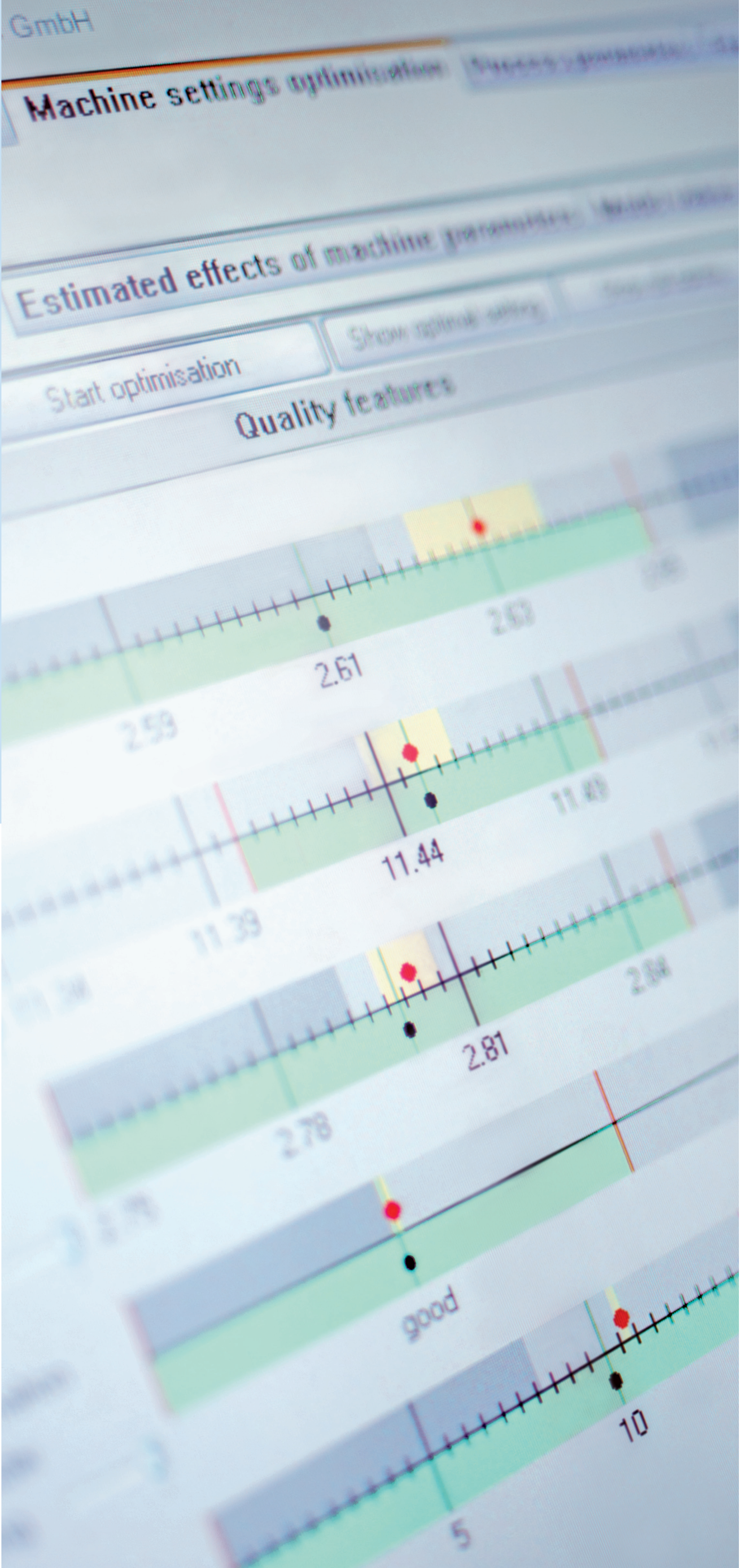

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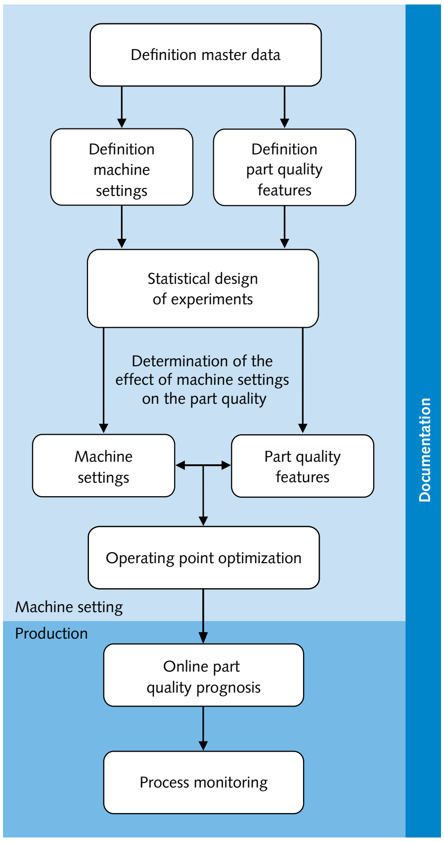
Systematic Process Parameter Optimization

Stable Processes, Short Cycle Times and the Best Machine Settings for More Productive Injection Molding Processes

QUALITY MOLDING
powered by Kistler

Systematic Process Parameter Optimization

The STASA QC software for injection molding processes increases the process stability and part quality while optimizing cycle and set-up times. With the help of a lean statistical design of experiments, it systematically determines the effect of relevant machine parameters on the part quality and optimizes the operating point, taking into account all optimization targets. A stabilized process, high part quality and shorter cycle times translate into higher output rates and significant savings.



