PROCESS MONITORING AND CONTROL

Transparency in networked injection molding production

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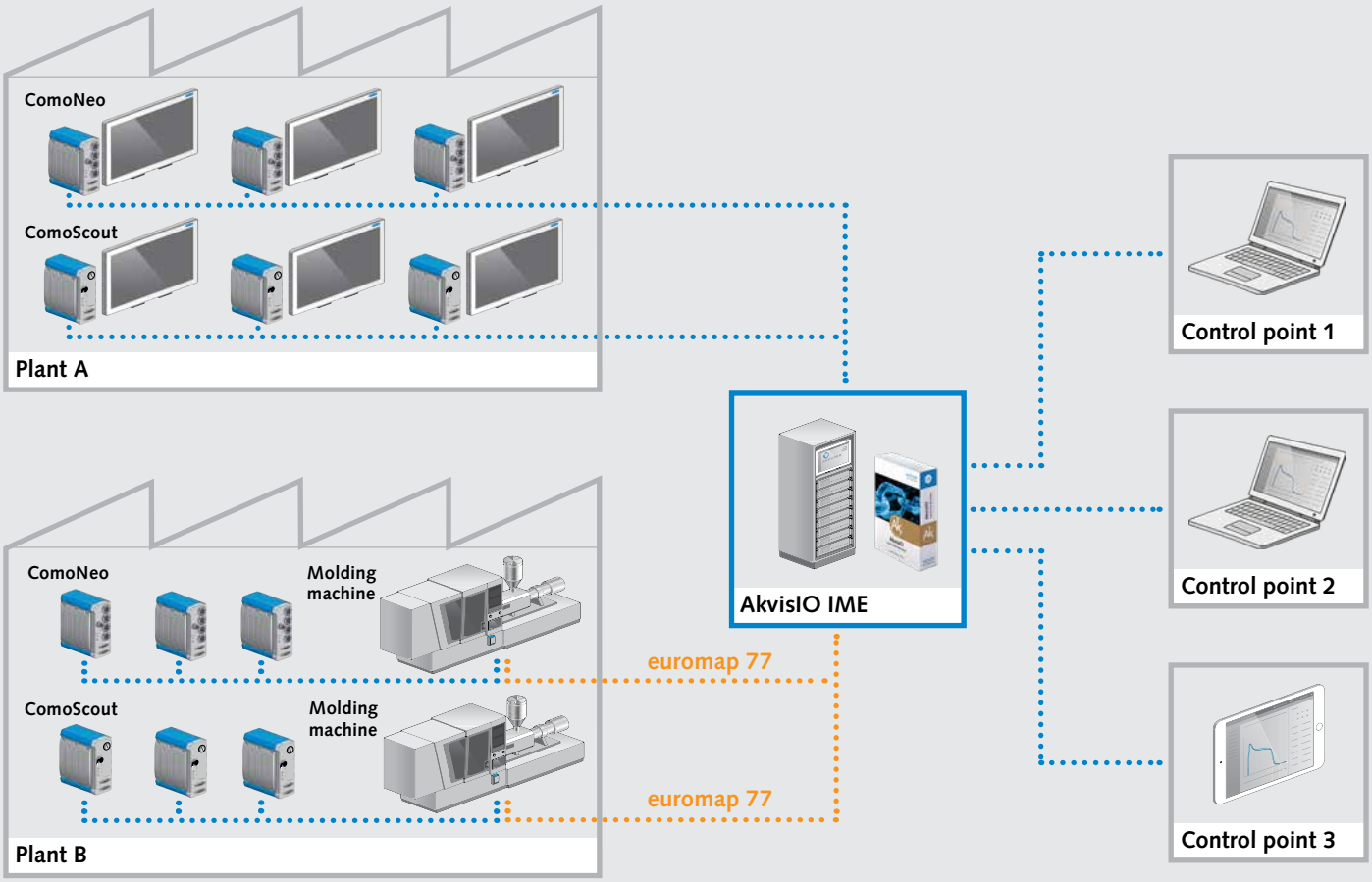
Kistler systems: the ideal basis for enhanced transparency in networked injection molding production

The Industry 4.0 vision has already emerged as a distinct reality in the injection molding sector. The new approach to production focuses on consistent digitalization – leading to enhanced product quality and increased cost-efficiency. Injection molders equipped with Kistler systems for process monitoring and control are ideally placed to meet the requirements for digital networking. Information networking and data management are gaining importance as we advance towards Industry 4.0.

Quality requirements for injection molding are constantly increasing, so permanent control of the entire production chain is essential. Kistler presents ComoNeo, ComoScout and AkvisIO IME: three system components that offer the best possible basis for achieving this goal – perfectly suited to both novices and experienced users.

The features integrated into ComoNeo and ComoScout have been specifically developed to meet requirements as they arise. First and foremost among these features is ComoNeoRECOVER: the Restart Assistant integrated into ComoNeo that ensures efficient reproduction of established processes when changing machines.

Benefits of Kistler systems
- Zero-defect production
- Reduced quality costs
- Optimal process efficiency
- Enhanced process reliability
- Optimized cycle times
- Lower staff costs
- Increased plant efficiency
- Rapid amortization (RoI)
- Industry 4.0
- Networking
- Data management and optimization



The systems also support the OPC UA interface in compliance with the established Euromap 77 standard, which is increasingly applied throughout the injection molding production sector. Integration of OPC UA in ComoNeo also makes it possible to implement hot runner control as an entirely standalone solution, without an additional PC. The benefit: significantly less effort is required because the entire setup process is simplified.

Another addition to ComoNeo: an integrated feature that allows reliable advance predictions about every part to be produced, so the full bandwidth of cavity pressure monitoring methods is available – from monitoring of process fluctuations and manual or automated EO monitoring (with ComoNeoGUARD) through to online quality prediction (with ComoNeoPREDICT). This is a high-end solution for direct calculation and evaluation of part characteristics.

Kistler also offers ComoScout – a lightweight process monitoring solution that focuses on general signals originating from injection molding machines or sensors (other than cavity pressure sensors). ComoScout is an ideal entry-level solution for process monitoring – and it is equally suitable for retrofitting injection molding machines with a data interface.

In a nutshell: thanks to the features integrated in ComoNeo, ComoScout and AkvisIO IME, Kistler is paving the way for yet more future improvements to product quality and cost-efficiency in the injection molding production sector.

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Process monitoring with ComoNeo: transparent injection molding processes guarantee quality

The ComoNeo process monitoring system uses the measurement values (such as temperature and pressure curves) from the injection molds to monitor and evaluate the quality of an injection-molded part. For this purpose, the system checks whether a specified value is reached or exceeded in the profile, with the help of defined evaluation objects that are set either manually or automatically.

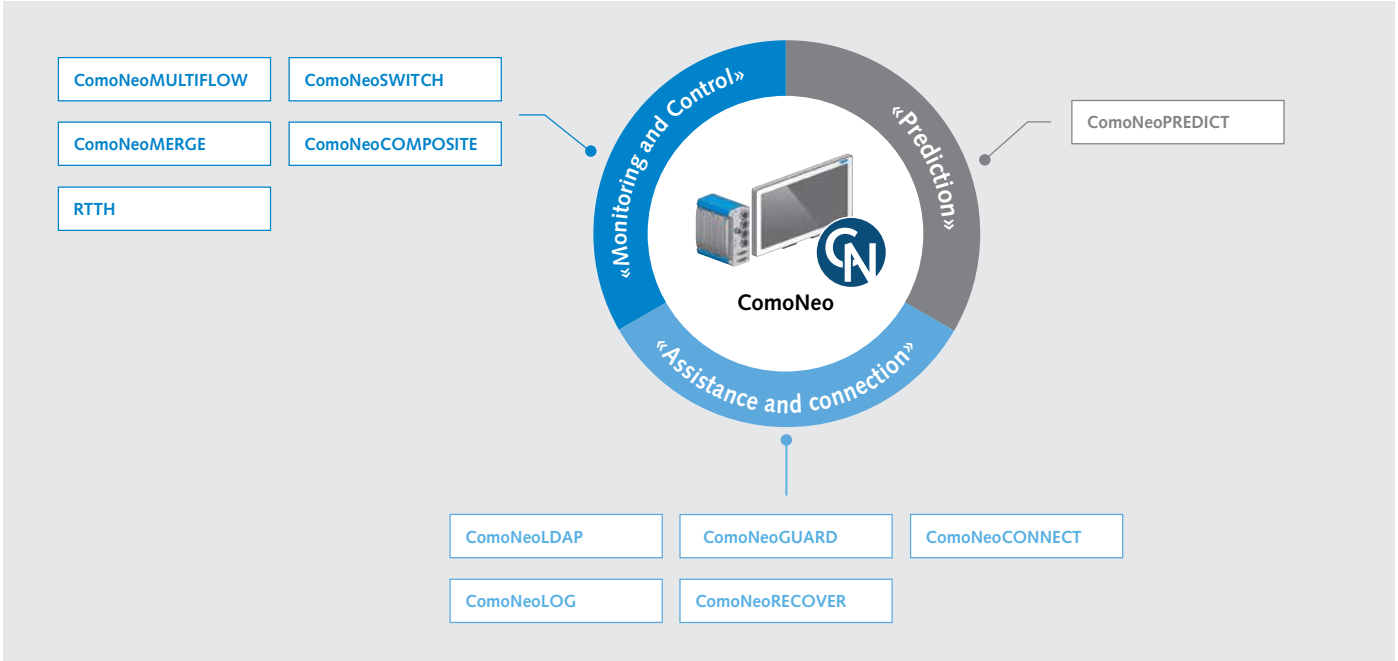
The ComoNeo monitoring system analyzes quality-relevant sections of the measurement curves captured via the measurement functions, with the help of defined evaluation objects – known as EOs. To do this, ComoNeo verifies whether the curves pass through the evaluation objects as predefined (illustration on page 7). If so, ComoNeo generates an "OK" result; otherwise, the result is "Not OK" (NOK). This allows sorting into good and bad parts. The EOs are set either manually or with the help of an intelligent assistance function. Users also benefit from additional practical tools including online quality prediction based on statistical test planning, and the Restart Assistant.

Benefits of process monitoring with ComoNeo

- Integrated process dashboard for a quick overview of production status and progression
- Separation of good and bad parts
- Monitoring of cavity pressure by setting evaluation objects (EOs)
- ComoNeoGUARD: automatic monitoring of cavity pressure
- ComoNeoPREDICT: reliable prediction of quality data based on cavity pressure
- ComoNeoRECOVER: the simple way to transfer established processes from one machine to another
- OPC UA and ComoNeoCONNECT: making process and quality data available to higher-level software solutions

ComoNeo: with innovative features for all-round process optimization

Whether you want assistance with setting up your injection molding process, a system that can optimize process monitoring and control, or a quality prediction tool: the ComoNeo system is the ideal choice for these requirements and a vast range of other applications.



On the one hand, ComoNeoGUARD and ComoNeoRECOVER are assistance systems that provide valuable support during the setup phase. And on the other, ComoNeoMULTIFLOW, ComoNeoSWITCH, ComoNeoMERGE and ComoNeoCOMPOSITE are used as specific monitoring and control systems. Kistler also offers ComoNeoPREDICT, the online quality prediction system – so you can benefit in advance from reliable forecasts for each part to be manufactured.

Practical tools for optimum support
As well as assisting users during the setup phase, ComoNeo provides support with recovering injection molding processes that have already been successfully validated. ComoNeoGUARD gives users reliable support with defining the scrap boxes (page 10). And to avoid losing time when restoring a process (after a machine changeover, for example), ComoNeoRECOVER is the solution of choice.

The customized system for monitoring and control
ComoNeoMULTIFLOW ensures individual control of the nozzle temperature on the hot runner so as to achieve optimum hot runner balancing. The ComoNeoSWITCH system was specifically developed for manual or automatic adjustment of the switchover point: the key to optimizing fill time differences. With the ComoNeoMERGE feature, users can adapt the process sequence and its monitoring to meet the specific needs of multi-component injection molding; and ComoNeoCOMPOSITE makes it possible to gear the monitoring strategy to the special requirements for fiber-reinforced plastic parts (RTM).

ComoNeoPREDICT – the basis for reliable quality prediction
Thanks to ComoNeoPREDICT, the online quality prediction system, machine settings can be improved so as to achieve the best possible values for quality, production time, and process stability.

The OPC UA interface and ComoNeoCONNECT make process and quality data available to a higher-level software solution. All devices include a basic dataset that can be upgraded via CONNECT license.

