Shaping the future: Dorst Technologies on digitisation, data and the PM 'smart factory'

Whilst some areas of the Powder Metallurgy industry, particularly those involved in the automotive and hardmetals sectors, have leveraged the production data for many years, others have yet to embrace the opportunities presented by the vast quantities of data that their production processes are able to generate. In this article, Christian Müller, from Dorst Technologies GmbH & Co. KG, considers the opportunities that exist for the digitisation of the Powder Metallurgy process and a move towards PM 'smart factories.'

Dorst Technologies, based in Kochel am See, Germany, is a leading international supplier of machinery and complete production systems for the Powder Metallurgy industry, specialising in material processing, forming via compaction, and process automation. Although the wider industries, markets and regions served by Dorst have embraced digitisation to varying degrees, a general trend towards increasing digitisation and interconnectivity, all the way to 'smart' autonomous production, can be seen clearly across all sectors. With this in mind, this article focuses on solutions that can be integrated into the overall system landscape, effectively targeting the specific needs of individual customers while providing measurable added value on the road to the PM 'smart factory.'

The status quo and challenges in production environments

In the industries where Dorst Technologies' machines and systems are used, the degree of digital maturity, the amount of data available and its quality, as well as the extent of interconnectivity, vary significantly. In the automotive sector and the hardmetals industry, for instance, machine and production data have been gathered and analysed for many years and Production Planning Systems (PPS) or Manufacturing Execution Systems (MES) have been in use for decades in the processing of orders. Digital recording and managing of tools and raw materials are commonplace, as is quality