The Stasa QC software has a systematic approach to determining the best operating point. This approach is radically different from the empirical approach of machine setters. Machine setters therefore benefit from the additional support provided by this software.

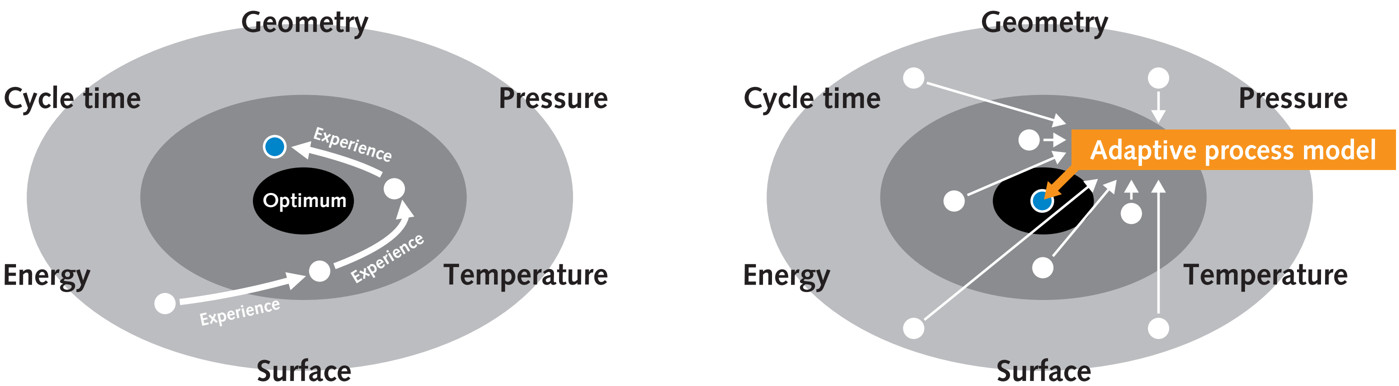
Conventional Trial-and-Error Methods

Machine setting normally involves an adjustment of the injection molding machine's operating point through successive modification of relevant parameters until all quality targets are met. During the setting phase, the operator uses trial and error and their own experience with similar parts, materials and the injection molding machine at hand. Online optimization processes during active series production are even more complex, as it requires a modification of machine parameters, recording of cycle times and measuring of molded parts after every parameter modification. Due to post-production shrinkage or water absorption, it often takes several days until the parts are ready for use. This delay often calls for a readjustment of the operating point.