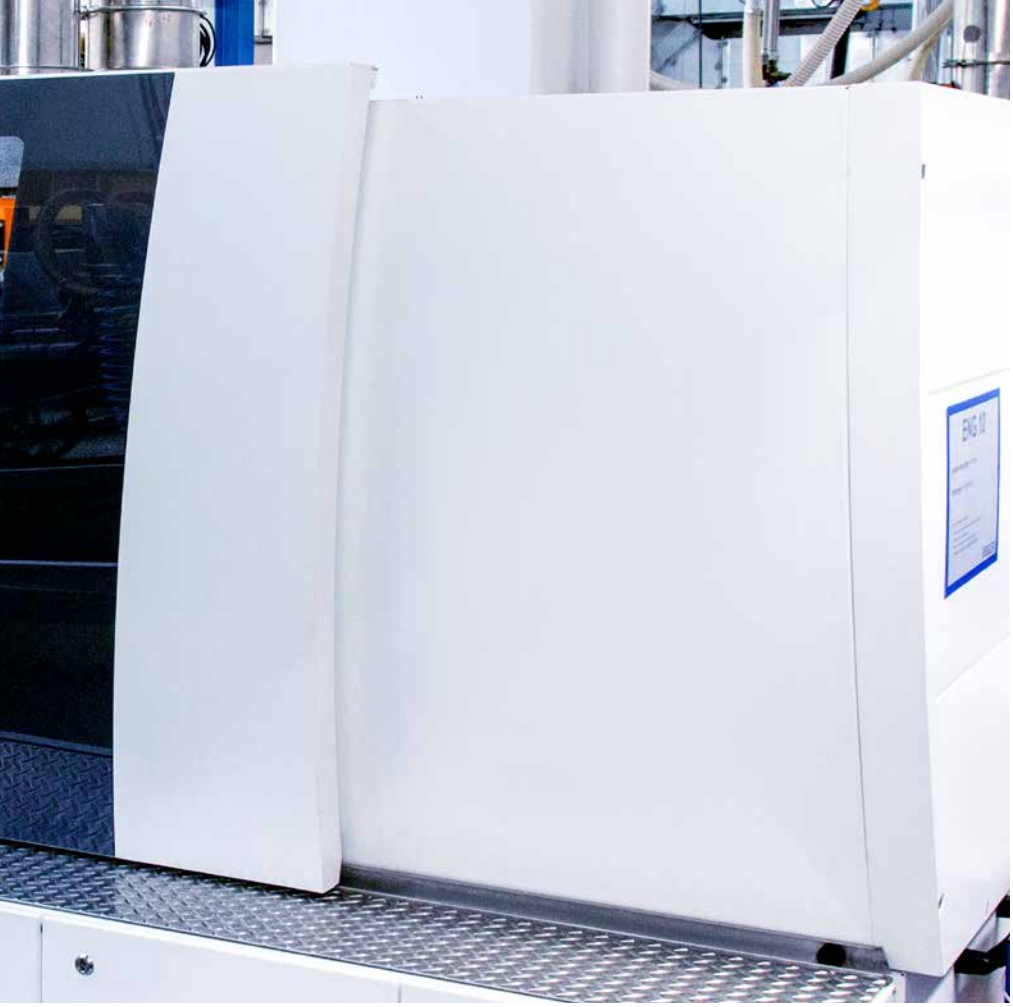
Source: Riegler GmbH & Co. KG

Process monitoring with ComoScout: ideal for injection molders' retrofit and entry-level needs

ComoScout is a process monitoring system for injection molding machines. Unlike ComoNeo, it is not connected to cavity pressure sensors: instead, ComoScout makes use of signals coming from the injection molding machine and any other voltage-output sensors (such as temperature transducers). ComoScout offers versatile monitoring and optimization functions based on the acquired data.

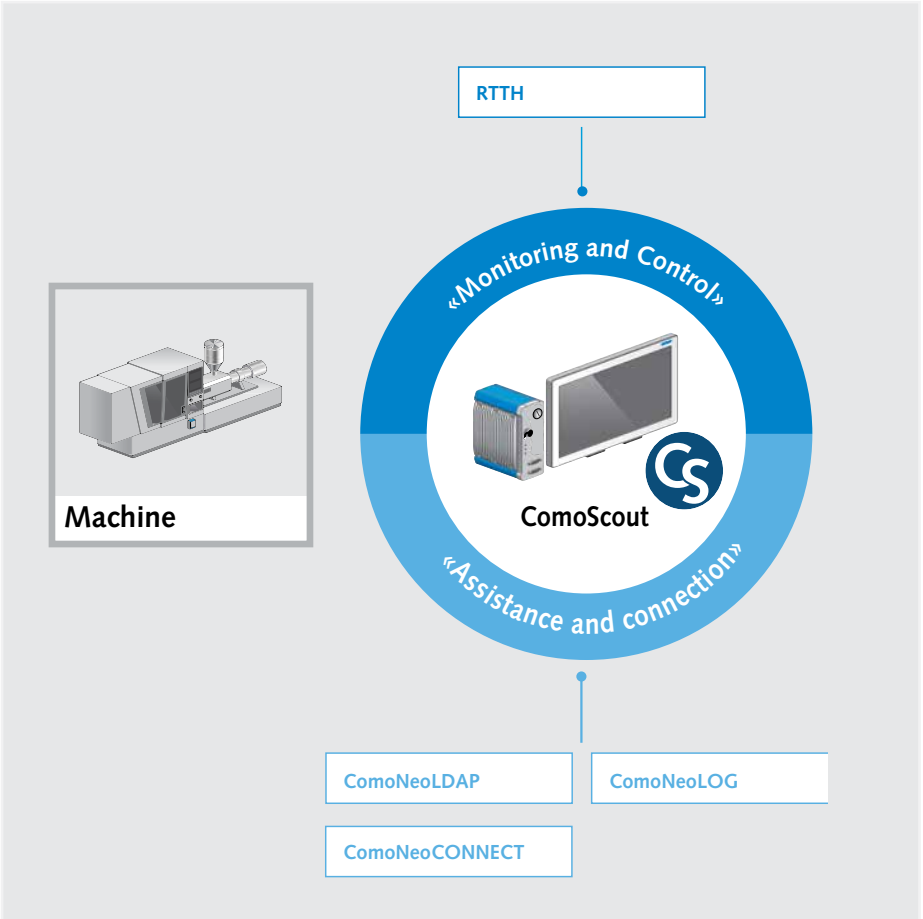
Digitalization of production processes is opening up new opportunities in many industries. It offers greater product flexibility and variety, enhances resource and cost efficiency, and leverages transparency and traceability. ComoNeo Scout is ideal as an entry-level solution for process monitoring and a springboard for Industry 4.0 in plastics processing and injection molding: a highly cost-effective choice for users to enter into the digital world.

Thanks to its OPC UA functionality, ComoScout provides a data-driven interface to higher-level systems such as an MES – so it can even connect older machines with modern smart production environments. ComoScout's retrofit capability makes it especially attractive for sectors and applications that have not yet made the leap into the digital realm.



Benefits of process monitoring with ComoScout

- Dashboard for quick overview and visualization of the injection molding process
- Process monitoring and control with defined thresholds for selected machine and sensor signals
- Digital interface from injection molding machine to production environment (via OPC UA)
- Enhanced user management and usability functions
- Efficient data transfer and enhanced traceability (also for older machines)



As a solution that visualizes process curves based on machine and sensor data, ComoScout offers two integrated monitoring and control functions: first, it enables monitoring of the injection molding process via manually defined evaluation objects (EOs). These predefined "windows" cover selected sections of the process curve that must be passed. Failure to pass these sections means that the part was not produced according to the fixed parameters, so it can be separated out automatically.

Second: real-time thresholds can be used to control the injection molding process and trigger actions.

ComoScout offers an intuitive user interface featuring the latest software functions. All actions performed by different users are recorded continuously, and profiles can be imported directly from the company's existing Windows user management.

ComoNeoGUARD: the user-friendly assistant for high-precision part monitoring

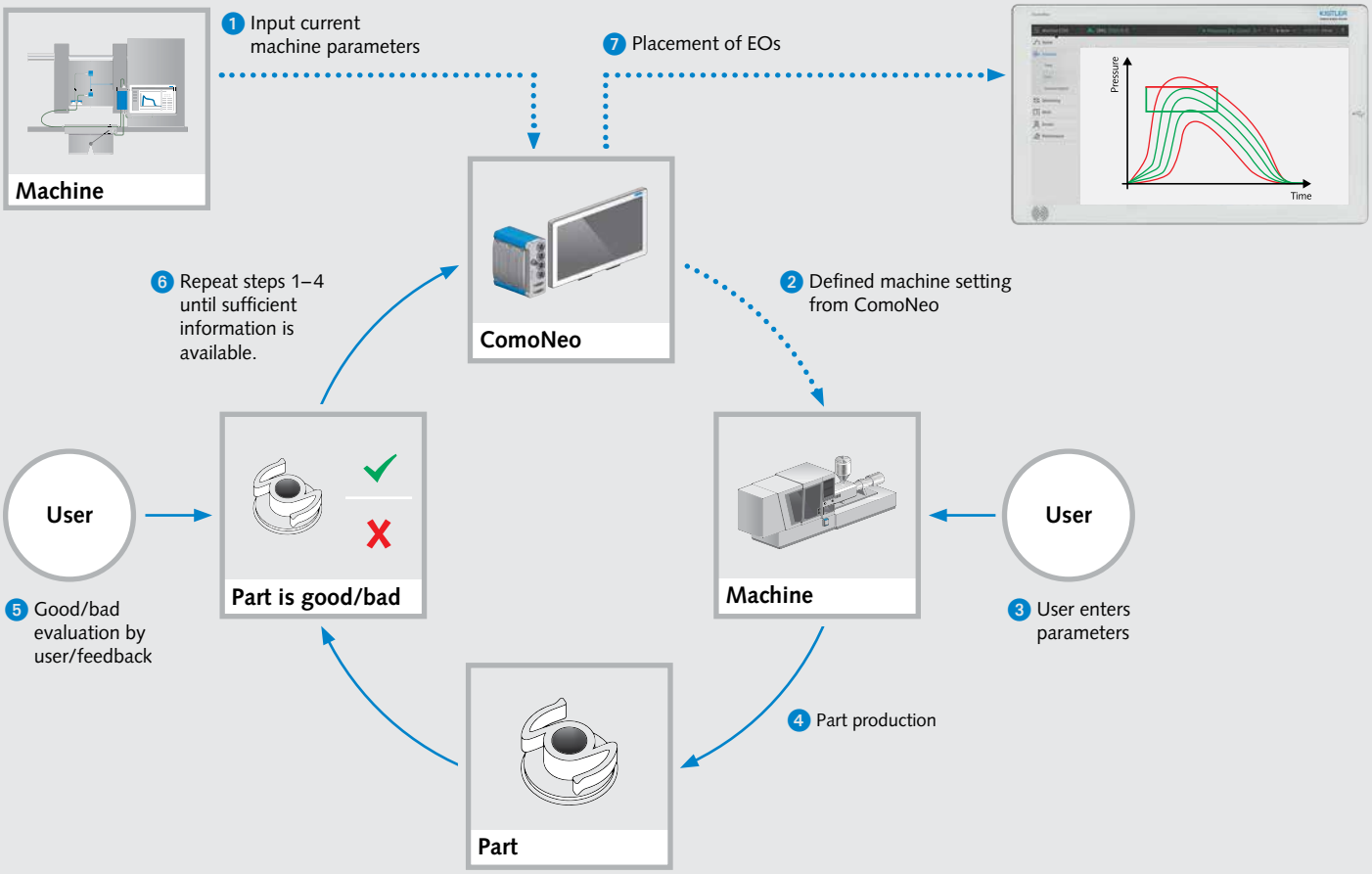
ComoNeoGUARD is a tool that generates and positions the monitoring boxes for good/bad evaluation – guiding users quickly and seamlessly to the scrap limits. The results define the evaluation types and the relevant limits. Thanks to this approach, components can be monitored and sorted into good and bad with high precision – and pseudoscrap (i.e. "presumed" scrap) is reduced.

ComoNeoGUARD allows user-prompted generation of the EO limits. This tool supports users with the procedure for defining the correct scrap limits (illustration, page 11) – so they can set up full process monitoring even if they have no previous knowledge of this subject.