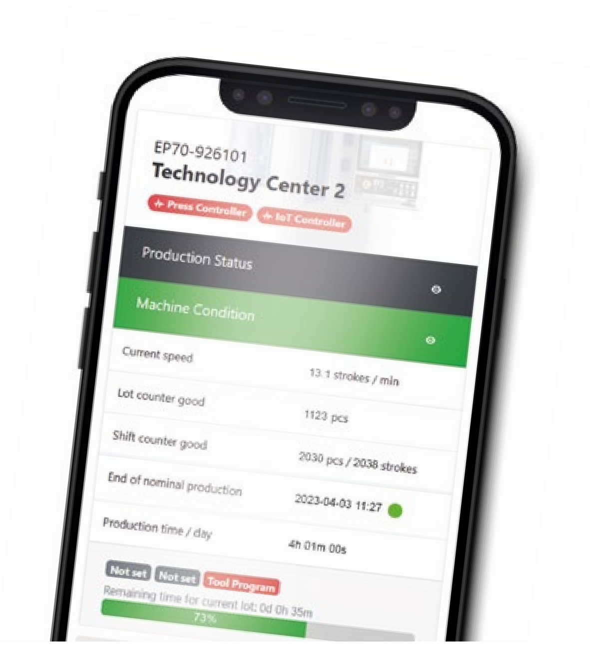

Fig. 1 Real-time powder press production data from the Dorst IoT app

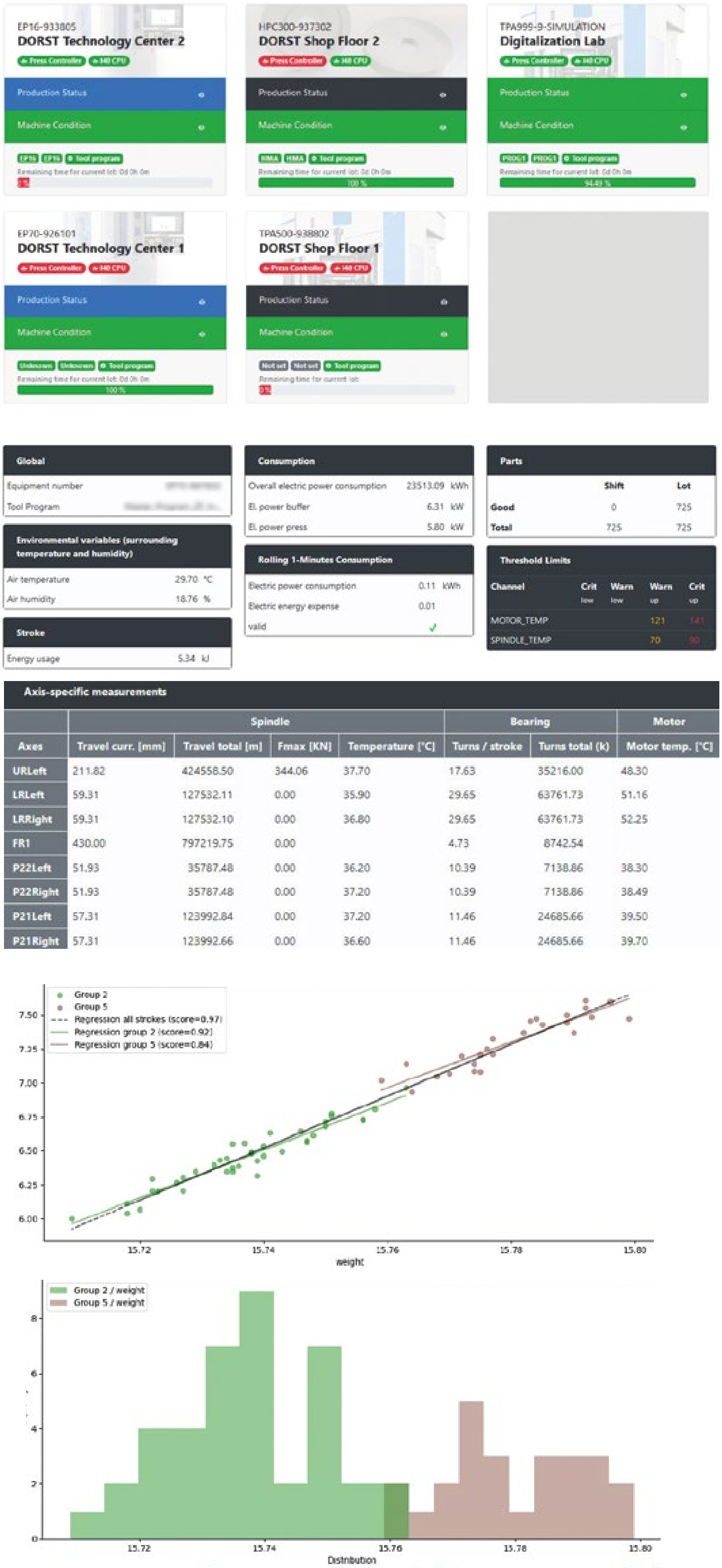

Fig. 2 Screen shot examples of typical data presented by the process data dashboard of the Dorst IoT Field Manager

assurance based on computer-assisted measuring and testing equipment. For these industries, the main gap that remains to be closed relates to production machines and the specific processes that take place on these machines.

Other sectors of Powder Metallurgy, however, have neglected the capture and use of data, partly because they could see no direct added value in using such data. Nevertheless, digitisation has found its way into almost every company, even though the configuration of a higher-level system landscape often requires several iteration stages to integrate the entire production environment effectively.

Data generation and processing

The data relevant within the context of production using a PM compaction press can be divided into three different categories: machine data, production data, and order-specific data. The corresponding measuring values and parameters of machine data should be as significant as possible and be captured in a reliable way by appropriate sensors. Order-specific data, in particular, must be assigned clearly to an individual pressed part in the first processing step, even if the time stamp for the respective measured values differs.

In the case of Dorst, both the assignment of values to measure, and the analysis and presentation of data, is achieved by the IoT Field Manager platform. An independent CPU is used for processing the data in order to guarantee the performance of production cells. This IoT Field Manager platform is the basis for all further digitisation concepts for Dorst Technologies' machines and systems. Only by providing qualified information – along with information that has already been prepared – for each step and at any time, can we provide a fully-digitised process chain with its corresponding added value for the customer.

Production data

The acquisition of production data is a largely self-explanatory and almost standard component of machine visualisations and conventional production control systems. Typical variables are the number of strokes, pieces produced, good and rejected parts, machine operating and downtimes and the remaining production time. Production data are related to order data and other operating equipment data, such as tool IDs or powder batches (Fig. 1).

