Robust Molding Processes

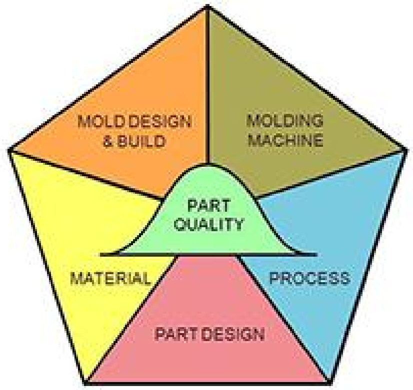
THE FIVE PILLARS AND THE THREE CONSISTENCIES

It is relatively simple to injection mold a plastic part. It is simply a ‘Melt – Inject – Cool’ process. Once the user figures out the machine controls and its settings it is almost as simple as ‘Play dough in a kids hand’. It is this very reason that most companies struggle with molding parts consistently and eventually some companies go out of business for lack of efficiency. The process settings on a molding machine consist of various speeds, pressures, times and temperatures. Each of these must be optimized in such a way that the molded parts are consistent in quality. Quality consistency is only achieved when the process is consistent which means that the process must be robust and not sensitive to natural common cause variations. Robust processes produce parts that have a consistent and predictable quality. The following are the main advantage of a robust process

- Reduced or No ‘process tweaking’ – once the process is set it molds parts consistently – (Cruise Control process as some of you have heard in my seminars)
- Reduced scrap at startup and during production
- Quick startup of the job – one need not spend hours trying to ‘adjust’ the process to make good parts
- Reduced inspection times
- Better cycle times and therefore better yields
- Predictable ‘time to finish’ of the job.

The Five Pillars

A molding process can only be robust provided the following five pillars are considered:



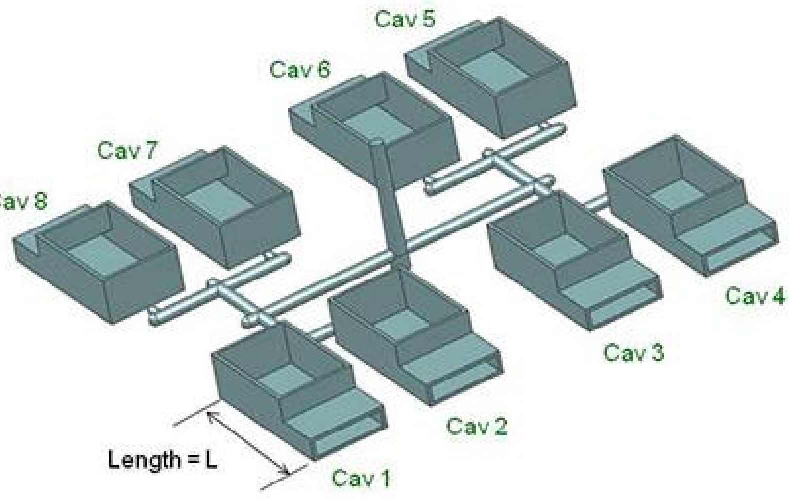
1. Part Design
    - Design should lend itself for injection molding
    - Design should follow Plastic Part Design principles
2. Plastic
    - Should be selected to match required quality and tolerances
    - Should be possible to process with given equipment
3. Mold Design and Construction
    - Design should provide optimum gate location, runner design, venting and cooling
    - Construction should be robust providing a wide Cosmetic and Dimensional Process Window
4. Molding Machine
    - The % shot size used should be ideally between 20% and 80% of the machine shot size (but there can be exceptions to these numbers)
    - The residence time in the barrel should be less than the maximum recommended residence time for the material
5. Molding Process
    - Should be robust and optimized
    - Should be repeatable and reproducible

The Three Consistencies

There are three types of consistencies that need to be achieved in Injection Molding. These are as follows:

1. Cavity to Cavity Consistency

In multicavity molds, every cavity must produce identical quality parts.



