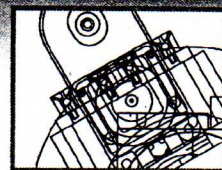


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The Inside Look At Post Casting Operations

Trim Tooling, Necessary Evil, Value Added Process or Profit Opportunity



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In order to achieve a PPM level quality rating, one must address all the processes. Well known speaker and author Stephen Covey states, "Begin with the end in mind," a principal that certainly applies to the design of castings and trim tooling.

At least one die casting company has found that 75 percent of its quality complaints were not casting but trim related defects. There is a common tendency to regard trim tooling as a "low-tech" process of de-gating the casting so we can then either ship the casting or transport it to the machining department where we can begin to perform the real value-added processing. In fact, most companies use a "rule of thumb" for estimating the trim tooling cost that is a fracture of the die cast tooling price. Anyone who has purchased or maintained trim tooling for a modern automotive generator knows those pricing formulas are no longer valid. If one is to remain competitive and build a reputation for being a supplier of quality components a fresh approach is necessary. Furthermore, since trim presses are often regarded as "low-tech," aside from the safety systems, they tend to receive a low priority when it comes to investment and maintenance.

COMMON TRIM PROBLEMS INCLUDE:

- Trim slugs (surfaces damaged from left over material on the casting or trim support). Examples include dents on seal surfaces and damaged edges.
- Shear/gouges in a hole or an outside surface. These can be due to miss-loading, bent or loaded-up punches, trimming hot castings, trimming dry or dull cutting edges.
- Left over material in a trimmed hole. The flash or slug punched from a cored hole either rolls over or doesn't fall free

Typically, one leaves the cores short in an aluminum die casting due to the difficulty in maintaining the shut off. However, if the flash is too thin, it will not trim clean and is merely pushed to one side. The slug can cause problems later.

- Pressure marks due to improperly fitted nest or pressure pad, or over-stroked. If the pressure pads bottom out against the casting, damage will result. Positive stops will help prevent this.
- Bent or cracked castings due to sticking, miss-location, over-stroke or foreign material.

Similar to the above, the limits and positive stops on hydraulic presses should be set correctly to avoid placing excess force on the trim tool and the castings.

- Extra hand deflashing operation to trimmed castings
 - This occurs when the trim steel either can not reach or smashes flash in to a corner.
 - One common cause is a parting line that does not have adequate clearance behind it for the flash to fall free after trim. The solution would be to design clearance into the casting.
 - Other options include adding compound movements to the trim to reach difficult parting lines.

The listed problems may be caused by poorly designed or maintained trim tooling. In addition, trim location can be easily overlooked when designing the casting and die cast tooling. On one occasion, a die caster needed to trim a round casting with a number of small cores that were punched. To further complicate the situation, the trim design was a "push through." Therefore the casting simply set on a ring. To index the casting a precision diameter boss was created on an ejector pin on an overflow. The top 1/4" of the ejector pin hole was jig ground to provide precision indexing.

EXCESS MATERIAL LEFT ON PARTING LINE

- Excess material is a matter of casting specification. (See *casting temperature discussion above*.)
- Other causes can include:
 - Trim cutting edges worn. Needs replacement or welding and refit.
 - New die cast die (sizes at minimum, while the trim die is original and worn and polished to fit the old, oversized castings).
 - **Trim cutting edges relieved to accommodate multiple cavities from several different dies. Since no two dies are exactly alike or have the same number of shots on them, the sizes vary widely. For the greatest accuracy, trim dies need to be matched to the die cast die.**

EXCESS W.I.P. (WORK IN PROCESS) BETWEEN DIE CAST MACHINE & TRIM OPERATION

Trim press located remote from the die cast machine.

- Not enough trim presses to cover every die cast machine or die cast tool.
 - Trim presses need to be matched to the machine. This includes: platen size and tee slot or bolt-hole locations; press tonnage appropriate; controls to operate special sequences, such as side punches and limit switches.
- Poor or non-existent parts cooling between the die casting machine and the trim press. In order to have a repeatable process year round, the castings and tooling temperatures must be maintained as closely as possible. Water quench options are: dip tank, car wash tunnel (conveyorized with nozzles spraying down on top of the castings).
- Some have found it useful to control the temperature of the quench water for improved repeatability.
- Forced air cooling: conveyor, chutes

OTHER QUALITY ISSUES

- Castings contaminated with hydraulic fluid. This can originate from the die casting machine or the trim press.
- Cracked castings
- Damaged tooling
- Bottle neck of untrimmed parts due to slow trim press
 - The trim press should be able to cycle faster than the die casting process. This is especially important if the die cast machine is fully automated because it can produce castings continuously while the operator is at lunch or break.
- Downtime waiting for non-standard replacement parts
 - To minimize downtime, it is necessary to evaluate the machine and the tooling to identify special parts that are not currently stocked either at your location or local suppliers. Components that must be produced and shipped from greater distances require higher priority.
 - Also, non-stock or special order parts must be identified. Consider the cost/benefit of stocking the part versus being unable to ship castings.

If maintaining the above sounds daunting, try producing parts with no trim dies at all.