If appropriate measuring sensors are available, data on the energy and material consumption of the equipment will be available. These can be related to order and production data and thus enable statements to be made, for example, about the manufacturing costs per pressed part.

The recording of environmental conditions in the production field can reveal additional interesting correlations, such as the tendency of powder materials to stick to the tool and the number of cycles required to clean the machine, depending on the temperature and humidity at the time. Objective, personnel-independent decisions are possible only if data are collected and prepared in a target-oriented way and the information thus obtained and verified is presented in a straightforward manner.

In many cases where absolute measured values are not available, quality statements are based on whether a pressing process is stable during a task or not. Once a process or operating condition is found to achieve the desired quality, the aim is to keep this condition as steady and reproducible as possible, so that the scatter range is influenced by only a few disturbance variables such as powder parameters. In individual cases, long-term observations can be used to predict the influence of individual interfering variables on the quality of the pressed parts.

It is invaluable to measure and evaluate the quality characteristics of actual pressed parts, as the information gained for process development and quality control purposes is crucial. However, evaluating the quality of a process, down to each pressed part itself, on the basis of status parameters and their stability, is an important 'indirect' procedure (Fig. 2).

Fig. 3 Machine status and condition monitoring of Dorst equipment worldwide

Machine status detection and service

Machine data provide a direct overview of the equipment itself and can be used for various purposes when combined with new digitised processes. From the first moment of commissioning, each piece of equipment is subject to alteration due to daily stress. The wear and tear of equipment can develop slowly and unnoticed, but it can become immediately apparent in the case of exceptional events, such as an evident overload. Slow wear, in particular, is an often-underestimated cause of quality problems in production. The purpose of regular maintenance and recurring servicing is to determine the wear rate, slow it down and prevent the uncontrolled failure of equipment as far as possible. The general aim is to maintain the best possible machine condition over the entire life cycle of the equipment, so that it can be relied upon to be available at all times for production (Fig. 3).

The continuous recording of machine data, especially the calculation of a wear index, represent a major challenge. For example, it is often not technically feasible to use appropriate transducers for direct wear detection. Such approaches sometimes fail due to the size of the