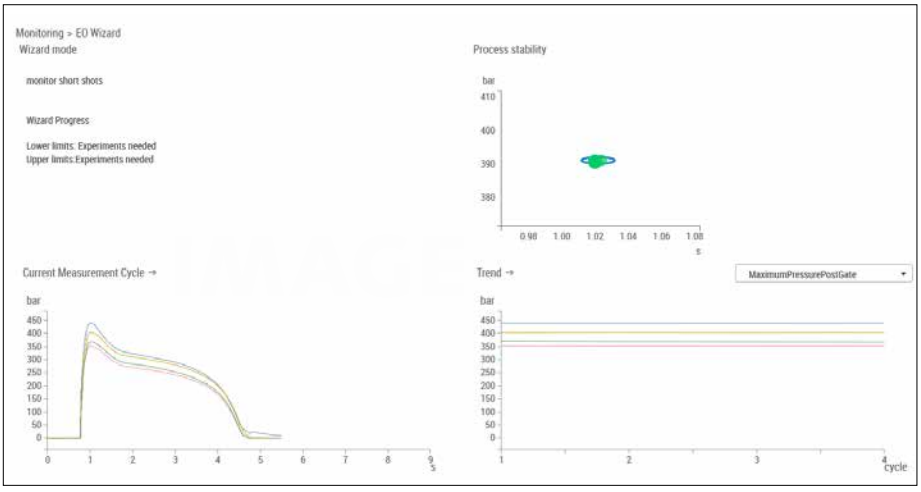
Simple user guidance
This automated method requires an existing established process with good parts. Taking this as the basis, ComoNeoGUARD selectively changes the machine parameters to provoke a new cavity pressure profile, with the result that the part's characteristics change.

As the next step, the user can take measurements or perform an optical assessment to evaluate the produced parts, and then decide whether the relevant cavity pressure profile is good or bad.

Systematic changes make it possible to work through the process window within a short time, and then to repeat the steps until sufficient information is available for automatic placement of the EOs to monitor the parts. Users themselves can decide when to discontinue EO evaluation. The more test cycles are completed, the more accurately the EOs can be placed. In this case, "more accurately" means that fewer good parts are declared and separated out as scrap. Of course, all bad parts are always separated out.



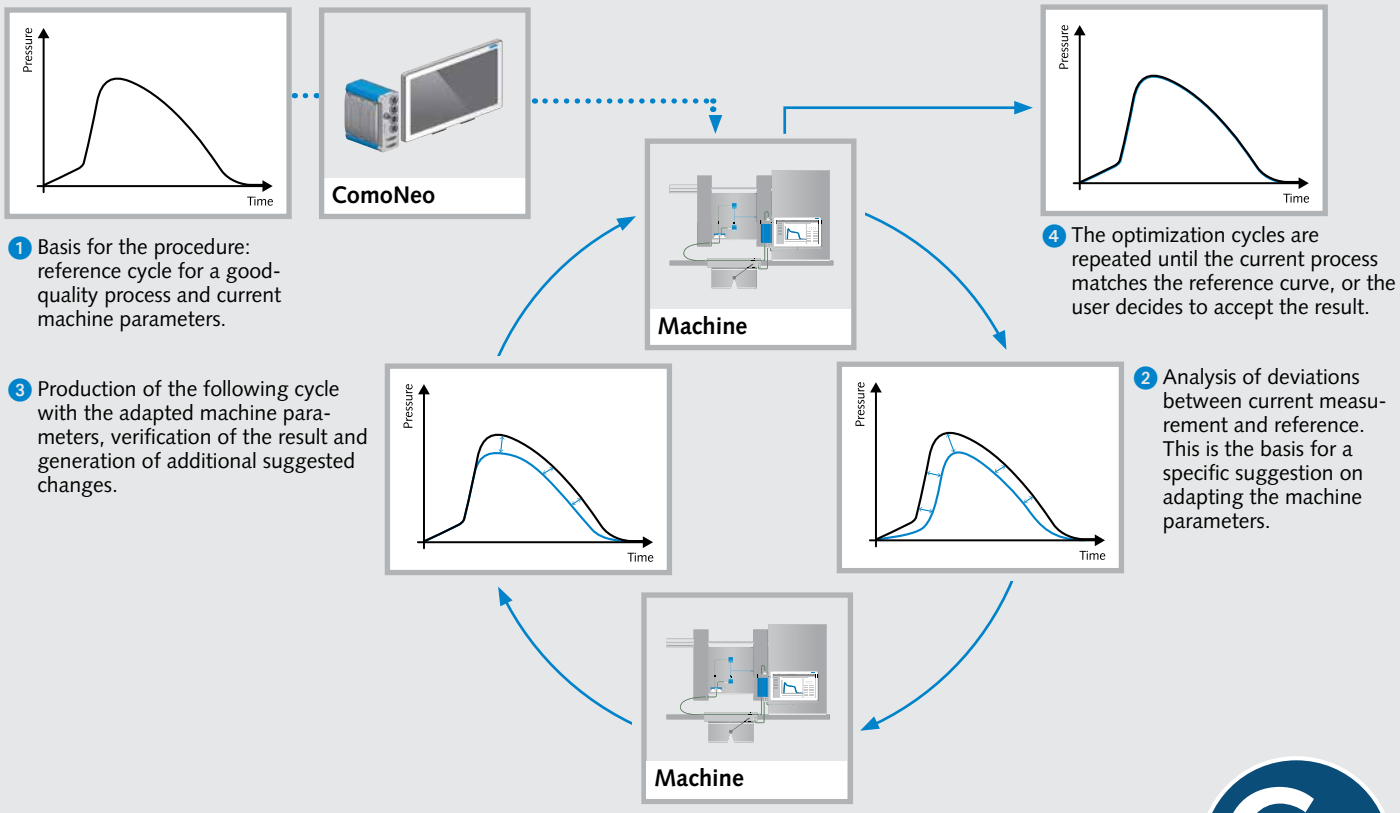
User-guided generation of EO limits with ComoNeoGUARD



Overview divided into 4 areas, which appears after calling up the EO Assistant.

ComoNeoGUARD benefits

- Users are guided through the individual steps
- Know-how is integrated within the system, so users do not need to be specialists
- More accurate evaluation limits (as wide as possible, as narrow as necessary)
- Scrap is separated out more accurately
- Pseudoscrap is reduced
- Systematic procedure, not dependent on individual staff members
- Adaptive system with learning ability, so it can increase the accuracy of the scrap limits
- Standardized, documented procedure
- Option of choosing the monitoring strategy (e.g. one EO across multiple cavities)



Step-by-step optimization in the injection molding process with ComoNeoRECOVER

ComoNeoRECOVER: identical reproduction of the injection molding process after changing machines, with the Restart Assistant

With ComoNeoRECOVER, pre-established processes can be transferred from one machine to another with no problems at all. This makes it easy for users who have no specific previous knowledge of cavity pressure to optimize processes and improve part quality.

The purpose of this restart assistant in ComoNeo is to reproduce the quality of an established injection molding process identically on another machine (see the illustration above). This is why ComoNeoRECOVER is used as a tool to optimize injection molding processes, rather than as a monitoring instrument.

Know-how integrated in the assistant
With this module, processes can be quickly and systematically optimized after a machine change, thanks to a user-guided procedure. As the basis, the assistant needs a reference curve representing a process of good quality.

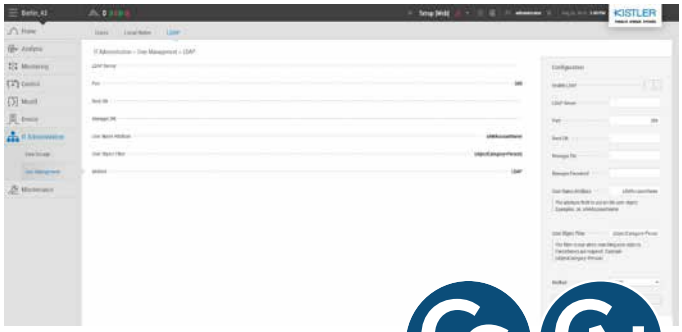
Once the reference cycle is stored and the assistant is started, measurement and analysis of the current process can begin. For this purpose, the current machine parameters are fed into the system as reference points. A detailed analysis then shows where there are deviations from the reference cycle. According to the degree and position of the deviation, the Assistant automatically suggests changes to the machine parameters.

After checking the results, new changes are suggested on the basis of the deviations and the Assistant's accumulated experience of previous changes. Process optimization is completed when the cavity pressure profile deviations are reduced to a tolerable level.

ComoNeoRECOVER benefits
- Users are guided through the individual steps
- Know-how is integrated within the system, so no specialists are needed
- Systematic approach
- Standardized, documented procedure
- Transparent, no dependencies on individual staff members
- Time savings on process start-up
- Part quality differences are minimized when manufacturing on different machines
- Users' process understanding is actively developed

LDAP

This software module is integrated in both ComoNeo and ComoScout so the process monitoring system can use the company's existing user management. Existing profiles as well as related rights and restrictions can be imported to ensure efficient, secure and comfortable operation of all injection molding machines.

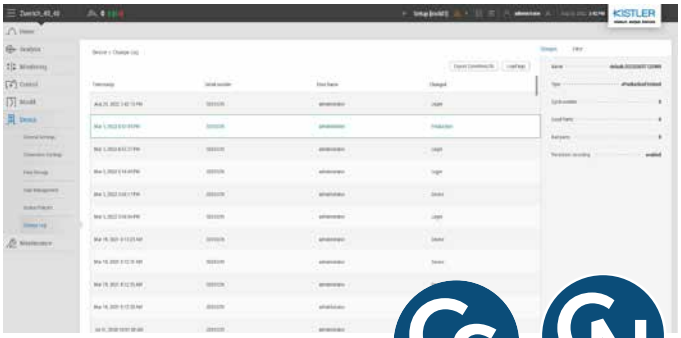


LDAP benefits

- Quick setup of different users and operators
- Direct import from existing Windows accounts
- Differentiation of user rights and access permissions

LOG

With the LOG feature, ComoNeo and ComoScout provide advanced security and traceability for production: all user activities executed on the process monitoring system are stored electronically, including a time index. This feature – also known as the audit trail – provides enhanced transparency for all applications but is especially important for medical device manufacturing.

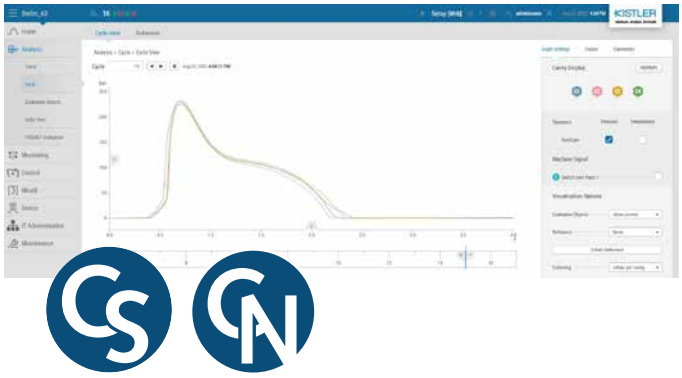


LOG benefits

- Complete control and history of all changes to machine settings
- Full transparency thanks to time-indexed record of all user activities
- Compliant with medtech requirements (audit trail)

Communication

To make process monitoring and control with ComoNeo and ComoScout even more comfortable and versatile, operators can now create an individual HMI (Human Machine Interface) for both devices. External data from sources such as AkvisIO IME or an MES (Manufacturing Execution System) can be displayed on ComoNeo via the external UI function. And with the VNC (Virtual Network Computing) function, the user interface from ComoNeo and ComoScout can be used on the injection molding machine or any other VNC-compatible device. This paves the way for individual, tailor-made dashboards and interfaces that are independent of the control unit – taking connectivity and usability in plastics processing to the next level.



