The Do's and Don'ts of Design

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This article is written from the perspective of the die casting supplier. However, there is plenty of application to other industries and processes.

In North America, the terms die casting, cold chamber die casting, aluminum die casting and high pressure die casting are synonymous.

There are many pressures in the world of manufacturing. Designers are being directed to provide product designs that reduce costs while increasing value. While it is true that many of these new products and components hit the mark, many of the so called "aggressive designs" create problems for everyone involved. These include the product designer, the die casting mold designer, secondary trim and machining fixture designers, manufacturing and others.

Beginning with the end in mind is often quoted by management and motivational speakers. It is equally true with design. The difficulty is that the designer's vision is limited to the finished product with no insight into the manufacturing processes that are required.

Problems

- The designer may be isolated from manufacturing.
- Their only guidelines are material specifications, but what of the limitations placed by the particular process?
- The plastic material suppliers have aggressively promoted their products by providing on-site design and sampling assistance to designers and manufacturers.
- In every industry, there are parameters that are well-known internally but not to the designers.
- Materials are selected from published material specifications without regard to additional processing costs (for example, ZA alloys, 390 or other high performance alloys).
- Processes may be pre-selected without regard for costs or even availability of the equipment.
- Angles are easier to draw than radii.
- When you don't know what tolerance the process can hold, adding wall stock can create additional problems.
- Designs that keep changing, even while the dies are being produced.
- Lack of understanding of tooling programming and manufacturing needs.
- Taking too long to review approval drawings.
- Thinking size of the product has no effect on the amount of time to produce the tool.

Details and Examples

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Their only guidelines are material specifications, but what of the limitations placed by the particular process?

It is not uncommon for an engineer or designer to request a material that is only practical in another process. For example, we frequently receive requests to quote aluminum die castings using a sand cast material. They have carefully researched the materials book and decided that this is the best material for their very special application. I have even received requests for aluminum alloys that were chosen based on their superior electrical conductivity. The distance that the electrical current needed to flow was not miles or yards or feet. It was a few thousands of an inch, and the benefit would not have been measurable.

Other examples are requests for heat-treated die castings. While this is done on a limited basis, the extra cost is seldom worth the benefit.

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The plastic material suppliers have aggressively promoted their products by providing on-site design and sampling assistance to designers and manufacturers.

As metalcasters, not all competition is from offshore or low-priced suppliers. Particularly in high volume applications, the plastic material sales people visit designers and engineers looking for the opportunity to simply sell material. They will often develop the product in their own or a custom shop to prove to the customer that it's a viable alternative to a cast metal component. A custom shop will produce the product and the material supplier makes his sale.

We need to aggressively seek to provide solutions to designers by proving why our material and process is the most cost-effective and gives the highest performance.

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An example is designing the need for core pulls in more directions than are practical.

Materials are selected from published material specifications without regard to additional processing costs, (for example, ZA alloys, 390 or other high performance alloys).

The ZA materials provide superior strength and ductility to most standard zinc or aluminum alloys. However, they cost more, wear dies out faster than standard zinc alloys and some may require a cold chamber machine. They are not always compatible with the suppliers existing equipment, furnaces or melt practices.

This is not meant to discourage use of these materials, but to emphasize that if this is what's required to meet the performance criteria, then be aware, it's not free.

Processes may be pre-selected without regard for costs or even availability of the equipment. (A recent event tells of an auto executive demanding that the grill for his newly designed SUV be die cast zinc. The problem is there has never been a zinc die casting machine large enough to cast the part. Pity the poor designer or buyer who had to deliver the news that no one could fill his order.)

There are some size castings that are fairly safe in designing prior to looking at suppliers. But in most cases, it's a good idea to find out if the capacity exists for the product. An electronics customer came to me with a design that required a 2,000-ton machine. The availability of a 2,000-ton machine for 1,500 pieces a year and a two-year product life was not to be found.

Angles are easier to draw than radii.

You might ask, "What's the difference?" Radii are good for both the supplier and the customer!

- Radii in the tool can improve tool life and reduce the tendency for catastrophic cracking.
- Radii on core pins will reduce breakage by eliminating stress risers. Adding radii to core pins where they had previously been sharp corners has proven to extend the core life by 5 to 10 times. This translates to improved productivity and part quality overall.
- Radii in the casting can make it stronger and improve strength tests.