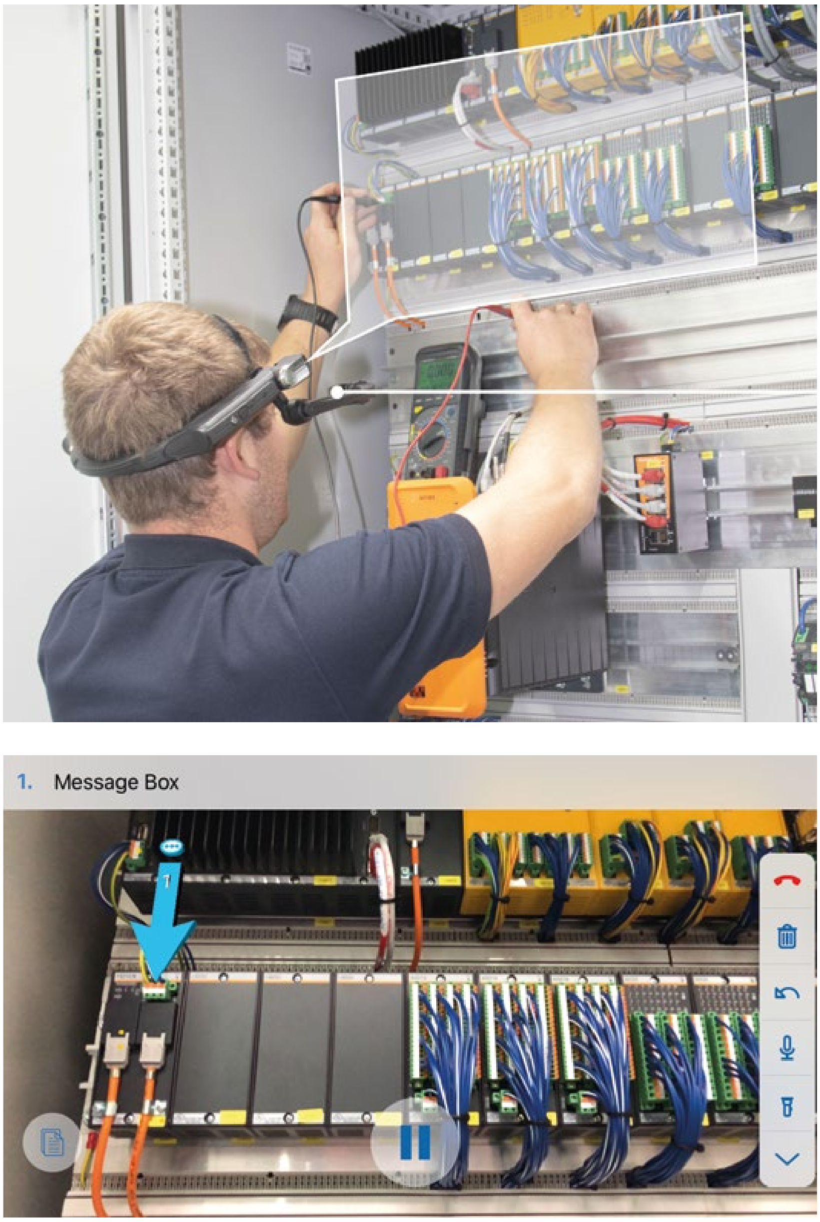

Fig. 4 Dorst remote service support using augmented reality glasses

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transducers, installation options at the site of the occurrence, the measured value resolution or simply the costs involved. Moreover, not every potential wear or failure of a mechanical machine element or electronic component can be prevented and monitored by measurement technology.

Therefore, it is not enough merely to measure the direct wear of an assembly or machine element or, more generally, the alteration of the machine over its service life. In practice, the most effective procedure is to observe the pressing cycle continuously, based on individual produced parts and their associated path curves and secondary data. However, a deep understanding of process control, control behaviour and machine properties is required to understand how a part can affect the machine condition.

A machine's condition and its potential availability is, as a result, no longer assessed solely on the basis of specific measured values but on data-based observations of the long-term behaviour of the pressing process. An operator who lacks the dedicated detailed knowledge of the press, its installed components, and the control system will generally not be able to make this extended condition assessment on their own. Hence, the manufacturer of the press, thanks to its specialised knowledge, can provide customer-specific consulting services as well as active support by accessing the data of the machine, its collected load profiles and current snapshots.

Such digitised service models can support the operator, in that the machine is under regular online supervision by the manufacturer, with the operator benefitting directly from the accumulated specialist knowledge of the press manufacturer.

Service

The global travel restrictions caused by the COVID-19 pandemic provided an unexpected push for the development and general acceptance of digital services. Digital services

Fig. 5 Dorst remote service support using smart devices

make it possible today to act more quickly, more directly and with a high degree of sustainability. Dorst Augmented Reality Assistance is a remote service solution, developed to establish a safe VPN video connection between the mobile devices of our customers and the service centres of Dorst Technologies. So, when our customers need assistance or support, they can consult a Dorst expert from anywhere in the world. The live image of the system condition can be enhanced by additional information and content, with the visual reality seen through a virtual reality headset (Fig. 4).

"Augmented reality assistance has enabled us to raise customer support to an entirely new level. It has improved the quality of our service by accelerating the reaction time while increasing our focus on the problem at hand."

Digital tools have helped us, for instance, to hold a training session on a real machine in the Technology Center in Kochel am See and, at the same time, let the customer and our own employees overseas participate in a direct way, thus allowing us to combine conventional remote maintenance with audio-visual transmission and direct contact (Fig. 5).

It is also possible to supervise, document and assist in the commissioning of tools or the running-in of new components, with the additional advantage of being able to access documents, drawings and manuals stored in digital form directly and at any time. Augmented reality assistance has enabled us to raise customer support to an entirely new level. It has improved the quality of our service by accelerating the reaction time while increasing our focus on the problem at hand. We have seen that the technology transfer between us and our customers has improved in terms of practicability and everyday suitability.

