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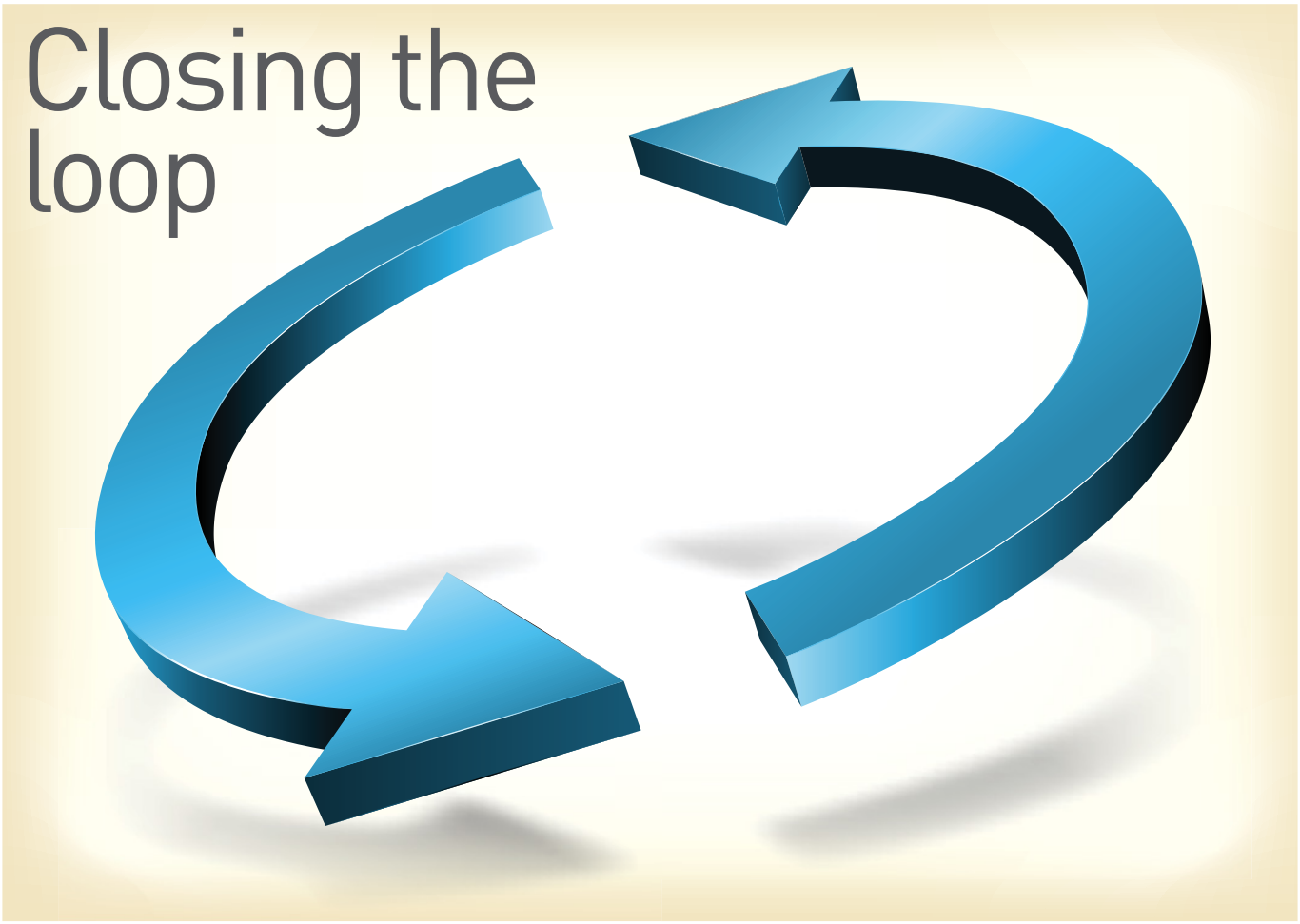

DFM considerations do not end at mould qualification. **André Eichhorn** discusses the importance of ensuring processing specifications are maintained in production

Completion of a structured and detailed upfront Design for Manufacturing (DFM) programme not only enables the optimization of the design of an injection moulded component prior to tool construction and production, it also allows the design team to control production costs and to carry out very specific and precise computer-based predictions on cycle time, number of cavities, tool setup and required moulding equipment. This detailed analysis allows the design team to determine whether the anticipated future production volume can be achieved or if more capital investment will be needed.

The predictions made during the DFM process will typically be taken as the calculation baseline for a project. Once fixed, they must meet the numbers achieved later on in production. For planning purposes, one of the most important figures is the cycle time. It is clear that, when combined with data on the number of mould tools and cavities in use, cycle time determines production volumes. But cycle time can also provide a basic but effective indicator of part quality, which can suffer if the injection moulding machine is not run within the DFM determined specification.

The intention of this article is not to get involved in the details of process optimization, which is a topic on its own. But, during the DFM process, a cycle time will have been determined and the mould tool and the injection moulding process will have subsequently been qualified to this specific target. It is important that once production is underway, that this cycle time is held to. If the cycle time is allowed to divert from this qualified value, it can put quality, dimensions as well as the production volume of a component under risk.

Many of the customers that AST provides in-depth DFM, tool specification and approvals to outsource their moulds to contract moulding companies for production. For a number of reasons, fully validated mould tools may subsequently undergo changes to their qualified injection moulding settings. For example, it may be decided to run a mould tool on a longer cycle time to extend the tool life and to reduce predicted mould maintenance efforts.

