Error Proofing Your Process – "Man or Machine?"
Error Proofing Your Process — “Man or Machine?”

Ed Wrench, Plant Manager
Auto Cast Inc.
Grandville, Michigan

Introduction
Things have changed considerably for all of us over the last 20 years. What used to be acceptable can no longer, in most cases, be sold as a conforming casting. Quality requirements are far more stringent than ever before, and the demands from customers for 20 ppm or less have now become a demand for zero defects shipped to their facility. Anything other than this usually requires additional cost to the die caster for sorting and containment procedures. How will we, and can we, reach these demanding expectations?

Can we continue to use the same manufacturing techniques that we used over the last 20 years and achieve something different than what is currently being accomplished?

Current Practices
We all struggle with the concept of shipping zero defects. Is this even possible, and if so, how do we achieve it? In the past, most die casters have relied on a person or persons for the quality of casting that was sent to the customers. Unfortunately, human beings do not have the ability to be error free for an entire shift due to distractions during the day, fatigue or many other factors that affect the human performance. This lack of consistency is one of the primary causes of defects. To maintain a stable and robust manufacturing procedure that minimizes and/or eliminates casting defects from castings produced and shipped, 100% consistency along with 100% inspection are needed. Since man is not capable of achieving these requirements, new practices must be implemented that rely on technology and complete automation of the manufacturing work cells and inspection procedures. This article will cover some specific practices and equipment that are an absolute necessity to reach the die caster’s objective of zero defects.

Shot Monitoring Equipment
It is amazing how many die cast machines are still in production today without some method for measuring the performance and consistency of making a casting. This is an area which could be the most important and beneficial investment that could be made to improve the process. Things can and will change weekly, daily and hourly in the injection and clamping phases of the process. These major or minor changes in the process do indeed affect the consistency of the castings and have a potential for producing non-conforming castings. A good monitoring system that is dedicated to a specific machine for the measurement and plotting of each cycle is an absolute must to reaching zero defects. Parameters are established for each individual job that is run in a particular machine, based on product requirements. These parameter “examples,” such as the slow and intermediate shot speeds, fast shot speed, fast shot start point, biscuit size and solidification pressures are monitored each cycle. If at any time one of these parameters is violated either above or below the high and low set points, an alarm can be sounded to notify the operator that the casting is defective and must be scrapped or removed from the normal process flow. A better and more absolute scenario is to not rely on human decision and interaction, but to have some sort of robot extraction system tending the casting work cell. When a casting parameter is violated, the robot controller is notified that the casting must not be trimmed, and it is immediately placed in a designated containment container such as a scrap conveyor. This designated area must not allow the operator to bring the gate to an area in the work cell that could accidently allow it to be trimmed and placed in the normal work flow process. The casting must be removed from any physical human interaction where a mistake based on opinion or distraction can be made.

Metal Delivery Systems
This is an area of the process where it is almost impossible to achieve consistent cycle times, pour temperatures and biscuit sizes by hand ladling or relying on the operator to monitor plunger drift and ring conditions. Although the practice of hand ladling is still used in many operations, today’s strict casting requirements will eventually make it impossible to remain a competitor without automating the ladling process.
Only by auto ladling or dosing, with some means of monitoring current plunger position, will the required consistency in shot size, cavity pressure and injection temperature be achieved. External defects can usually be detected by the human eye. Internal defects, however, caused by inconsistent conditions in metal delivery will most likely get past the operator unless there is some sort of automatic measuring device or devices. Although automatic ladling and/or dosing substantially improve the chances for minimal defects, they are not free from fault. These machines must be maintained properly to eliminate malfunctions that may occur through excessive use and environmental conditions. Automatic ladling and/or dosing, in combination with a measurement system for every shot that is produced, will be essential to improving the consistency of the casting process.

**Die Spraying Techniques**

When comparing hand spraying to automatic spraying, which technique will provide the consistency that is required to reach zero defects? As you attempt to answer this, keep in mind that most operations run a two- or three-shift operation, and we therefore need to choose the method that will provide the least amount of variation over all shifts.

Differences of opinion are always present throughout the workforce as we strive for improvements and optimum performance in the spray processes. If one shift to another varies at all in the spray application, the quest for zero defects will be met with the obstacle of being able to maintain consistency in the cycle time and method of applying lube, water and air to the die. Only with automatic spraying techniques can a company reduce the variation in the spray process to an absolute minimum. Dedicated manifolds with non-adjustable fixed orifices and the ability to measure the amount of lube applied are a few of the features on automated spray systems that will help reduce die spray variations to a minimum. Any time the operators are responsible for determining how much lube is to be applied, based upon their opinion and experience, the casting becomes more susceptible to excessive variation. Stored and automatic recall of specific job programs is a must in order to reduce the possibility of incorrect positions and times that are entered during job changeovers. In addition to automating the spray application device, it is also imperative that the die spray mixing system be automatically regulated for dilution ratio and consistent monitoring of ratios. Manually mixing tanks each day will not provide the consistency needed to achieve zero defects in the casting.