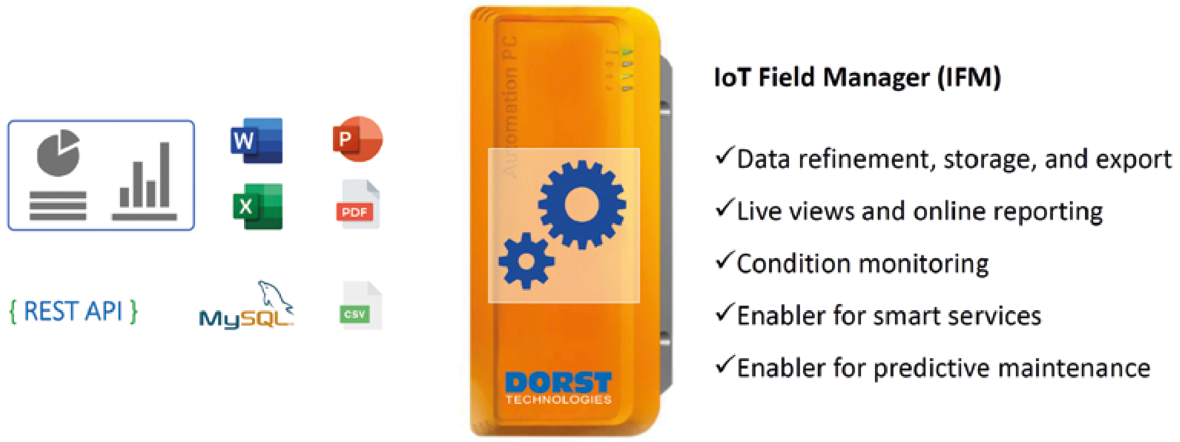

Fig. 6 Dorst IoT Field Manager – hardware and features

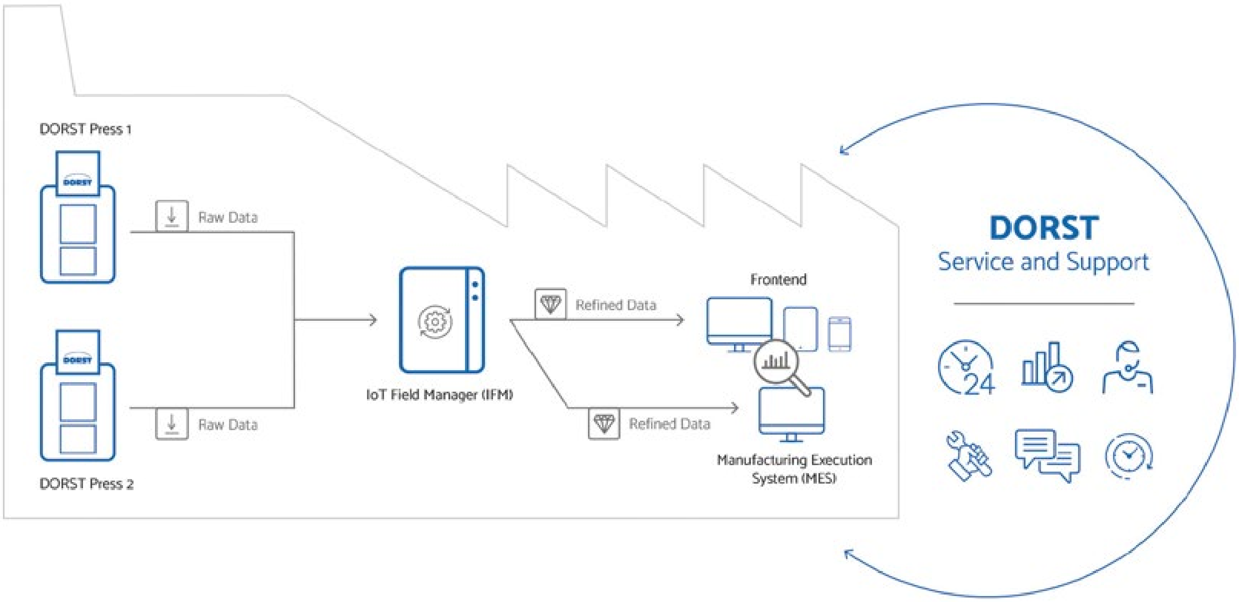

Fig. 7 Dorst IoT architecture

The Dorst IoT solution

IoT Field Manager is a secure stand-alone platform consisting of hardware components and several software packages that can be extended on a modular basis into a comprehensive overall system, according to the customer's wishes and needs (Fig. 6).