VNC and external UI benefits

- Versatile use of data streams with ComoNeo and ComoScout
- Visualization of process parameters on other devices
- Creation of individual, tailor-made user interfaces
- Enhanced process visualization and transparency

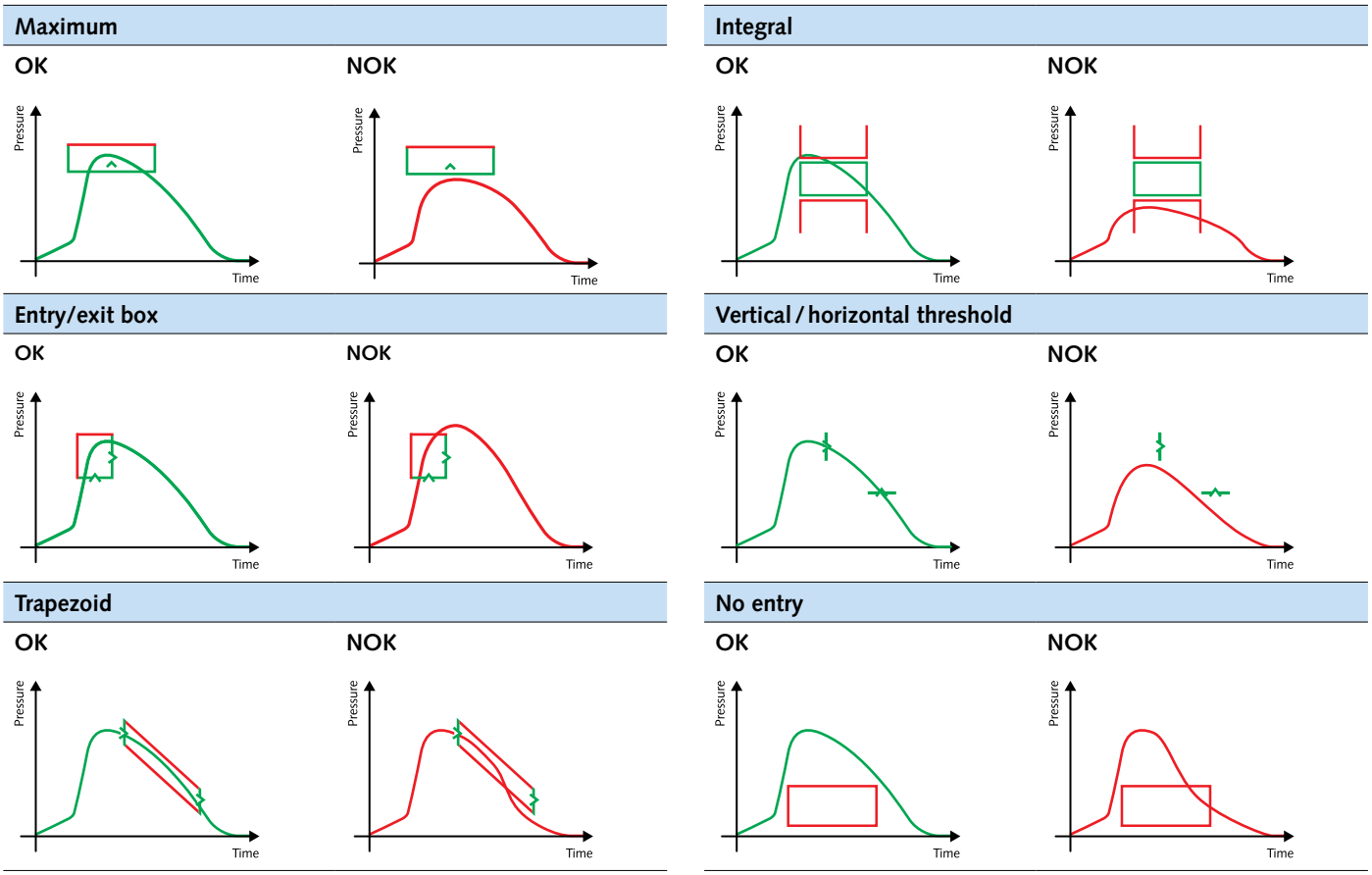
Monitoring and control systems: new approaches to balanced injection behavior

ComoNeo is not only suitable for monitoring purposes – it is also an excellent choice for controlling injection molding processes. As a ComoNeo option, ComoNeoMULTIFLOW can balance pressure curves by individually controlling the nozzle temperatures on the hot runner, based on cavity pressure curves. The system also includes automated switchover (ComoNeoSWITCH) to ensure perfect timing when switching over in response to cavity pressure.

The purpose of hot runner control is to give the pressure curves of the individual cavities an identical filling progression so as to guarantee constant production quality in all cavities. This is achieved by automated temperature control of the relevant hot runner nozzles.

With switchover point control, either manual or automated setup of the control within a cycle are possible. The main advantage of manual control setup is that multiple dependencies can be set; however, the advantage of Switch Level Process (SLP) is that calculation of the switchover point is self-optimizing.

These process control options are integrated in ComoNeo, so process fluctuations can also be compensated during the production phase. ComoNeoMULTIFLOW uses hot runner balancing to compensate for differences in filling behavior when multiple cavities are present; ComoNeoSWITCH, on the other hand, ensures optimal timing of the switchover point throughout the entire production sequence.



ComoNeo evaluation objects (EOs)

Manual monitoring of cavity pressure, machine or sensor signals

Any signals sent by cavity pressure sensors, the injection molding machine or any other sensor can be monitored by using predefined evaluation objects (or EOs). These EOs can be set manually in relation to a process curve so that various quality features can be monitored. This allows evaluation of the injection molding process with reference to the specified tolerances. The next overview explains the most frequently used functions.

Maximum
The Maximum function checks whether the curve reaches a specified value (green line), or whether it does not exceed that value (red line). Typically, this box is used to determine whether the cavity was completely filled (short shot).

Entry/exit box
The entry/exit box function ensures that values only pass through the green lines, not the red ones. These boxes can be selected freely. The progression may be horizontal or, as in the illustrated example, via entry (below) and exit (right). These boxes are always rectangular. They can be used for virtually all applications because they allow checking of the pressure level as well as the time component.

Trapezoid
The curve can only enter this item from the left, and it must exit to the right. The upper and lower limits must not be at the same level. This box is recommended if compliance with a specified holding pressure profile must be ensured.

Integral
The area below the curve must maintain a specified value for a defined period. The Integral function is used for a variety of purposes, including monitoring of sink marks.

Vertical or horizontal threshold
A vertical threshold has to be crossed from left to right. For complex curves, this EO should be used in addition to other EOs. The horizontal threshold monitors crossing of the line from above or below.

No entry
No curve is allowed to touch this box. This function can be used (for example) to effectively monitor any occurrences of pressure loss.

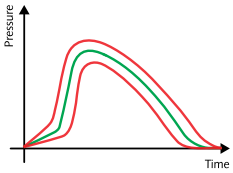
In full control with the **Envelope Curve** – automatic evaluation throughout the process

For sensitive processes that require a very high level of accuracy, monitoring based solely on evaluation objects might not be sufficient or even possible. That is why ComoNeo from Kistler now offers an additional feature to monitor and control these processes precisely: the Envelope Curve, which ensures parameter supervision of a very high grade throughout the process.

In principle, the Envelope Curve acts as one large evaluation object covering the whole process curve. It can be calculated on any desired number of actual curves, and it includes probability assumptions. Once the Envelope Curve is in place, it provides an accurate reference for a stable injection molding process.

This is especially helpful when users need to evaluate individual events or when (almost) the entire profile has to meet critical tolerances. The Envelope Curve does not exclude setting the quality criteria manually – it can also be used in combination with manual EOs.

OK



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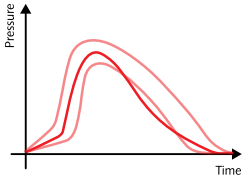


Envelope Curve benefits

- High-level quality control throughout the process curve
- Automatic calculation including probability assumptions
- Works with any given number of curves
- Envelope Curve is trainable
- Compatible with manually set EOs

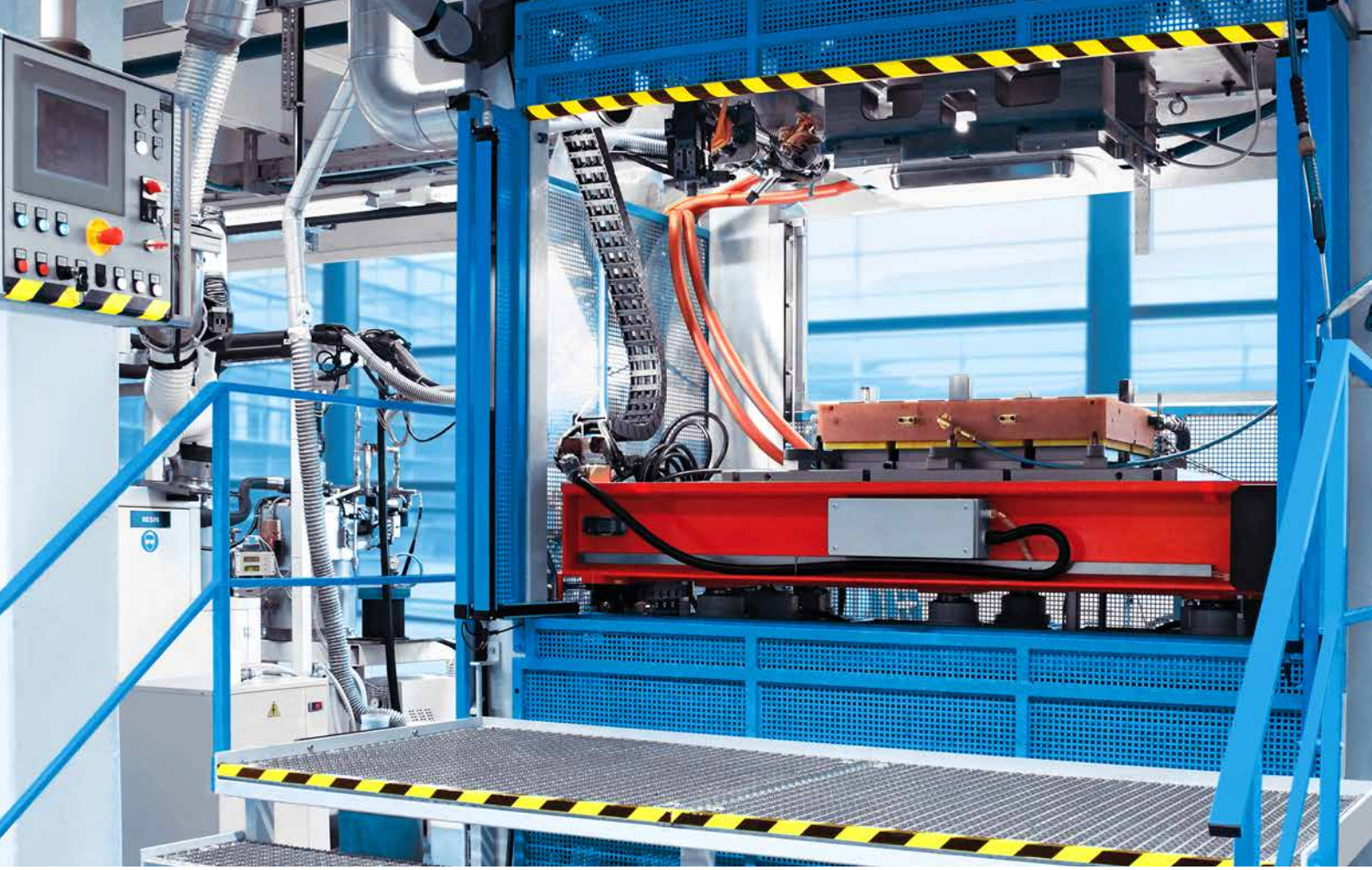
ComoNeoMERGE: transparent process monitoring for production of parts with multiple components

ComoNeoMERGE is especially helpful with the production of multi-component parts such as toothbrushes, complex housings with sealing functions, and switches. All the cavity pressure data measured in the manufacturing process is merged to provide a clear visual overview of the complex multi-component injection molding process.

In multi-component injection molding, different materials are joined successively to create a complex product. Different (and sometimes highly complex) molds are used for this purpose. ComoNeoMERGE maps all the components and the individual process steps for each cavity as a curve. The benefits: precise monitoring of the complex process sequence for multi-component injection molding – so quality costs for the production process are reduced. Users can take advantage of ComoNeo's full functionality as a process monitoring system for multi-component injection molding, allowing overall assessment of parts that are manufactured in stages.

ComoNeoMERGE benefits

- Specially designed for multi-component parts
- Different multi-component molds are visualized (different sensor positions or slider molds)
- Individual process steps and components are visualized
- Part-based good/bad assessment, independently of the shot
- Part-based storage of process data



ComoNeoCOMPOSITE: quality assurance and process optimization based on monitoring and control of the RTM process

As is the case with other filling processes (such as injection molding), the pressure curve in the mold is also a critical factor in optimization and production monitoring for the RTM process. ComoNeoCOMPOSITE ensures that users can easily recognize the characteristic phases of the process – such as evacuation, filling and curing – in the cavity pressure curve. This makes it possible to optimize the parameters for industrial processing of long-fiber composites, paving the way for more cost-efficient production in the lightweight construction segment.

