

An individualized QR code on the components manufactured at the K 2016 trade show guided the owners of smartphones to the respective report of “their” article.

Photo: Krauss Maffei

# Microscope for processes and hardware

Data Xplorer by Krauss Maffei continuously records up to 500 signals during injection molding

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**Y**ou cannot control something you cannot measure.” This insight of American economist Peter Drucker applies equally to technical and economic processes. Only somebody who knows the exact actual status is able work on its optimization. Data Xplorer, the data acquisition and analysis system by Krauss Maffei, now provides a previously unseen look into the depth of processes and hardware during injection molding. Up to 500 signals can be recorded as con-

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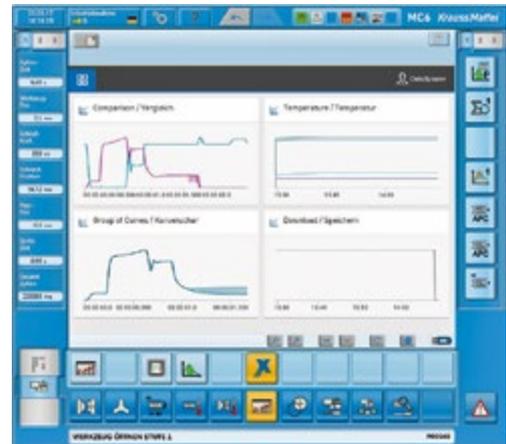
**MELT PRESSURE CURVES** in the group of curves can illustrate deviations inherent in the production process and reveal problem sizes for NOK parts.

tinuous curve progressions at a resolution of 5 ms. Even an individual value such as the melt pressure already tells a lot.

Data Xplorer is the product of a cooperative effort: For the first time, Krauss Maffei and Iba, a specialist for measuring and automation technology, are making state-of-the-art processes of data acquisition and analysis usable for plastics processing. As in the flight recorder of an airplane, all essential data of systems and processes from different signal

## Reliably networked – Plastics 4.0 solutions by Krauss Maffei

**DIGITALIZATION** The Data Xplorer is part of the Plastics 4.0 solutions by which Krauss Maffei supports its customers in the implementation of the potential and opportunities in the course of Industry 4.0, the fourth industrial revolution. Front and center of Plastics 4.0 is the digitalization and networking of the global production processes with the goal of higher production efficiency, flexibility, automation, availability and quality. The range of Plastics 4.0 products by Krauss Maffei extends from intelligent machines and functions optimizing themselves through the uninterrupted analysis and networking of various components of the production process through a global range of services.



The data is accessible on the MC6 control system for at least seven days and can be transferred to a USB stick.

Photo: Krauss Maffei

sources within the injection molding machine can be recorded. Unlike Euromap 63 and the actual value report of a machine, this happens continuously—that is, in the curve progression, and not as a discrete value in a discrete moment.

These curves provide customized key figures used for extensive process analyses and continuous monitoring of the generated key figures. Data Xplorer receives the data of the MC6 machine control system; default parameters such as the injection pressure and screw position are available, as well as varied signals from auxiliary devices, such as the mold cavity pressure. Altogether, up to 500 signals can be recorded at the extremely high resolution of 5 ms. For each cycle, one file is created, which remains accessible at the machine for at least seven days. Furthermore, data transfer works by USB stick or the Ethernet interface. For interaction or further processing, the data can be converted into an open format.

### Part quality and traceability are ensured

When using Data Xplorer, there are essentially three decisive motivations the user can have. The first is to answer questions regarding the component quality. Then, continuous documentation of manufacturing processes—above all, for safety-related components—must be continuous to allow for tracing. Or finally, continuous monitoring of machines and systems is desired in order to be able to maintain

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### MILLISECONDS

resolution – up to 500 signals can be recorded in this brief period. One file is created per cycle.

them (efficiently) based on factors such as their state and condition—or to have detailed data available for their diagnostics.

In laboratory and experimental systems, which are mostly used for generating new processing knowledge, the use of a comprehensive analytical tool is particularly attractive. Likewise, in technically complex applications, such as foamed parts or articles with in-mold labeling decoration, in which rejects are particularly undesirable due to the high prices of these components, plastics processors have a lot to gain from scrutinizing the processes and optimizing them by means of an analysis. But even companies with projects of lower complexity, whose systems are spread over various production locations, can benefit from the advantages of the Data Xplorer, gather knowledge in the technical central station and make use of them throughout all their locations.

For the varying demands of its customers, Krauss Maffei therefore offers two modular packages in addition to the Data Xplorer in collaboration with Iba. The Data Xplorer itself, a small computer integrated into the control cabinet of the machine, encompasses the freely licensed basic functions of the Iba Analyzer. Thus, detailed visualizations and data comparisons are possible. The user can manually generate characteristic values and reports. Package 1, the analysis and development package, includes additional licenses for database extraction and batch processing. Key figures and reports ►

can thus be automatically created and stored for multiple cycles.