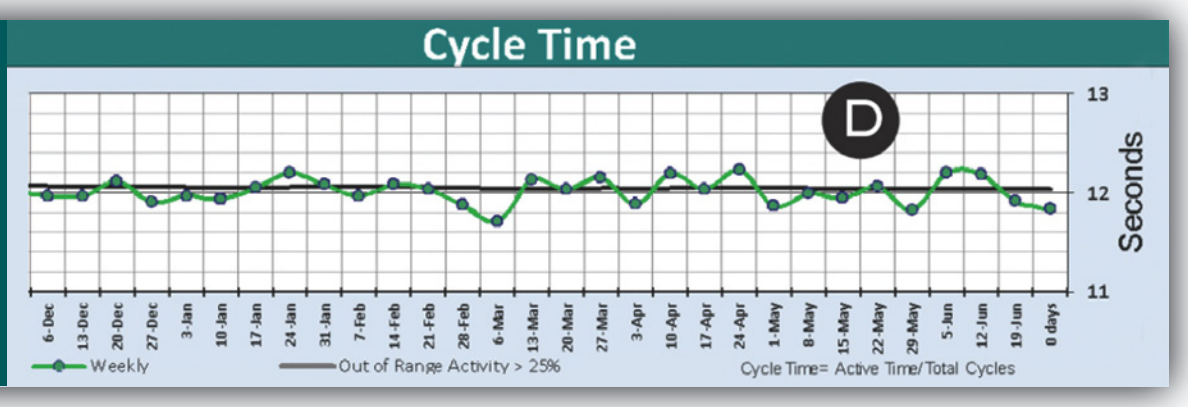

Figure 2: Cycle time data captured from AST's mould-mounted CVe monitoring device

Alternatively, it could be decided to run a tool on a shorter cycle time to free up production capacity.

It is important to understand, however, that component quality can suffer if the cycle time is allowed to divert from the DFM predicted settings and final moulding parameters. Consider the example of the POM medical component in Figure 1. This incorporates an undercut which has to be bumped off. During the DFM process, it was predicted it was necessary to eject the part at a defined cooling time when it was 85% frozen to ensure the dimension of the cylindrical sealing area remained within tolerance. The potential for cycle time changes to impact on product quality is clear in this example.

If the cooling time is too long, the part will be too stiff at ejection and damage will occur during demoulding. If the tooling time is not sufficient, the polymer will be too soft and will bow and not flip back into shape, putting the critical sealing dimension out of specification.

AST was involved in a recent tooling project for production of an automotive connector component with a clip feature where a cycle time reduction was made by the moulder to free up additional production capacity. During the original DFM process it was determined to run the mould tool at the higher end of the allowed temperature range to achieve better weld line fusion (due to the higher temperature at the polymer flow-fronts). The connector ran in production for two years, during which no failures in the field were experienced.

During the third year of production, however, the clip feature started to break. The cause of the problem was identified as a small reduction in the mould temperature, which allowed the cycle time to be reduced by around five seconds but reduced the polymer temperature at the flow-front and so resulted in a weld line weakness. Around two in every three connectors subsequently failed in the field because of this weld line issue. A key factor in quickly identifying the cause of the problem was knowledge of the specified cycle time and that being used in production.

By making frequent checks on the cycle time, it is possible for the project team to step in before production quality issues develop. A number of systems and devices are available today that trigger and record the activity of injection mould tools. These range from complete integrated systems such as those from BAKO and others, where every production moulding machine is providing data into a database for analysis, to solutions such as Männer's moldMIND or AST Technology's own CVe Monitor that stay with the mould tool.

Integrated solutions can capture a great deal of data but are, perhaps, more beneficial for the plant operator than the mould owner. Mould-based systems are less powerful but offer the advantage of continuing to capture date wherever the tool is in the world. The CVe System, for example, can pull information on cycle time and mould activity. This data can be delivered from the production site to the mould owner using applications such as OnDemand or CVe Live.

The data from the reports generated by these systems can also be taken as a lessons learned for new projects, allowing future DFM work to be improved. Required cycle time changes in production will be highlighted and the component and mould tool could be revalidated in an additional DFM loop to check on root cause impacts and possible improvements.

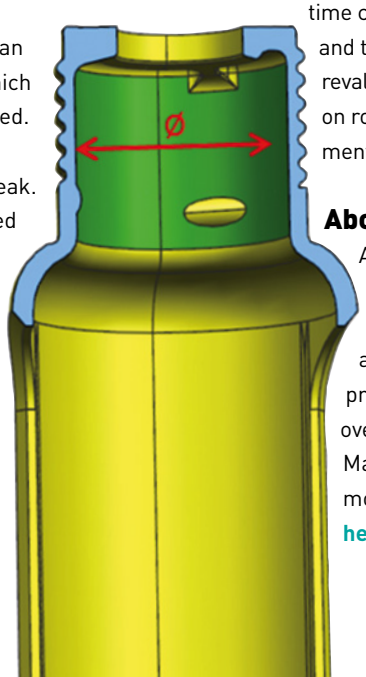

Figure 1: The bump off feature and sealing diameter in this medical component are very sensitive to mould temperature and cycle time changes

About the author:

André Eichhorn is general manager of Germany-based **AST Technology**. This is the latest instalment in a series of articles in which he discusses how product manufacturing problems can be overcome by the application of Design for Manufacturing techniques. You can read the most recent articles in this series **here**, **here** and **here**.