USEFUL DATA AND MODELS WITH MACHINE LEARNING

1 *Planar glass plate before the bending process*

2 *Elevated glass plate after the bending process*

Model-based optimization of production processes significantly reduces production costs while maintaining or even improving product quality. However, to get the best possible results, it is crucial that the underlying models are reliable. Oftentimes expertise is already available in practice, either through experience or through well-established scientific equations. From this knowledge one can derive a preliminary expert model. Most of the time though, this model contains too many gaps, so that an overall process optimization is not possible. This is where our optimization department with its proficiency in "machine learning" comes into play.

Supervised and unsupervised learning methods

In addition to the expert knowledge, large sets of data are usually available for implemented production processes, where sensors monitor and log the operating state of the production system over time. In chemical production plants, for example, these sensors might monitor pressure, temperature or electrical power consumption. With a sufficient amount of data, statistical learning algorithms can be used to close the gaps left in the expert models.

There are many kinds of learning algorithms, broadly divided into unsupervised and supervised learning. Examples of unsupervised learning are pattern recognition and time series clustering. The supervised learning algorithms include, for example, classification methods or approaches via mathematical regression. It is often not trivial to find which algorithm to use in which situation.

Statistical learning algorithms create coherence and reliability

One difficulty with the expert models is that a production process usually consists of many individual, interconnected production units. Gaps in the expert models can result from a lack of data on these individual units or from insufficient knowledge of how they interact.

Through statistical learning algorithms the overarching interactions within the production system can be explored. More detailed models can then be developed and their reliability evaluated with confidence intervals. If physical knowledge is used not only in areas where data exists, but also for extrapolation to areas where no data has been collected. Using strategies for the optimal design of experiments, we can even make suggestions for further data acquisition in order to further reduce uncertainties.