When you don't know what tolerance the process can hold, adding wall stock can create additional problems.

It is not uncommon for people to add wall stock to compensate for out of tolerance conditions. As more wall stock is removed from a heavy wall section, you are more likely to expose shrinkage porosity. While the porosity may be minor, it may be unacceptable to the customer and result in rejections, lost sales or late shipments.

The solution is to improve the tolerance of the tooling and the casting so that the machining tolerance can be minimized. This reduces cutting tool wear and improves productivity and cost control.

8 Designs that keep changing, even while the dies are being produced.

Once the purchase order has been placed, it's time to leave the design alone. No more last-minute changes.

With today's tool manufacturing methods, a change in the middle of a CNC cutter path can mean a program rewrite. This type of interruption can affect final delivery and result in cost overruns and mistakes.

In addition, confusion over which is the current version can lead to producing a tool that is simply wrong. A tool that is made with obsolete data can be very expensive, especially when it's part of an assembly that is late due to one missing part. Then, the debate about whose mistake it was and who will pay for it begins.

9 Lack of understanding of tooling programming and manufacturing needs.

See above. In one example, the designer was still introducing changes four weeks into the tool construction. Each new change required modifying the CNC cutter paths and EDM electrodes. All physical work stopped until the program changes could be completed. Of course, purchasing continued to insist on maintaining the original delivery date. Everyone on the purchasing and engineering team needs to understand when the clock starts and who will have the authority to interrupt it, as well as the costs and timing associated with an interruption.

10 Taking too long to review approval drawings.

This is equally important for both product and tooling engineers.

A tooling approval drawing that sets on the desk for a week awaiting mark up or approval can adversely affect the tool delivery and ultimately a product launch.

We need to understand the purpose the drawing was sent to us.

- Was it sent as "information only"? A client spent a lot of time reviewing and making suggestions on a preliminary tool drawing only to find out that it was only intended as information. The tool shop completed the tool "as designed" with no regard for the input from their customer.

- If the tool drawing requires approval and/or mark up, it is imperative that this be completed in a timely manner. And, it must be clearly understood by the tool shop. A final design incorporating the changes should be sent for review and agreed to by the tooling customer.

11 Thinking size of the product has no effect on the amount of time to produce the tool.

One of our customers had worked previously in an industry that dealt in small castings. Most were smaller than your hand. In his new job, we were building him a tool to produce a large casting that required a 1,200-ton machine. Because of his previous experience, he believed that all tools took the same amount of time to produce (8 to 10 weeks). We had to educate him on the fact that we were going to produce 6,000 pounds of machining chips in the production of his tool. And no, it takes longer to make 6,000 pounds of chips than it does 500 pounds.

Some of the largest die cast dies in production today take nearly a year from design to completion, while small dies are routinely built in a matter of a few weeks.

12 Management's need to understanding the business.

In a recent example, a client purchased a large quantity of plastic injection molds to produce molded parts in Asia. They thought they were purchasing multi-cavity molds and found they had only purchased single-cavity molds. Since there is only one of each, the supplier will not have the capacity to meet their customer's production needs without building additional tooling.

There simply is no substitute for the knowledge that is available from experienced professionals.

Conclusion

There are plenty of ways to improve the design process, and the number one method is to learn more about the process that will produce your finished product. Regardless if the process is high pressure die cast or gravity casting of aluminum, magnesium or zinc, time and money will be saved by becoming more familiar with the limitations of the material and processes.

Use your supplier's experience. It could be the best investment you've ever made.

About the Author

Bob McClintic began his die casting career as a tool and die apprentice. He has served in numerous capacities in the die casting industry, including controls engineering, plant and facilities, tooling, project and plant management and technical director. He has been active in several NADCA chapters and is currently a board member of NADCA Chapter 3, Western Michigan. He enjoys travel especially to visit family and friends throughout North America. McClintic began his consulting business in 1998 and since has served clients throughout the USA, Mexico, Australia, Malaysia, Turkey and India. He can be reached at rmcclintic@ameritech.net, or visit his Web site at www.diecastingconsulting.com.