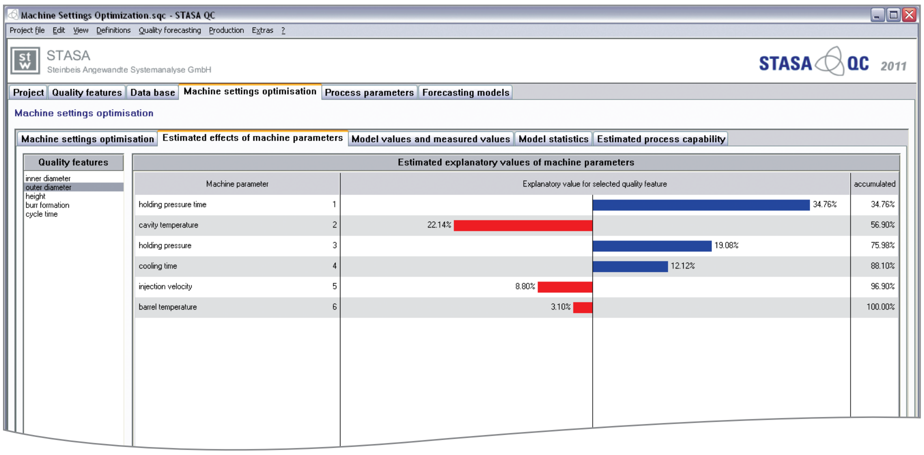
Systematic Approach with Design of Experiments

The Stasa QC software offers an alternative to this conventional, costly and time-consuming method. Right from the beginning of the machine setting procedure, the software uses a systematic, scientifically corroborated and objective approach to optimizing the operating point so as to improve the process quality and cycle time. No other machine setting besides the best operating point can achieve better quality or shorter cycle times. Stasa QC can determine the best operating point during machine setting as well as online, i.e. while the part is being produced.

The successful operation of Stasa QC is based on a systematic design of experiments (DOE). Based on injection molding machine parameters that can be freely determined by the machine setter such as holding pressure levels, injection speed and others, Stasa QC recommends a number of experiments. The machine setter can now change or enhance this selection. All parts resulting from the experiments are analyzed; not only "OK parts", but also parts with deficient quality are assessed, as they can provide valuable process information. This information is requisite for determining the best machine settings. The geometry of parts produced according to DOE is measured. Attributive features such as surface gloss, burrs or warpage are graded 1 (excellent) to 6 (insufficient) or rated good/bad.



During the conventional approach, successive modification of several parameters will eventually identify a operating point, at which the part meets all set quality targets (left). Statistical design of experiments (right) however, objectively determines the best operating point with the help of systematic experiments and very few parameter variations.



The software automatically gages the effect of machine settings on the part's quality features. The size of the bar corresponds to the magnitude of the effect, while direction and color refer to the effective direction of the setting.

Automatic Determination of the Operating Point

The measurements and features are imported into the software so as to ensure that the system has stored the required dimensions and variations as well as the attributive part features for every machine setting. Using this data and applying innovative methods for data-based modeling, Stasa QC identifies a correlation between the machine setting and the part quality. These tried-and-tested, adaptive methods are distinguished by their robustness and flexibility, which are important for the non-linear injection molding process.

With the help of this correlation between machine setting and part quality, the software determines the operating point and the machine setting that produce the best results, i.e. the point and setting at which the machine ideally meets the set quality requirements. It takes into account statistical fluctuations of the part dimensions. The best operating point is also the most stable point, i.e. the operating point that produces the lowest amount of defective parts. The software also checks the potential processability of the defined setting. At the same time, Stasa QC determines the dependence of individual quality features on machine parameters.

Systematic Operation During Online Processes

During the simulation of an injection molded process with Stasa QC, the parameters can be changed interactively, simply by clicking and dragging with the mouse. The effects of these changes on each quality feature can be tracked on-screen. The following experiments are carried out on a PC only, not on the injection molding machine. This is of benefit, particularly for the online optimization of active production processes. A systematic approach that involves the statistical design of experiments and the visualization of the machine behavior prevents unnecessary experiments. Stasa QC has an integrated report feature for protocols that provide an end-to-end documentation of the setting procedure and all results of the optimization.