The ComoNeoCOMPOSITE feature takes account of specific requirements for the RTM process such as long measurement times, evaluation of the evacuation phase, and point recognition.

The pressure signal can also be used as a control variable for individual steps of the process – so online process control can be implemented. At the same time, anomalies in the pressure curve indicate whether faults can be expected in the finished part and, if so, which ones.

Capture and recording of the pressure signal with ComoNeoCOMPOSITE also ensures traceability of the individual process steps. All these reasons make the pressure curve indispensable as a quality assurance tool.

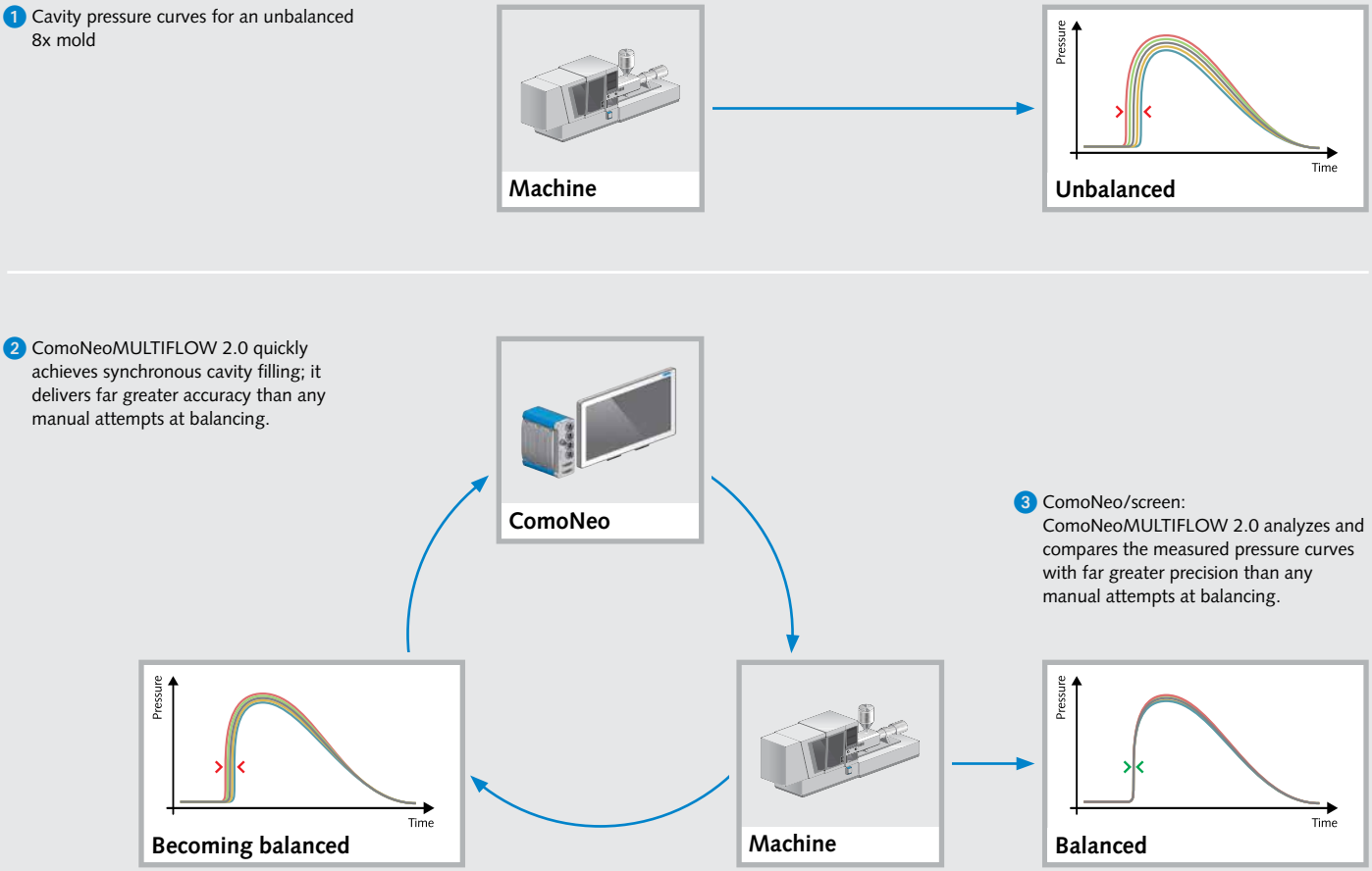
Using the pressure curve to identify defects

Vacuum is too weak or intermittent

Causes:	Faulty mold sealing
	Vacuum pump failure
Consequence:	Air bubbles and imperfections in the part

Irregularities in the injection phase

Causes:	Dislocation of the preform
	Preform defect/incorrect orientation of a layer
Consequence:	Incorrect fiber content
	Dry spots



ComoNeoMULTIFLOW 2.0 synchronizes the pressure profiles on the hot runner.

ComoNeoMULTIFLOW 2.0: temperature-controlled hot runner balancing

As an option for ComoNeo, ComoNeoMULTIFLOW 2.0 synchronizes the pressure profiles by individually controlling the nozzle temperatures on the hot runner by a fast, robust and self-learning algorithm. It stabilizes the process and adjusts for batch fluctuations as well as other process anomalies.

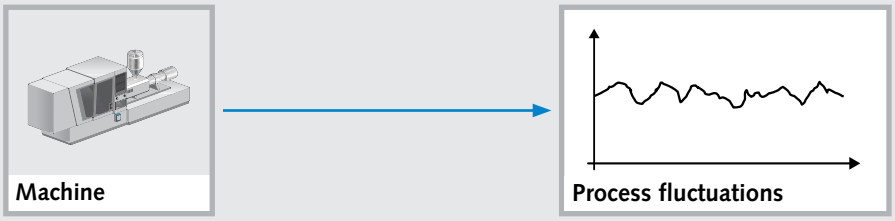
ComoNeo combines the advantages of automated hot runner balancing with 100% quality assurance based on cavity pressure (see the illustration above). The purpose of hot runner balancing is to ensure identical injection and pressure conditions in all the mold's cavities. The control variables used by ComoNeoMULTIFLOW 2.0 are the cavity pressure profiles in the individual cavities. The actuating variables are the temperatures of the hot runner nozzles.

ComoNeoMULTIFLOW 2.0 analyzes and compares the measured pressure curves. Nozzle temperature setpoints are calculated on this basis and transmitted to the external or machine-integrated hot runner control system via an interface such as OPC UA. The self-learning control algorithm adapts individually to the characteristics of the mold and the controller.

Automated balancing in case of process fluctuations
The basis for ComoNeoMULTIFLOW 2.0 is provided by reliable information about the entire mold filling process, so it enables automatic compensation for batch fluctuations and process anomalies. This is a key advantage as compared to systems based on melt front detection that control the point in time when the melt front reaches a specified position in the cavity.

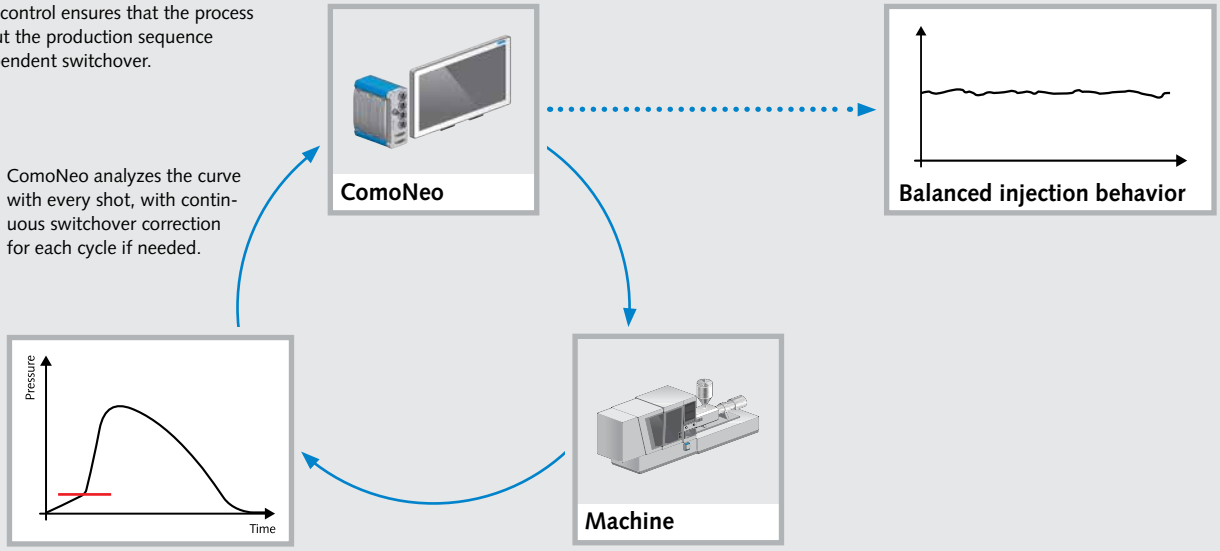
ComoNeoMULTIFLOW 2.0 benefits
- Identical filling conditions in all cavities
- Shorter tooling and setup times
- Fast injection molding process startup
- No manual setting or readjustment of temperatures and parameters
- Fully automated compensation of material fluctuations and process anomalies
- Integrated in ComoNeo as a standalone solution

Process fluctuations in ongoing production without real-time control
► distance-dependent switchover



ComoNeo's real-time control ensures that the process is balanced throughout the production sequence
► cavity pressure-dependent switchover.

ComoNeo analyzes the curve with every shot, with continuous switchover correction for each cycle if needed.



Compensation of process fluctuations based on cavity pressure-dependent switchover

ComoNeoSWITCH: reliable process control with switchover based on cavity pressure

ComoNeoSWITCH actively provides machine feedback. This allows ideal timing for the switchover from speed control to pressure control in response to cavity pressure.

The automatic switchover control can be used in two different ways. The first option involves manual setup, and control behavior only changes after the user intervenes. For example, a user can specify the defined level of cavity pressure at which the switchover should take place. The second option is ComoNeoSWITCH: setup in this case is fully automated, and control behavior is automatically optimized from one cycle to the next (illustration above).

For molds with multiple cavities, automatic switchover behavior has been optimized for the specific purpose of compensating for different behavior patterns throughout the production sequence. When conditions are set manually, additional dependencies across multiple cavities are available as control criteria.

On the other hand, the ComoNeoSWITCH fully automated switchover feature is mainly used for molds with small numbers of cavities. The benefit here: ease of handling. All that is needed is to activate the process: everything else is controlled automatically by the internal algorithm, virtually at the touch of a button.

Both switchover options actively help to prevent mold damage because safety functions respond to excessively rapid pressure increases, so mold overfill is prevented.

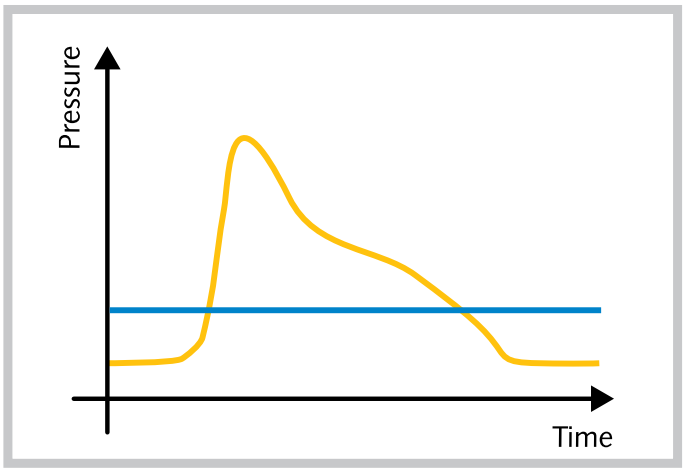
Benefits of process control with ComoNeoSWITCH:

- Perfect timing of the switchover from speed-controlled to pressure-controlled injection molding
- Maximum process consistency throughout the entire production sequence
- Switchover point can be adjusted automatically or manually, according to choice
- Optimized fill time differences
- Mold-friendly process
- Reduced internal stresses in the part

Trigger actions with **real-time thresholds** (RTTH)

Another option for controlling the process is the real-time threshold (RTTH). At a specified value of the measurement signal (cavity pressure, temperature, machine signals or switches, etc.), the device immediately transmits a signal to the output so as to trigger an external action.