It is possible to connect several machines and plants digitally via one IoT Field Manager and monitor them centrally by means of the intuitive visualisation interface. Standardised interfaces make it possible to export data to higher-level systems and databases.

The basic package already includes a regular individual service for security updates and bug fixes. Therefore, data security and data ownership will always be guaranteed when using the IoT Field Manager (Fig. 7).

IoT Basic Package

The IoT basic package, which comes with IoT Field Manager, already offers a wide range of functions and analysis options for the current production. A browser-based dashboard provides an overall look at all connected machines, even from a remote location and at any time.

IoT Package I: Part Quality

With its focus on the individual pressed part and the corresponding pressing cycle, this package records all relevant data, including program changes, powder parameters and the corresponding curve chart. Intelligent analysis tools allow the user to select unusual cycles and retrace every part (Fig. 8).

IoT Package II: Advanced Production

Monthly production reports keep a record of production outputs, scrap rates, failures and machine utilisation. In addition, it is possible to monitor all connected machines by means of smart devices, from any place and at any time.

IoT Package III: Advanced Maintenance

IoT Package III further improves communication between operator and manufacturer. This joint view of a machine from two different angles opens up a new perception of its condition, possible signs of wear and necessary maintenance measures (Fig. 9). The operator can draw on the manufacturer's expert knowledge so that a planned action, based on collected data, can substitute an unplanned reaction through predictive maintenance and service.

Many of Dorst Technologies' machines and systems have already been equipped with sufficient sensors for digital data mining. Still, additional sensor packages are available through IoT Field Manager for an even more detailed insight into the process and condition of individual machine types. To prevent data acquisition from straining the control system of a connected machine, independent data servers will be installed.

Fig. 8 Part analysis based on part-specific data

Fig. 9 Dorst machine condition monitoring

What is the smart factory?

The smart factory is a largely autonomous production environment, where manufacturing processes and production facilities function without human intervention to produce the desired products (Fig. 10). These highly integrated, interconnected systems are intended to achieve the profitable manufacturing of individual customer products in small lots down to a lot size of one.

