Troubleshooting – Discipline is the Key to Success
According to the late Philip Crosby "Quality is precisely measurable by the oldest and most respectable of measurements – cold, hard cash". An effective quality control system is necessary for profitable companies. There are two approaches to quality control: proactive and reactive. Proactive quality control involves techniques that minimize variation in key product characteristics, such as dimensions, appearance, durability etc.

One of the most successful proactive techniques is ISO 9000 series standards. It focuses on reducing variation for key inputs, thereby reducing finished product variation. ISO 9000 techniques focus on only three aspects of any process: is the process documented? is the staff trained to follow the documented procedures?; are the documented procedures being followed? ISO series standards really focus on improving consistency rather than absolute quality.

Other popular proactive systems formalize procedures with flow charts, fishbone charts and check lists. Statistical Quality Control (SCQ) is used to determine if the product can meet the specifications. Statistical Process Control (SPC) is used to make sure the process is under control. Both assume variations follow a normal, predictable distribution pattern. SPC is useful because it helps identify unusual variations in the process. The limitation with SPC is that it does not tell you how to correct unusual process fluctuations.

Troubleshooting is necessary when all the quality control strategies described above fail to keep the product within specification. Contrary to human nature, the most successful technique does not involve interrogating everyone involved until you can find someone to blame for the problem. A collaborative approach to problem solving is much more effective. Simple, open ended questions are best, not ones that require a yes or no answer. The purpose of asking the questions is to search for clues that will help you identify the most likely causes of the problem. Examples include: "Did you notice anything unusual when the problem occurred?" or "What else changed when the problem occurred?" Troubleshooting is the process of eliminating possible causes until only one remains. It is then a simple task to fix the problem.

Step 1 - Describe the problem
Everyone involved in the process must use the same terminology for defects or problems. This should be one of the outcomes from the proactive systems described earlier.

Step 2 – Record the information
Write down the nature of the problem and when it started. Use a standardized form to remind people what information should be recorded.

Step 3 – Take and store samples
Samples that exhibit the defect are critical because they may be evidence in a

compensation claim, from a raw material supplier for example. A list of sample quantities is included at the end of this article. Use clean, preferably transparent containers. The time and location that the sample was taken should be recorded on the container.

Step 4 – Plan your strategy
History is a useful ally. If you have successfully produced the product in the past, ask "what has changed?" Accurate process condition records are very useful. If you don't have them, consider implementing a system right away. If you are producing a new product, ask "what can be done to improve the product?" Most companies use some form of flow chart, fishbone chart or check list at this point to help identify possible causes. Check the simplest causes first. For example, check for contamination in the feeding system if you see a color change or gels.

Step 5 – Take corrective action
Use a clear set of rules so personnel know the range of adjustments they can make without seeking approval from a supervisor. The most adjustments are to production rate, temperature, pressure and formulation. Significant changes may affect properties in the product that are not measured during manufacturing. Examples include strength and barrier properties. The time any action is taken and the results should be recorded on the standardized form mentioned earlier.

One common pitfall is to slow down the process. If the problem disappears, no further action is taken. Although the percentage of defects returns to normal, productivity suffers. Classic examples include curling in extrusion profiles and melt fracture in film.

Step 6 – Assess the results
Make only one adjustment at a time and wait for a reasonable amount of time to confirm the outcome. Keep in mind that adjustments may have consequences further along the manufacturing process, so be prepared to make those adjustments as well. For example, adjusting process temperatures may result in hotter material, which will require more aggressive cooling later on.

If the first adjustment did not solve the problem, repeat Steps 4 to 6. Don't forget to take samples before making any other changes, and record what changed as a result of the adjustment. Use a clear standard concerning the amount of time that can be spent fixing a problem before stopping the production run and moving to another product. The information and samples collected should be reviewed by senior production personnel who can what else to change. This often involves changing formulations or equipment used to manufacture the product.

Success Factors
The most important success factors in troubleshooting are:

- Use the same terminology

- Pay attention to the details
- Keep accurate records
- Think before you act

In Case of Problems
Collect

Information

- Raw materials
- Processing conditions
- Document the details

Right Samples

- Raw material from feed hopper and from original containers
- Samples which have defects
- Samples without defects (if required for comparison)

Minimum Sample Size Requirements for General Tests

Test	**Film**	**Resin**
Melt flow index	0.1 M^2 / 1 ft^2	125 g / 0.1 lb
Viscosity		500 g / 0.1 lb
Film density	0.1 M^2 / 1 ft^2	
Resin density		125 g / 0.1 lb
Additive concentrations	0.1 M^2 / 1 ft^2	125 g / 0.1 lb
Molecular weight distribution	0.1 M^2 / 1 ft^2	125 g / 0.1 lb
Haze / Transmittance	1 M^2 / 10 ft^2	
Gloss	1 M^2 / 10 ft^2	
Impact strength	3 M^2 / 30 ft^2	
Tear strength	1 M^2 / 10 ft^2	
Tensile strength	1 M^2 / 10 ft^2	
COF /Blocking	1 M^2 / 10 ft^2	
Heat seal range / Hot tack	2 M^2 / 20 ft^2	
Surface treatment level	1 M^2 / 10 ft^2	
Gels	3 M^2 / 30 ft^2	