**Part Handling**

Another crucial aspect in the action plan to reduce process variation is the method of part handling after the casting is produced. When a casting is manually extracted, the operator is responsible for determining if it should continue through the value-added stream or be scrapped and removed from the workflow. Statistically, human judgment in this area is only correct approximately 80 to 85% of the time due to distractions and fatigue that affect operators during a normal work day. Just one defective casting that is accidently left in process is all it takes to upset a customer. If the number of defective castings received by a customer starts increasing from 5% to 15%, it then becomes much harder to ask for forgiveness and maintain that customer/supplier relationship.

Properly programmed robotic extractors that are interlocked with the work cell do not experience daily fatigue or make decisions based on opinions from shift to shift, day to day. Instead, after the casting has been removed from the die cast machine, the robot/extractor will present it to an inspection device with whisker sensors, photoeyes or limit switches to determine if the casting is acceptable. If the detection process is more involved than these devices can handle, a vision system can be added to communicate specific programmed data to the robot. Based on the information received from the sensing device, the extractor/robot will automatically remove any defective castings from the work cell and place them into a designated scrap or containment area.

**Conclusions**

If we design our processes to eliminate or decrease the causes of potential failures, the number of castings shipped with defects can be reduced to a minimum. Can this reduction ever reach the zero percentage we are all striving to achieve? At this period in time, it is doubtful that even with all the innovative technology available, any company can run each and every day without the potential of producing a non-conforming casting. Unfortunately, there still remains numerous variables in the process that cannot be measured, including malfunctions in equipment, human errors, normal wear or catastrophic tooling failures. Although automation has made great strides over the past decade in helping the die casting industry overcome many of these issues, the need for persistence in creative thinking and new innovative technology remains an important element in keeping U.S. die casters alive.
Even after the necessary steps have been taken to control the amount of defective castings that make it through the casting process, the fact remains, we still have to provide a final means of inspection prior to packaging to ensure the customer is being shipped the best parts possible. Automatic or semi-automatic inspection devices at pack-out can include gauging machines, vision systems, x-ray unit and resonant acoustic testing. While all of these methods assist in preventing defective castings from making it into the shipping container, there is unfortunately no method to discover a failure condition may exist with the final inspection device. Sensor systems will fail eventually, which makes having the appropriate procedures and engineering in place to failsafe the method of failsafe so crucial. The only alternative is to continue to rely on human eyes to catch every non-conforming casting that may possibly be shipped to the customer. Which will bring us back to the question of how to error-proof the system. That is a choice that each one of us must make based upon production rates, probability of defects and the value of a dollar for man vs. machine.

**Personal Remarks**

How will AutoCast still be here producing castings for another 45 years and longer? These are thoughts that I and the great people that I have had the privilege to make castings with for the last 20 years are constantly contemplating. The operation that I belong to is not free from fault or even close to where we need to be to reach zero defects. But the recommendations made in this article are a few of the paths that we have chosen to ensure our survival. It is my belief that those who keep up with technology and modern production advancements will be the only ones that can make it in today’s market. We have to change our thinking and methods continuously if we are to survive. I realize that there are so many other practices that need to be in place and working effectively to insure our survival, but I hope that these ideas will help others as it has me to improve our operations and capabilities.

**Acknowledgments**

These ideas are not my own, they were placed in my head over the years by the advice and teachings of so many people that I respect and could not have been in this business so long without. My mentor Ron Lockman and the employees of Auto Cast Inc., Jack Helder, Wayne Alofs, Bill Walking- ton, Derek Cox, Ed Herman, Russ VanRens, Phil Van Huis, Paul Cnossen and so many others that it would take several pages to express my gratitude to them all for their contributions to the industry and my education.

Thank you to Miss Linda Wise from Rimrock Corp. and Buhler Prince for their assistance and contributions to this article.

**About the Author**

Ed Wrench is the plant manager for Auto Cast Inc. in Grandville, MI, and has been with Auto Cast since January of 1998. Over the years there, he has worked in the casting departments, maintenance and process control. He has also been an instructor for NADCA since 1996, focusing on training in areas of process and automation for the die casting industry.