Package 2, the production monitoring package, extends this function to multiple machines and locations and includes a Web interface for visualization. Heads of production thus can access an overview of all processes and systems. In this, extreme data depth represents the biggest difference from a manufacturing execution system (MES), which remains rather superficial. But MES can use the data from package 2 to be able to evaluate processes even better themselves. While the Data Xplorer hardware must be integrated into every machine, user-specific or computer-specific licensing is sufficient for packages 1 or 2.

## Continuous documentation of melt and pump pressure

The example of the melt pressure, which plays an important role for the later part quality, demonstrates the wide variety of ways the data thus recorded can be used. The formation of a melt pressure group of curves, that is, the simultaneous display of the melt pressure curves of, say, 100 cycles, visualizes the minimal deviations inherent in the production process. If the individual curves are assigned to OK or NOK parts, key figures for the melt pressure in discrete points can be created, calculated (extracted) and monitored. Conversely, the Iba Analyzer can import quality data available in the .csv, .txt or .tsv formats and visualize it together with the measuring data.

The level of the melt pressure at defined times in the cycle offers further insight into the process. The melt pressure builds up if the return-flow lock is closed, and it increases during injection until it reaches its maximum value at the changeover point from the injection phase to the holding pressure. If the curves for the melt pressure and the screw position are displayed simultaneously, this correlation becomes obvious immediately. In turn, the level of the melt pressure at the changeover point often permits conclusions about the resulting component weight. If injection employs cascade closures, the melt pressure decreases incrementally within the injection phase. If this not the case as it should be, the obvious conclusion is that the cascade closure does not work properly, for example because a closure does not open. By visualizing the melt pressure values after the respective opening, the correct function can be monitored.

Simply on the basis of the melt pressure alone, much knowledge can be obtained this way. And this is just one value out of many that can be analyzed and set in a relation to others. The pump pressure during plasticizing, for instance, allows for conclu-

**“Continuous documentation can assign all production processes to each individual component, even after many years.”**

**Dr. Stefan Kruppa,**  
Head of Machine Technology, Injection Molding Machinery, Krauss Maffei



Depending on the equipment of the machine, Data Xplorer records up to 500 high-resolution signal curves, visualizes them and prepares them for evaluation.

sions regarding the viscosity of the material. How much torque is required? This question is answered as well. Besides that, conclusions regarding the mold state can also be determined. Which pressure and, consequently, which friction by the ejector pin is required? Is it possible to predetermine tool maintenance in this way? Full data transparency makes it possible for users to define individualized wear key figures for their molds and processes. In combination with user expertise, valuable information (smart data) for further production can be derived from the quantities of raw data. Krauss Maffei and Iba offer training courses for correct use to ensure that users new to Data Xplorer can peer into the depths of processes, molds and systems in the best possible way.

## Automated evaluation and reports

Here, creation of one's own templates and reports is also important. While it has been necessary so far, for example in validations, to record many individual values manually, such as the temperatures of various barrel zones, the Data Xplorer can take care of this automatically provided that it has a corresponding template. Or, heads of production starting their shift in the morning can find an automatically completed evaluation of the previous night shift at their desk. These reports are stored as PDFs so that forwarding to co-workers is possible.

A follow-up scenario could be: what is the cause for the increased rejects during night shift? A com-



Photo: Iba

parison of the pressure curves indicates differences in amplitude (no offset). The consideration of further curves likewise yields deviations in the mold wall temperature but not in the other curves and temperatures. The track finally leads to the cooling water, which has a different temperature at night.

Production can be recorded with great thoroughness in this way. Krauss Maffei demonstrated this at last year's K trade show at the example of the FiberForm technology, in which composite sheets—fiber rovings embedded in a plastic matrix—are heated and covered with plastics. An individualized QR code on the components manufactured on site guided the owners of smartphones to the respective report of “their” article. Here it was possible to learn not only about the melt pressure and screw position but also, for example, the heat-up time of the composite sheet and its transfer time from the heating station to the injection mold

### Conclusion

Data Xplorer displays the entire production with processes and machines in the same detail and clarity as a microscope would. While in the latter, the

“Increased number of rejects at night? Perhaps the temperature of the cooling water is different at night.”

**Dr. Stefan Kruppa**

various sections through the specimen yield complementary perspectives, the same is achieved with the Data Xplorer thanks to the wide variety of data and the comprehensive combination options. There are hardly any questions that cannot be investigated by it—which is very helpful for fault patterns with an unclear cause. Uninterrupted documentation is also very interesting for safety-related components because all production processes can still be assigned to any individual component after years if they are marked correspondingly. Mold servicing can be designed in a more demand-based manner than before because the actual condition can be accessed at any time, which makes condition monitoring possible. Gradual wear becomes obvious early on and can be predicted and remedied before production downtimes occur. Thus, data becomes a reliable source for predictive maintenance applications.

Data Xplorer is a powerful tool to measure one's own production and then to control it—as defined by Peter Drucker. ■

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