The real-time threshold can be used (for example) as a safety option while the process is running. Also, it can be used both as a single trigger and as an on-off-trigger.



Benefits of real-time thresholds:

- Mold protection for unexpected high pressure or other misfunction
- Protection of critical components in insert molding
- Trigger of opening or closing of additional hot runner nozzles
- Melt flow depending release of mechanical support function of slim cores in the mold
- Triggering of mechanical mold functions (e.g. core back) or second component injection in a 2K process
- Trigger and control the mold compression molding function
- Cavity pressure controlled activation of backpressure levels

Prediction systems: ComoNeoPREDICT – the systematic way to determine part quality

Integrated online quality prediction is the basis for reliable statements about every manufactured part – ahead of time. Taking the current cavity pressure profile as the basis, ComoNeoPREDICT forecasts the part's eventual dimensions.

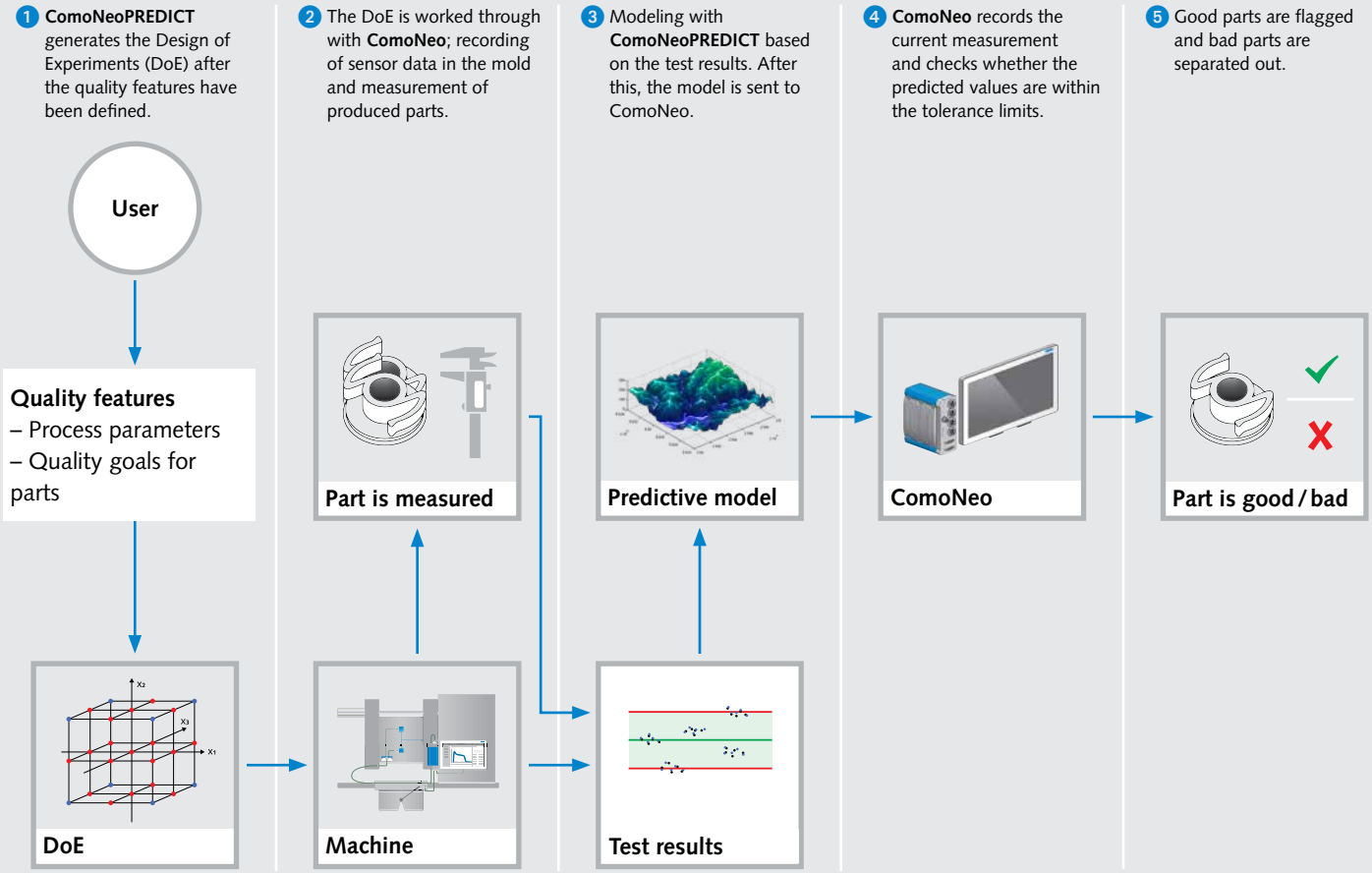
The ComoNeoPREDICT online quality forecasting system is based on models that make it possible to calculate the characteristics of parts (illustration on page 19). The statistical DoE (Design of Experiments) process for test planning helps to determine relationships between pressure / temperature profiles and defined quality features. To carry out online quality prediction, users need the machine and the part, plus the ComoNeoPREDICT system and the software (PC software) to generate the DoE and the prediction model.

Performed in a few easy steps

The first step is for the user to enter specified tolerance limits for the part's quality features in the ComoNeoPREDICT software. Then, the software automatically generates a Design of Experiments (DoE) which users can adapt as they wish.

ComoNeoPREDICT benefits:

- An exact method for separating scrap, thanks to complete quality records
- Direct monitoring of predicted quality features makes it much easier for users to understand the process
- Pseudoscrap is minimized
- Simple handling of tolerances as scrap criteria (transferred from the part drawing)
- Systematic determination of part quality
- Automatic selection of relevant curve points for calculation
- Can be used even without in-depth mathematical or statistical knowledge
- Models can easily be retrained to achieve further improvements



Workflow for online quality prediction

In the second step, the DoE is worked through with ComoNeo on the injection molding machine; all cavity pressure curves are recorded and the parts are removed and measured. Features such as surface quality or flash can also be evaluated. Then the results are fed into the PC software and linked to the mold measurements (pressure, temperature). The software uses this data to produce a model so that part quality can be predicted on the basis of the mold measurements.

In the next step, the model is sent to ComoNeo where it is enriched with the current mold measurements as input variables. The output from the model on ComoNeoPREDICT consists of quality data calculated on the basis of cavity pressure (length, width, weight, surface characteristics, etc.) At the same time, checks determine whether these predicted values are within the tolerance limits. Once all the features for a component are correct, the component is flagged as "good"; as soon as a component is "bad", it is separated out and flagged as such.

For manufacturers of high-grade components

This standardized and documented procedure means that tests and model calculations can be performed regardless of which staff members are available. The method's transparency gives users a far better understanding of the process. Manufacturers of sensitive precision parts for the medtech sector as well as producers of other critical high-quality components benefit from this tool, which gives users 100% in-process prediction of all quality features.

AkvisIO IME: All quality-related data in one place

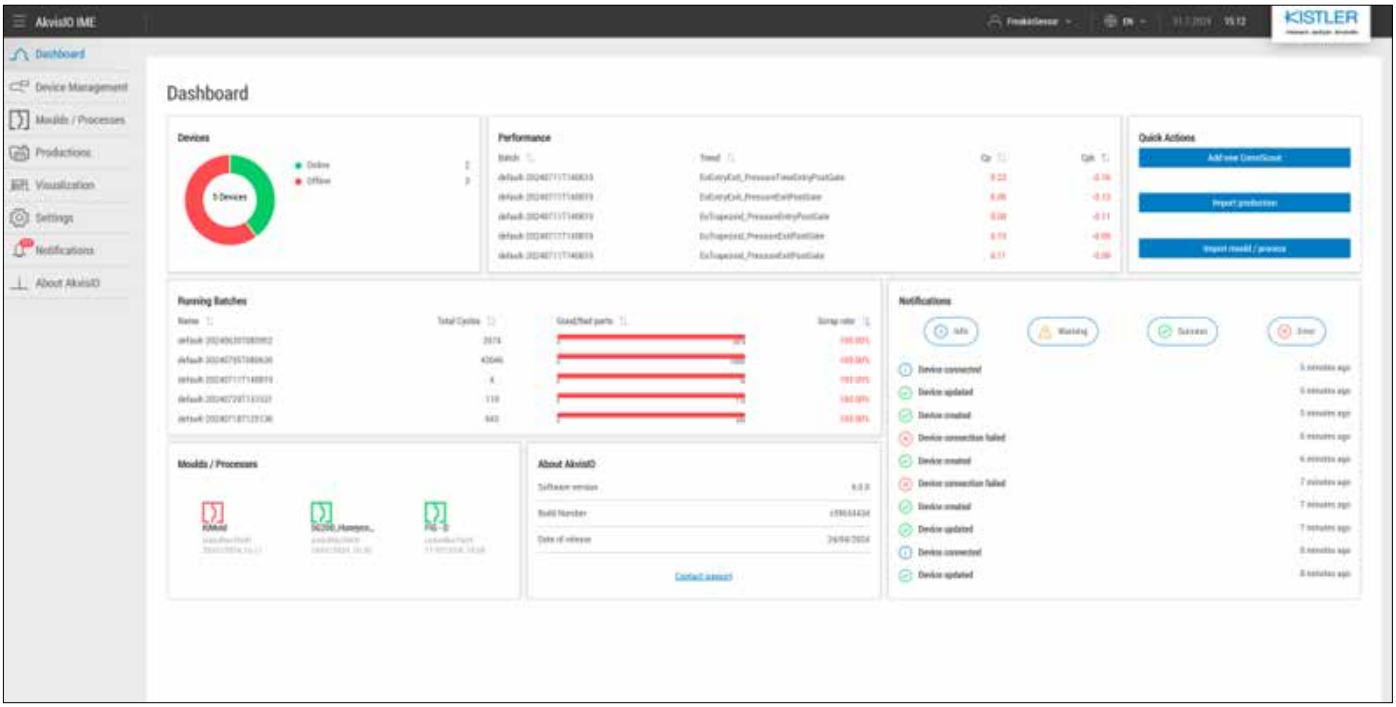
The AkvisIO IME (Injection Molding Edition) server application synchronizes all process data collected with ComoNeo and ComoScout, manages mold and process configurations and completes your data management.

With AkvisIO IME, Kistler presents a server application that stores process data from our edge devices and injection molding machines via EUROMAP 77, and prepares it for analysis to ensure the traceability of part quality. The integrated mold and process management also makes it easier to manage configurations for quality monitoring across plants and machines. AkvisIO IME is therefore the key to accelerating the setup of processes with integrated quality control.

Intelligent networking multiplies efficiency
AkvisIO IME offers users the benefits of intelligent networking – a major step towards the smart factory of the future. Through complete transparency of quality-relevant data, the software increases efficiency in injection molding: across production and worldwide.

AkvisIO IME: Quality-related process data and mold management at a glance

- Quick overview of relevant key figures on production efficiency from batch-related scrap rates to statistical process capability via cp and cpk
- Central storage of all recorded process data as a high-resolution curve graphic or cross-cycle trend
- Fast detection of process fluctuations through trend or cycle comparison
- Detailed analysis options and statistical evaluations of all historical and current productions
- Central storage and management of all mold and process settings
- Seamless documentation of production-relevant notifications and audit-relevant events



The dashboard acts as the start page in AkvisIO IME and provides a direct overview of the current status of production so that initial diagnosis can be made immediately and optimization measures can be initiated

User interface

The graphical user interface in AkvisIO is based on the control elements developed by Kistler, which are also used in other solutions and systems. The Skybase UI, which is constantly being adapted and further developed, thus ensures intuitive and pleasantly flowing navigation through the system and its components.

The expandable navigation menu provides quick access to relevant system areas. These include:

- Device Management: Management of data sources
- Molds / Processes: Management of monitoring configurations
- Productions: Access to productions and batches as well as their quick analyses and statistics
- Visualization: Display of trend and cycle data, statistics and good/bad part analysis
- Settings: System configurations for users, access and editing rights, audit-relevant content and user-specific display units
- Notifications: Detailed listing of production-relevant events

Dashboard

The dashboard (Fig. above) shows a simple overview of all relevant events in ongoing production. This includes the status of the connected data sources, the performance of Evaluation Objects set up (EO) with regard to the process capability of production and an overview of the current production batches and their reject rate.

