Troubleshooting Defective Parts

By Douglas M. Bryce - December, 2003

* For our purposes, troubleshooting can be defined as an activity that takes place to determine the cause of, and solution for, defects found in a molded part. This activity usually takes place while parts are being molded and occurs when the normal production of acceptable parts is interrupted by the unexpected production of one or more defective, unacceptable parts.
* The person performing the troubleshooting activity may be an operator, a process technician, a plastics engineer, or even management personnel. For our purposes, we will call that person the ``troubleshooter,'' although that actual title seldom appears as a job description.
* In some cases, troubleshooting occurs when analyzing parts that were previously molded, such as when parts are returned from the field because they did not properly perform their intended function. Usually this situation is analyzed using failure analysis activities but troubleshooting may be also called upon.

What Causes Defects?

A study that took place over a 30-year span (by Texas Plastic Technologies) analyzed the root causes of most common injection molding defects. The defects studied were process related and did not include those resulting from poor product design. Everyone agreed to the product design with no further changes, and the molds were producing acceptable parts in a manufacturing environment. This study found that the defects could be traced to problems with one or more of the following four items: the molding machine; the mold; the plastic material; and the molding machine operator. The most interesting thing was what percentage each of these items contributed toward the cause of the defects. Below list the most common causes of defects in molded parts and the percentage for which each cause took affect.

1. Molding Machine = 60%

2. Mold = 20%

3. Material = 10%

4. Operator Error = 10%

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Contrary to what the study found, most of us in the industry have held the belief that the most frequent cause of defects is usually the material, with the operator coming in a close second. However, as the study proved, the actual most frequent cause of defects is the molding machine, followed by the mold. Thus, when troubleshooting, the first place to look for a solution to a defect problem is the machine because the answer will be there 6 out of 10 times.

Troubleshooting Tips

1. A troubleshooter must be able to approach a problem with an objective mind. What solved a problem one day may not solve the same problem another day.

2. Because of the large number of parameters (more than 200) involved in molding, the variables of these parameters, and the way they all interact, many solutions may exist for a single problem. Conversely, many problems may be fixed using a single solution.

3. So, the troubleshooter must think through the problem and make sure the most obvious solution is being utilized first. This is accomplished by applying objectivity, simple analysis, and common sense.

By visualizing what happens to the plastic as it travels from the hopper through the heating cylinder, and through the flow path to the cavity image, you can determine what may have changed that could be causing defects. A heater band could be burned out, an injection pressure valve spring may be weak, or cooling water lines may have become blocked. Any of these problems will cause specific things to happen. A thorough understanding of the molding process will help determine these problems and their solutions.

For now, it is important to understand that most defects can be corrected by one of a variety of changes. For instance, either drying the material, reducing nozzle temperature, or increasing the backpressure usually can correct splay. The trick to proper troubleshooting is to know when each solution will work and how to identify which problem is actually causing the splay. Understanding this concept will make the troubleshooting process less of a mystery and more of a science.

Successful troubleshooting usually requires making a change to an existing process. These changes will sometimes have an immediate effect, but in all cases, any changes will also have long-term effects. This is because the total molding process requires a certain amount of time to stabilize after any change is made. For instance, an increase in barrel temperature will alter the flow rate of a material after only a few minutes. However, that increase also has an effect on the injection speed after a few more minutes because the material is easier to move. A faster injection speed may initiate a tendency for flash to begin after a few more minutes.

There are three major considerations to follow when adjusting molding parameters:

1. Create a mental image of what should be happening during the process and look for obvious differences

2. Make only one change at a time

3. Allow the process to stabilize for a period of 10 to 20 cycles after any single change is made to the process. If a particular change did not fix the problem, the change should be reversed (the setting put back where it was) before any other change is attempted. In addition, the next change should not be made until another 10 cycles have transpired.

This demonstrates that troubleshooting can be a time consuming process because of the amount of time required to allow the machine to stabilize between changes. However, without that stabilizing time, so many changes can be made so quickly that no one could determine which change actually solved the original problem. Of course, the major concern is that the entire process may quickly go out of control because changing one parameter will affect another.

It is a common misconception that a troubleshooter must have years and years of experience, and had to absorb some amount of ``black magic" over those years to solve processing problems. In fact, a good troubleshooter needs only a good understanding of the molding process, tools, and materials being used.

Too often a technician, engineer, or operator will be presented with a molding defect and will start turning dials, flipping switches, and adjusting timers without understanding what they are doing or knowing what results to expect. This is a common problem and is due to the fact that most troubleshooting is done as a result of doing something (anything) that worked in the past. Also, due to schedule requirements, a quick fix is desired, and the technician is pushed into a management-directed panic mode. The result is pandemonium, as attempts to correct defects only seem to make matters worse and the entire molding process quickly goes out of control.

While this is a standard scenario in most molding companies (but not highly publicized nor recognized), it does not have to be that way. The situation should be such that the troubleshooter can objectively analyze a molding defect and determine a probable solution before making any changes. The solution should be attempted, followed by another decision. Each solution should be determined independently and rationally. There should be no guesswork, and, when necessary, assistance from outside sources should be solicited and welcomed.

Developing Product Dimensions (...*NOT*)

One very common fault that occurs throughout our industry is that of trying to force the process to provide a molded part to specific dimensions when trying out a brand new mold. Although we can use the process parameters to make a part bigger or smaller, this should not be done on a new mold. This is because it minimizes the process parameter window for making changes when we do have the need. For example, when a new operator is placed at the machine, or the immediate environment changes, or a new batch of material is being processed the process parameters may need adjusting. On a new mold, it is better to create a process that produces the best visual part we can make, in the fastest cycle that we can safely attain. Then, once the process has stabilized (which may take up to eight hours), and the part has properly cooled (which may take another eight hours), we should check the part dimensionally. If any dimensions need adjusting, the mold should be pulled and the dimension adjusted by the mold maker who built the mold originally. This is called developing the mold and should be considered standard practice for new molds. If the dimension can be accepted rather than have to be fixed, the part drawing should be changed to reflect that decision.

Of course, once the process has been optimized and the mold has been developed and accepted for production, any future problems resulting in dimensional changes can be corrected with minor process adjustments. That is where troubleshooting comes in. An example would be excessive shrinkage from a change in melt index of the plastic material. A process adjustment can be made to accommodate this problem. That is why we need the large process window in the first place.

A more realistic proposal to troubleshooting is to use a two-pronged approach that consists of using the material suppliers' guide coupled with good old common sense. Remember: keep the troubleshooting process simple. In most cases, a single solution will correct a defective situation. The key is to come up with that single solution without wading through a myriad of possibilities.