Stasa QC at a Glance

- **Lower costs** thanks to shorter cycle times, less defective parts and forecast processability
- **Faster production start-up** thanks to fewer required experiments through systematic setting and statistical analysis of the correlation between machine setting and part quality
- **Safer processes** thanks to stable and continuous production of the required quality, fewer required readjustments during large-scale production processes, readily available process information through transparent documentation
- **Customer satisfaction** thanks to proven optimization
- **Accurate process information** thanks to automatic determination of the correlation between machine settings and part quality
- **Reproducible and recorded results** thanks to systematic approach

Benefits of Stasa QC

As a PC-based software, Stasa QC answers many important questions encountered by injection molders:

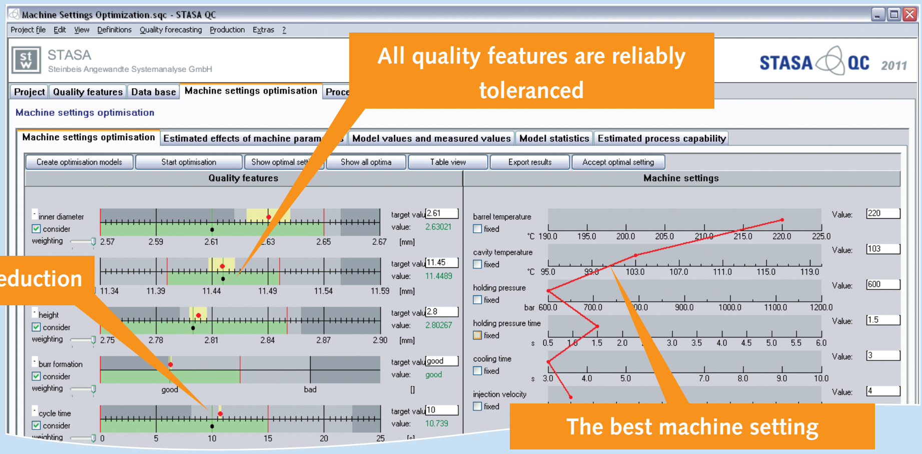
- How many parameters affect the quality of our products?
- Is it possible to determine a operating point where all set quality requirements are met?
- What is the best operating point? Why?
- Is it really necessary to constantly check the part quality in the laboratory?
- Is it possible to cut costs and cycle times without detriment to the quality?

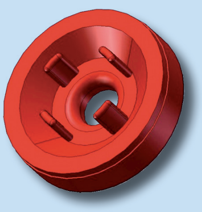
How Elfo AG Cuts Cycle Times and Saves Costs

Premium injection molder Elfo AG of Sachseln/Switzerland supplies plastic parts such as filters, inserts and machine parts to manufacturers of domestic appliances, automotive and electrical engineering parts, white goods and hygiene products. When Elfo decided to reduce the cycle times of their running production of POM baffles, the company elected a systematic optimization approach that would save time and costs.

It was important to ensure that relevant quality features such as inner and outer diameters, height and the attributively determined burr formation corresponded to the defined tolerance levels. The injection molding machine was set up by an experienced machine setter with cycle times of 13 sec. Stasa QC was used for the design of experiments (DOE) that took into account machine parameters such as melt temperature, mold temperature, injection speed, holding pressure level, holding pressure time and residual cooling time. After conducting all eleven experiments recommended by the Stasa QC DOE and subsequent measuring of the molded parts, Stasa QC optimized the operating point. The best operating point identified by the system achieved cycle times of only 10,7 sec, 2,3 sec or 18 % less than the former setting – with no detriment to the part quality.

Interactive simulation of changes to the machine setting: the model values of the quality features are displayed as red dots. The tolerance band is green. The yellow bars show the process uncertainty as a measure of the distribution of quality features.





Stasa QC reduces the cycle times of POM baffle production by 18 %.

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