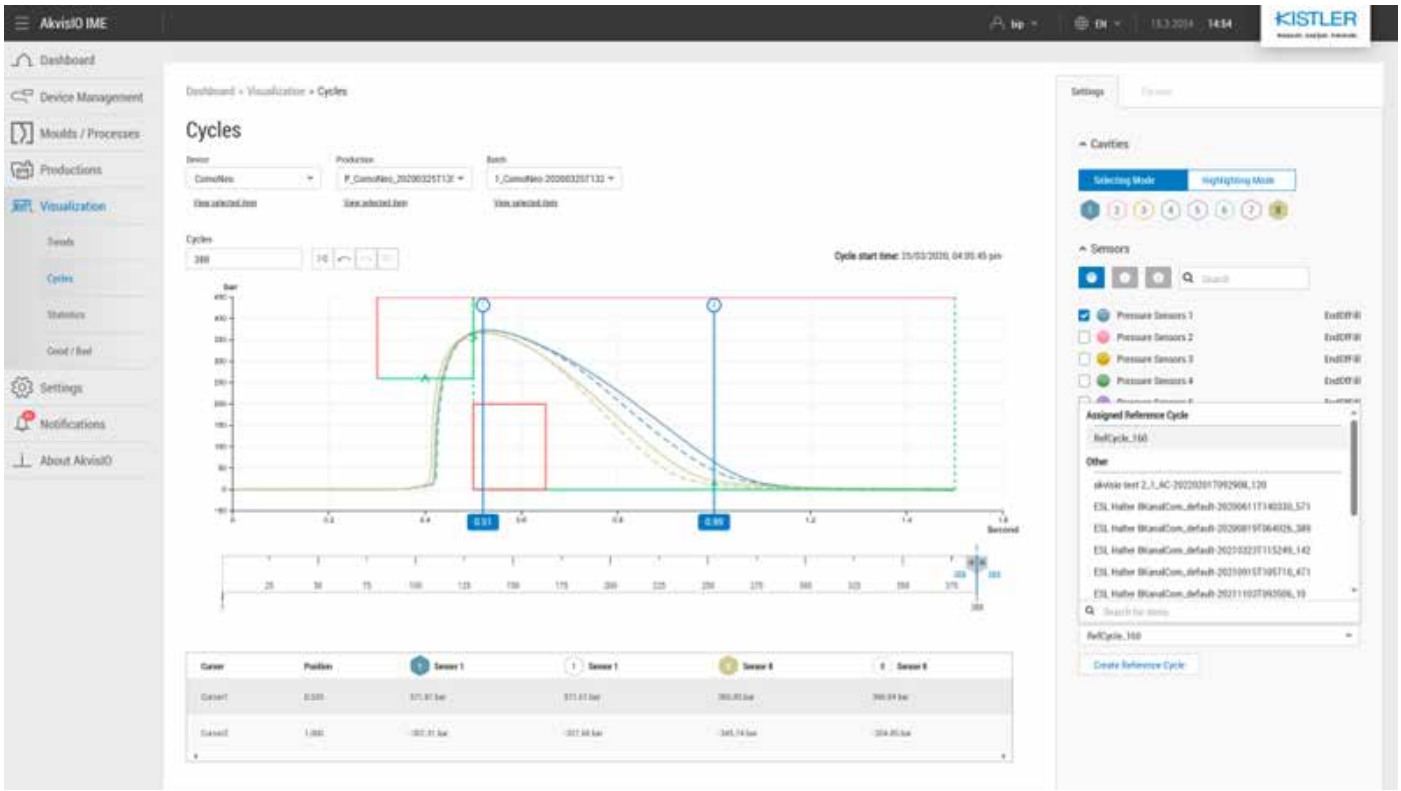
Trend analysis

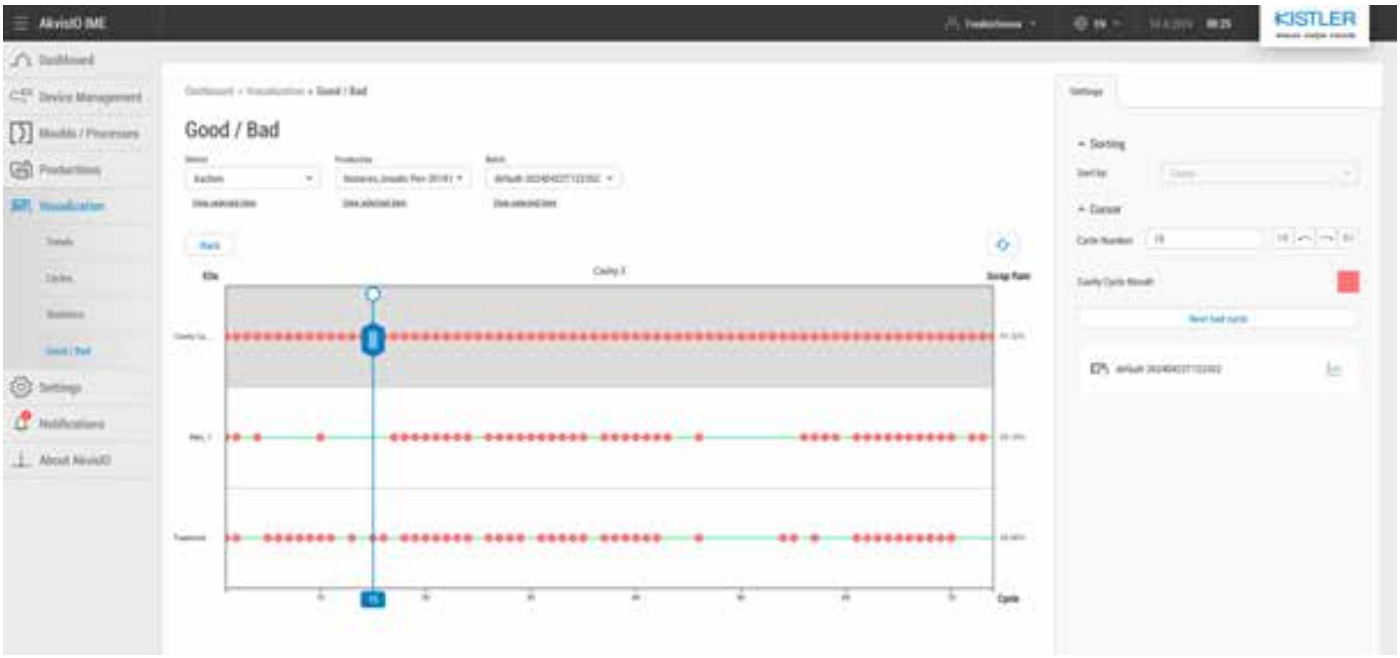
In the trend analysis (Fig. p. 26), the process data of various key figures can be displayed across cycles and compared with other trends from the same production or other productions. Up to six trends can be superimposed to reveal deviations and correlations.

In addition to the recorded process parameters from ComoNeo and ComoScout, machine parameters from the EUROMAP 77 can also be displayed as trends. Additional markers in the graphic display can also be placed on specific cycles to list their exact numerical values in an attached value table.

Cycle-related visualization
The cycle display shows the process data recorded by ComoNeo and ComoScout in high resolution as a cavity-related pressure, temperature or overall machine signal. Created evaluation objects that were used for quality monitoring are also displayed, so that a violation of the quality specification can be clearly demonstrated.

Reference cycles can also be generated, assigned and selected here in order to compare the sensor signal over the measuring time with a validated reference cycle. The familiar **markers** support the pairwise comparison of sensor curves by specifying the numerical value stored in the database as an absolute value, difference between two markers or integral value over time.

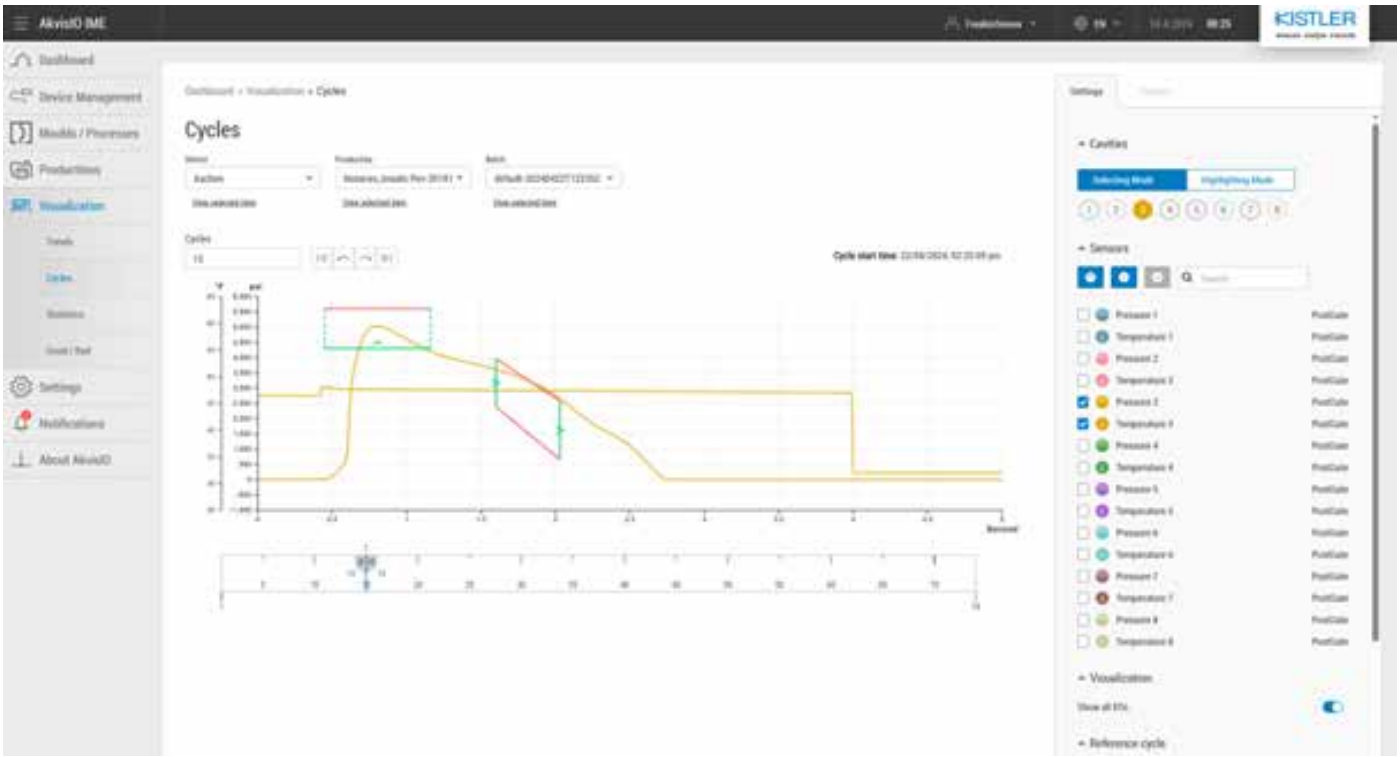




Good/bad analysis of a production batch with a specific focus on quality monitoring for cavity 3. Two evaluation objects are set up, one of which leads to the overall evaluation of the component as a reject in cycle 15. An insight into the course of the cycle data is worthwhile for further determination of the reasons for rejects

Identifying reasons for rejects through good/bad analysis
The good/bad analysis (Fig. above) makes it possible to take a close look at the reasons for rejects in quality monitoring. The cavity-related analysis of the evaluation objects set up (EO) directly shows the respective evaluation, so that it is clearly recognizable at which point the quality monitoring leads to a bad part evaluation and which monitoring element possibly causes a process instability or increased reject rate.

The quick access on the right-hand side can be used to go directly to the relevant cycle in order to examine the curve graph of the recorded sensor data. Deviations from the predefined target behavior of a good part production become obvious and corrective measures can be initiated quickly.



Detailed display of the cycle-related measurement data for good/bad analysis. The pressure curve for sensor 3 shows a clear deviation from the set evaluation objects. An adjustment of the packing pressure or the mold temperature could provide a remedy.

