processing large volumes of data in order to derive precise forecasts and to proactively optimize processes. This accelerates the continuous improvement of the production system according to the basic principles of lean production.”

Author:
Dr. Andreas Thoss, THOSS Media GmbH

Image captions:

Image 1: SCeye_Prozessbild.png
Scansonics' SCeye® process monitoring system displays a live image of the process zone (top left), the seam guide (top center), the result of the seams (top right) as well as the recorded process parameters (bottom). (Image: Scansonics MI GmbH)

Image 2: Trumpf.jpg
Trumpf shows how industry 4.0 works in its Sheet metal production unit (Image: TRUMPF/Frederik Dulay-Winkler)

Image 3: Pressenstraße BMW Group Werk Regensburg.JPG
The Pressing plant assembly line at BMW in Regensburg will be copied for all other product plants in the BMW group (Copyright: BMW).