Moulding expert **John Goff** introduces his regular series on process optimisation and troubleshooting, identifying the fundamental issues that prevent optimal injection cycles

Perfecting the process

In today's climate, where manufacturing costs need to be minimised, it is even more important that time and resources should be given for investigations into each individual moulding process.

Many injection moulding processes are originally developed in the early stages of a product's launch and for various reasons they are never revisited. Only very problematic processes tend to be reassessed. Processes related to pharmaceutical, medical and optical components tend to be interrogated most due to the necessary validation regimes dictated by external bodies. It must be stated, however, that a good percentage of these processes are still not fully optimised.

It is my experience that moulding process parameter selection often evolves as a consequence of processing around particular issues relating to the mould tool, injection moulding machine, ancillary equipment and the properties of the thermoplastic material itself. Such parameter selection results in a process which can be described as "on a knife edge". In such cases, subtle inherent changes within the process dramatically affect the quality of the component and subsequently the yield performance.

During my involvement with the injection moulding industry, many approaches have been proposed to resolve this issue. One of the more recent examples is Design of Experimentation (DoE), where part or the whole of the process is scoped.

However, performance improvements that directly affect process parameter selection can sometimes be more effectively and simply implemented, rather than undertaking cumbersome and resource consuming

Developing a better understanding of controllable variables. John Goff's colleague Roger Blackmore runs through a demonstration at G&A's machine shop

strategies such as DoE. As with previous approaches, DoE has a very important part to play in ultimately achieving a well designed and productive moulding process, but by itself it is not the answer to everything.

With this new series of regular articles in *Injection World* magazine, I intend to share some of the more important factors and considerations in assessing and optimising an injection moulding process. Such assessments can identify the restrictions within the moulding process that have led to the selection of process parameters to achieve a workable, visually and dimensionally compliant component. This may be moulded to the required quality standards, but not always at the optimal part cost.

We will explore each discipline, highlighting scenarios where the more common "road blocks" arise, and we will discuss the actions required to investigate and overcome these restrictions. To begin with, it is important to identify and categorise the types of process parameter. Fundamentally, there are two categories of process variables: controllable and consequential.

Controllable variables. These are the variables that the process technician actually selects to effectively produce a saleable product. These include holding (packing) pressure, holding pressure time, cooling time, clamping force, barrel temperatures, screw rotation speed, changeover position, screw stroke and so on. Such values are entered into the control system of the injection moulding machine and are often selected on the assumption and acceptance that the moulding machine will use and deliver these values.

Consequential variables. These variables reflect the outcome of the interaction of the different controllable values set by the technician. Some examples include melt cushion, mould filling pressure, screw recovery time, cycle time, component temperature upon ejection from mould and mould filling time (except when using the time mode option). Therefore, the actual stability and consistency of the moulding process is determined by the natural variation of the consequential variables coupled with weight/dimensions of the moulded component. The visual requirements of the component can also be included with these variables.

Furthermore, the **controllable variables** can be sub-divided into short-term and long-term. Consider the scenario of a component that has been produced according to the necessary quality standards, but has become smaller than the required dimensional specification over a short period of time.

A quick solution to maintain production performance could involve increasing the shot volume, holding pressure, cooling time and holding pressure time. As a result of this "short-term fix", the part volume increases and produces a slightly larger component to comply with the specification.

A long-term solution could involve lowering of the mould and melt temperatures. This "lengthy fix" will generate less shrinkage within the component, giving a larger and dimensionally compliant component after a longer period of time.

The action to instigate a change is usually at the discretion of the process technician. Which of the above options is correct?

Fundamentally, the investigation should focus on what has changed within the original process. What attributes of the component have changed - temperature, weight, shape and so on? Quite often, this aspect is overlooked and is not fully investigated during the initial proving of the mould tool, especially if the process is operating on a "knife edge".

In future issues of *Injection World*, we will be focusing on specific variables and issues to help you gain a better understanding of the injection moulding process. Our monthly features will build up to a practical guide to optimising and troubleshooting the whole injection moulding process.

To download and store these pages, click on the PDF button in the browser.

About John Goff

John Goff has more than 35 years of injection moulding experience. This includes: mould design and manufacture; materials selection and processing; machine specification and operation; process control and automation; and moulding assessment and optimisation.

He has co-authored numerous books and publications on injection moulding technology and is well known for his training seminars and courses. He was a senior lecturer at the University of London, and process engineering manager at Demag.

He is now managing director of G&A Moulding Technology which acts as a consultancy for companies in Europe, the Americas and Asia. He conducts training, troubleshooting, process optimisation, mould trials, computer analyses and project management.

In his regular Moulding Masterclass column for *Injection World* magazine, he will be sharing his considerable experience, providing educational, practical and thought-provoking articles on key aspects of injection moulding optimisation and troubleshooting.

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