Your benefits:

- Reduction of production cost and CO_2 footprint
- Optimized part quality
- Robust machine setting
- Maximized process windows
- Validated process with maximum transparency
- Buildup of a traceable knowledgebase, independent from Individuals
- Software customized to injection molding process
- No expert knowledge necessary
- Comprehensive documentation
- Time and cost saving vs. conventional optimizationd activation of backpressure levels

STASA QC Optimize: systematic process optimization for Injection Molding

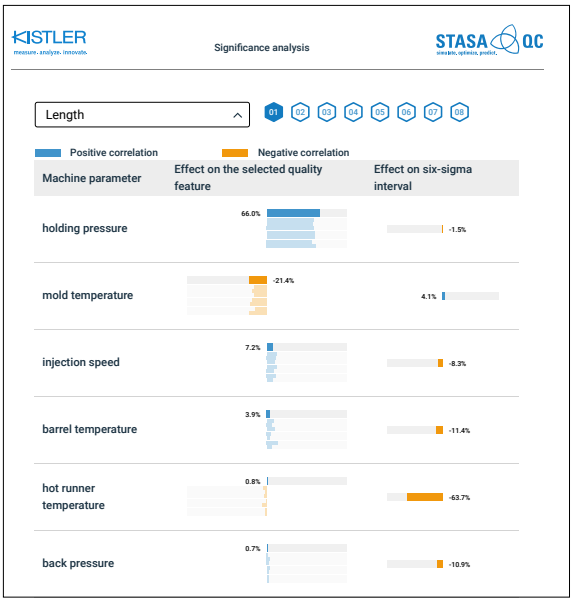
Both the increasing demands on the customer side and the cost pressure due to rising prices for materials and energy require continuous optimization of the production processes. In addition, it is becoming steadily more difficult to find employees with the appropriate qualifications. Process optimizations that are characterized by a systematic approach and automation are therefore inevitable.

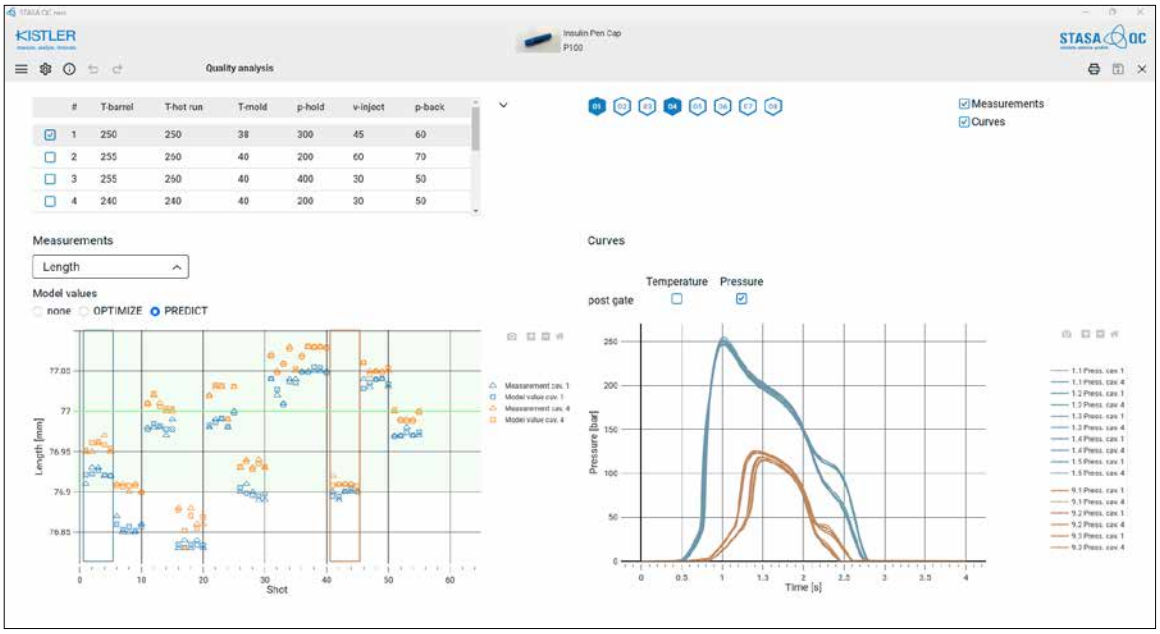
Conventional optimization methods

The conventional step by step optimization requires an experienced operator who is able to remind multiple requirements and boundary conditions of the specific injection molding process. This is very demanding due to the multivariate structure of the injection molding process. Even considering the best possible knowledge and a manageable number of technical and economical requirement this procedure is time consuming and may not result in the best possible machine setting. The alternative is a systematic approach using Design of Experiments (DoE) and advanced optimization algorithm.

Systematic approach with Design of Experiments

In order to find the overall best machine setting the influence of machine parameters on all defined demands, as quality specification (quantitative or attributive), economic framework as energy consumption or cycle time and process requirements as Cpk and robustness have to be known. A complex virtual model based on AI technology digitally mirrors the process and forms the basis for efficient optimization.

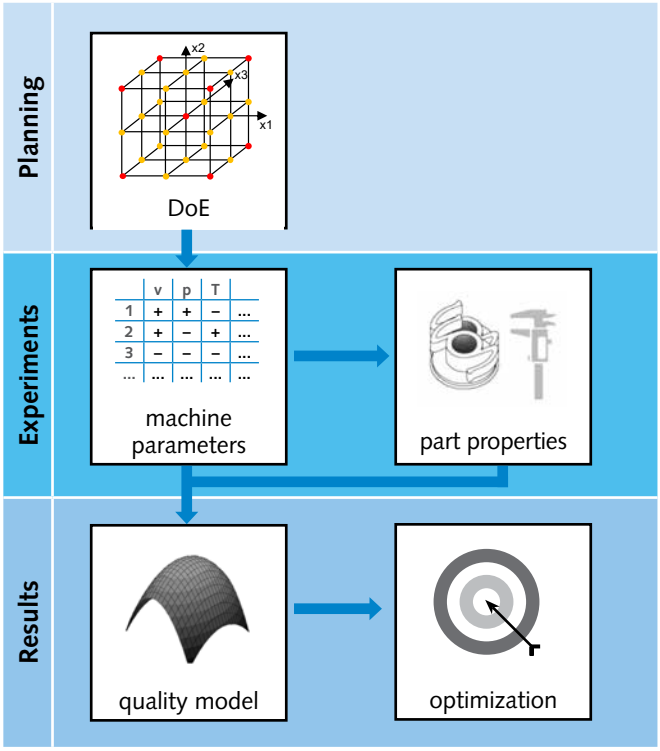




To create the process specific virtual model a systematic variation of the process is evaluated in the machine shop. The machine parameters are varied according to a minimal Design of Experiments (DoE) and quality features of the produced parts are evaluated. The resulting dataset is the base for a virtual model which is much more accurate and powerful than conventional statistical correlation. The following step of process optimization is automated, transparent, and fully documented.

At a glance all relevant information from DoE to quality featuresand - if available - sensor signals are displayed in one dashboard. The user can select and compare features, cavities, and machine setting. The customized view on the injection molding process provides a maximum of transparency and enables the user to understand and reflect the process conditions.

The optimization dashboard directly shows the machine parameters and their influence on the various optimization features like e.g. dimensions, surface quality or cycle time. The machine can be virtually changed and the influence on all resulting features including possible process windows, process capability and tolerance status is instantly visible. An automatic optimization provides the best compromise considering all kind of possible adjustments and exclusions.



STASA QC Optimize Features in a Nutshell:

- Easy to use
- Modern UI design
- Integrated Design of Experiments module
- Export of DOE to ComoNeo for automated execution of experiments
- Many import and export functions
- Full automized model creation with AI technology
- Unique and extremely fast training algorithm
- Optimization targets include:
- Quality, energy consumption process stability and process capability
- Simultaneous optimization of unlimited number of features (quantitative and attributive)
- Handling of multi-cavity tools
- Automatic calculation of process windows
- Influence of each process parameter clearly visible
- Manual adaption of optimization results
- Dashboard with direct influence visualization
- Full documentation with customizable report

Kistler service: customized solutions from A to Z

Kistler offers sales and service wherever automated manufacturing processes take place. In addition to sensors and systems, Kistler offers a host of services – from professional advice on installation to speedy worldwide deliveries of spare parts. For an overview of the services we offer, visit www.kistler.com. For detailed information on our training courses, please contact our local distribution partners.

From professional advice on installation to speedy deliveries of spare parts: Kistler's comprehensive range of services and training is at your disposal across the globe.

Kistler service at a glance:

- Consulting
- Support with installing sensor technology and systems
- Our experts support you with process optimization
- Periodic calibration of sensors in use at customers' premises
- Education and training events
- Development services

Our representatives are here to help
Whether you would like a consultation or require support during installation – our website provides the contact information for your local representative.

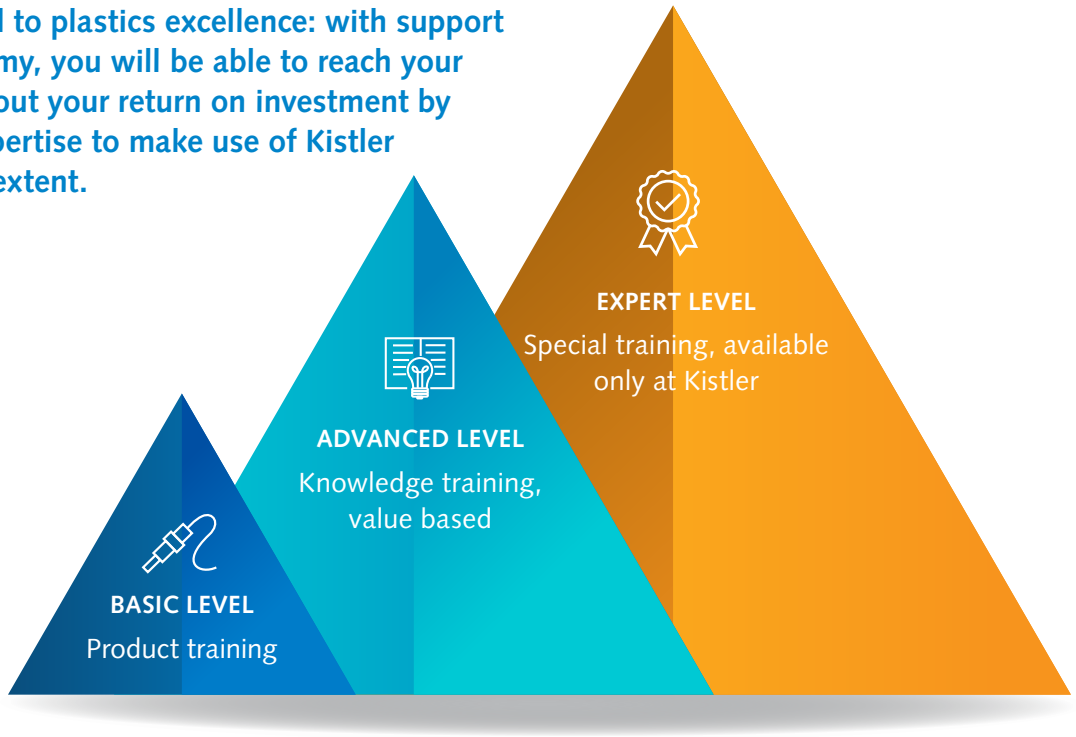
Education and training events
Education and training courses, during which our sensors and measuring systems are explained by Kistler experts, are the most efficient way for you to obtain the required user knowledge.

Data sheets and documents
Use our online search to download data sheets, brochures or CAD data on our sensors and systems.

Kistler Academy: Know-How is your most valuable asset

In modern plastics processing and injection molding, knowledge is a key factor for success. We are your companion on the road to plastics excellence: with support from the Kistler Academy, you will be able to reach your ambitious goals. Max out your return on investment by boosting employee expertise to make use of Kistler technology to the full extent.

Visit our website for more information:



Education and training are key innovation drivers in successful companies. In our dedicated product training courses, we teach your employees to unleash the full potential of Kistler technology. The Kistler Academy is an ISO-certified training organization. Its modular, knowledge-based training concept allows the participants to increase their skills and better understand the scientific background of injection molding. Therefore, we offer our customers specialized training on three different levels: from basics to advanced methods all the way to the expert level. Highly specialized training courses address new challenges of data management in the injection molding environment in particular.

BASIC LEVEL	ADVANCED LEVEL	EXPERT LEVEL
Target participants: process analysts, production planners, mold makers, production employees – everyone who works with Kistler products **Use your equipment safely and efficiently**	**Target participants:** process engineers and experts, key users – everyone who wants to know what is really happening inside the injection mold **Gain expert knowledge and optimize your processes**	**Target participants:** process engineers, analysts, quality engineers, data managers – everyone who wants to use data from the injection molding process **Benefit from process data to optimize production**
P1: Cavity Pressure Training **P2:** Sensor Installation **P3:** ComoNeo Training **P4:** Data Storage Options	**Q1:** Quality Molding I **Q2:** Quality Molding II **Q3:** Quality Molding III	**D1:** Data Management I **D2:** Data Management II

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