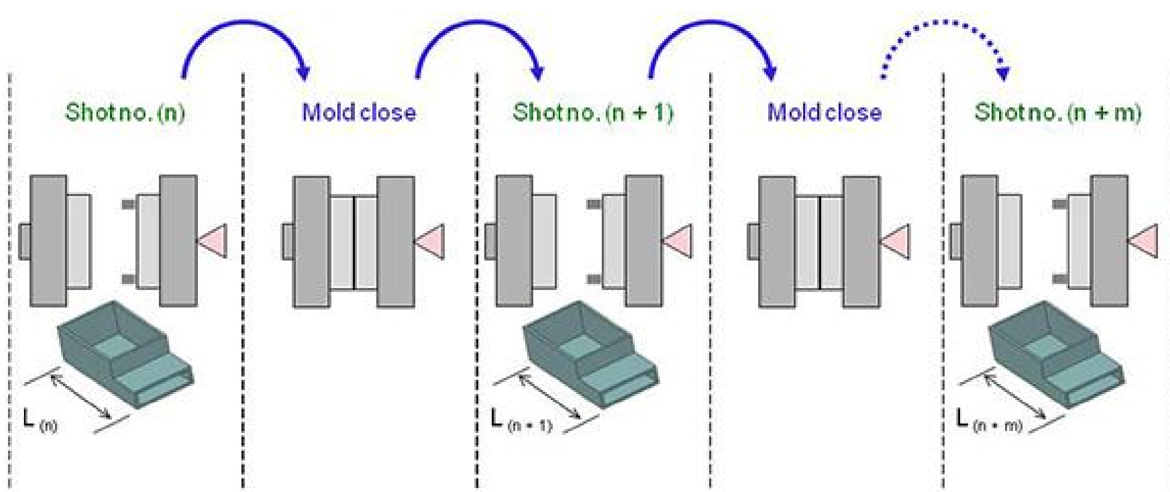
Cavity to cavity consistency:
Part length, $L_{(cav1)} = L_{(cav 2)} = L_{(cav 3)} = L_{(cav 4)}$ $L_{(cav 5)} = L_{(cav 6)} = L_{(cav 7)} = L_{(cav 8)}$

Some of the reasons why this may not be achieved:

- Cavity steel is not identical
- Rheological (flow) Imbalance between cavities
- Gate and Runner sizes for the cavities is not the same
- Uneven or insufficient venting
- Cooling between cavities may not be identical

2. Shot to Shot Consistency

The parts molded during every consecutive shots are identical in quality.

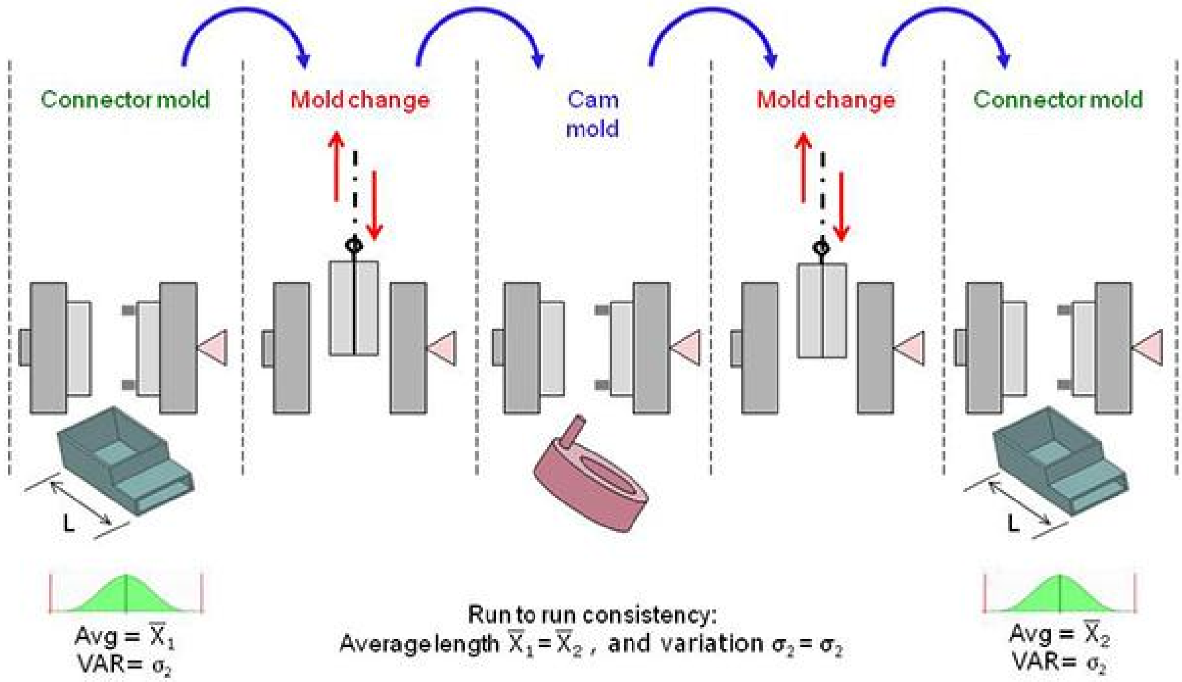


Shot to shot consistency:
Part length, $L_{(n)} = L_{(n+1)} = L_{(N+.....)} = L_{(n+M)}$

Some of the reasons why this may not be achieved:

- The process parameter settings are not robust
- The process is not optimized
- Machine is not delivering the melt consistently
- Mold and part design are not optimized

3. Run to run consistency



Some of the reasons why this may not be achieved:

- The recorded process is not robust
- The molding machine (previous or present) is not consistent or out of calibration
- All the molding parameters were not recorded and hence cannot be duplicated

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