This ultimate goal will not be achievable for all industries, prod-

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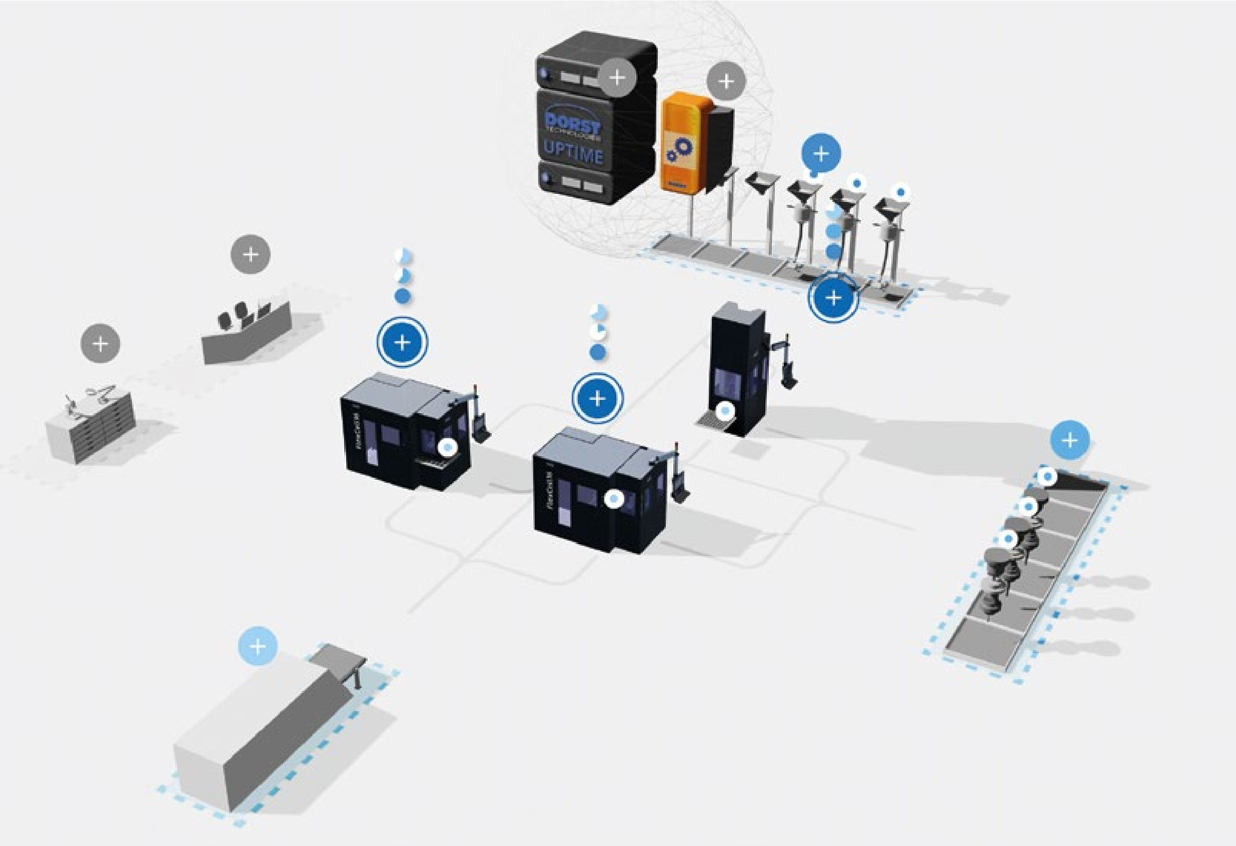

Fig. 10 Dorst's solution towards the Smart Factory. To explore a fully-interactive visualisation visit www.dorst-technologies.com/en/sf

ucts, production environments or applications. Yet, if smart solutions are adapted according to individual case requirements, the technology can provide considerable additional value for almost all sectors. The most essential feature will, therefore, consist of modular solutions that can be implemented gradually to achieve quick, measurable results.

Future demands on manufacturing processes and added value

Ultimately, all efforts and solutions will gain traction only if they can generate clear added value for the customer. This is usually the case if the solutions help to reduce the costs per component while maintaining a sufficient level of quality, if they contribute to improving the quality of the delivered goods while keeping a reasonable cost structure, or if they enable suppliers to increase their delivery reliability. These basic principles are the key requirements for the competitive manufacturing structure of the future:

- High output rates, brought about by high plant availability and performance
- Stable processes, brought about by stable process parameters and high control accuracy
- High flexibility, brought about by short setup times and easy use

Dorst's Uptime solution

The 'Uptime' concept increases the availability of production cells, which results in higher quantities of 'good' parts produced per time unit and makes it possible to standardise and largely automate the corresponding processes and operational steps. The

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focus is on quick and standardised product changes, which are of great importance especially when it comes to small lot sizes and resulting frequent setup procedures.

The Uptime_Data Interface transfers all relevant process data to the compaction press, including the part, tool and powder, as well as the production planning and process (Fig. 11).

It is essential that all press interface surfaces are referenced to enable a standardised, quick and smart product change and production start. There are major benefits to this concept:

- Standardised setup procedure
- Avoidance of failures
- Reduce setup time
- Increased productivity
- Ease of operation

Fig. 11 Relevant process data transferred by the Dorst Uptime_Data interface

Summary and perspective

A high degree of digitisation and, based on that, autonomous production can be achieved if it brings about measurable added value: namely a higher output rate; a more stable process; and more flexible manufacturing.

As well as the Uptime_Data Interface module, which is already being used, solutions for fully automatic and autonomous powder change, tool change and part optimisation will be necessary steps on the road to the smart factory. These are solutions Dorst Technologies is already working on intensely, in terms of development and stable process implementation.

Contact

Christian Müller
Director Customer Relations
Dorst Technologies
christian.mueller@dorst.de

www.dorst-technologies.com