PROBLEMS CAUSED BY NO TRIM DIES

- Increased W.I.P. (parts stack-up waiting for hand trim/de-gate. This could include waiting for entire shifts or even days. I once observed a plant that only trimmed when they received an order for the castings. Parts were cast as machines were available and stacked on skids and in containers awaiting the order. Frequently, the castings would be found defective and the entire run would have to be repeated. This increased costs and delayed the customer shipments.
 - Occasionally this is encouraged by cost accounting systems that show a profit when large quantities of in process castings are stocked in inventory.
 - Quality varies greatly with operator and time of day.
 - De-burring castings manually successfully requires skill and training. A frequent complaint is seal areas being damaged. In some cases, small features are accidentally removed by untrained workers.
 - Damaged castings due to method of removing gates and overflows, (hammers, files, mallets, other castings, etc...)
 - The surface of aluminum castings can be easily damaged by impact. In some cases this is only cosmetic, but in others functional seal surfaces are no longer effective.
 - Delayed customer delivery
 - The bottom line is shipping the casting. If processing is delayed while awaiting a hand cleaning operation, cash flow suffers and customer's production may be interrupted.
 - Increased labor costs: Manual operations can only clean one surface at a time. A trim operation can easily out-produce a manual cleaning operation. Especially on multi-cavity jobs. A trim die can be designed to simultaneously trim and de-gate multiple castings.
 - Learning curve for complex castings, especially when castings were produced with slides.
 - As the number of features and casting size increases, the difficulty of cleaning accurately increases. The opportunities for mistakes increase with the complexity.
 - Personal injuries from hand and deburring tools: Safety trainers tell us the most frequent industrial injuries are not from machines but from improper use of hand tools such as hammers and screwdrivers!
 - Large gate and risers are left in one bulky piece requiring increased material handling. Gates, risers and runners can be cut in to smaller more manageable pieces during the trim operation. This can reduce bulk in the scrap bins and reduce material handling.
- Why would a person want to consider increased investment in the design, construction and maintenance of trim presses and trim tooling?
- Consistent product
 - 25 PPM is an industry goal.
 - Opportunity to combine operations
 - Built in functional and quality check point
 - Reduced operations
 - Quicker delivery to customer
 - Reduce W.I.P.
 - Standardized components can be stocked or produced quickly and accurately from CAM files using CNC and wire EDM
 - Accurate segregation of casting part numbers or cavity numbers

MISSALIGNMENT— A COMMON PROBLEM WITH NUMEROUS POSSIBLE CAUSES:

- Trim tooling fitted to cold start up parts.
 - Trim tooling should be designed to fit “steady state” castings. For thin wall and larger aluminum castings, this could mean making 50 shots or greater before casting dimensions are stabilized.

The die casting mold expands as the temperature increases from room temperature. Larger molds and castings will demonstrate an even greater effect. Outside dimensions can change by more than 0.100 in. (2.54 mm) on large castings. Because of this, it is important that the castings are trimmed at the same temperature and the die casting die temperature is maintained.

- Trimming start up shots on larger castings or gates.
 - Both of the above are related. As the die warms up, it expands and the castings get longer and in some cases thinner!
 - Castings made during start up are not the same dimensions as those made during normal cycles.
 - Hot oil can provide assistance in reaching a stable temperature quicker.
- Trimming hot castings- A hot casting is larger due to expansion. Cored holes will likely be damaged as will the outside profile. Castings are also more likely to stick to the trim die since they will be tighter.
- Loose trim nest or support.
 - There is a tendency to relieve the trim nest so that the castings load and unload effortlessly. While both ergonomics and productivity must be considered in the design and operation, the castings must also be located precisely. Consider how CNC fixtures allow for quick loading and unloading yet still meet the requirement for consistent location.

If your long range plan is to automate trim, it is imperative to consider ease and accuracy of loading and unloading. If a human has difficulty accurately operating the trim tool then a robotic operation is doomed to fail.

- Bent or damaged punches.
 - Spare punches must be maintained. Also, they should be easy to replace with a minimum of downtime. Damage and wear will occur; Murphy's Law is still around the die casting business, so plan for the eventuality.
- Undersized or damaged core in die cast die.

If a core pin is worn or damaged, it will create problems for the trim operation, including difficult loading and removal as well as damaged castings.

- Pressure pad loose or inadequately supported. Pressure pad design and alignment is more difficult on small castings with lots of punches. Extra bearing surfaces may need to be designed in to the trim tool to provide alignment.

INCOMPLETE TRIM PRESS STROKE

Causes can include:

- Die requires more tonnage than the press can develop.
 - The total tonnage requirement is the sum of the spring pressure plus the shear force required to trim the flash, gates and overflows.
- Improperly adjusted “cycle complete” limit switch.
 - If the switch actuates too soon, the press will reverse before it has completed its stroke.
- Operator released the “pull back” handles or buttons too soon.
 - Results are similar to the above.

- Pressure set too low on the press.
 - The pressure must be adequate to accomplish the trim without overloading the motor or hydraulic components.
- Spring pressure too high in the trim die. (See previous.)
- Foreign material on the positive stops.
 - One thing that can help reduce the possibility of material on the positive stops is using a “split” design. With half the post on the top and the other on the bottom of the die. This raises the post away from any flash or overflows on the bottom die shoe and also creates more space for loading and unloading the casting(s).

MIXED PARTS ON MULTI-CAVITY TOOLS

Sometimes several part numbers are made on the same gate (family die concept). Occasionally the part numbers get mixed together. In another variation, cavity numbers are segregated for increased quality control.

- An automated system of removal and separation can provide accurate segregation. These consist of a shuttle table that advances under the trim die to catch the castings in individual trays. They are then dropped off into individual chutes and containers for inspection or transporting to larger containers. This system has been used to segregate as many as 12 individual cavities fully automatically.

OFF-LINE OPERATIONS DUE TO DAMAGED OR UNUSABLE TRIM STATIONS

- Scrapped castings due to damaged station.
 - A damaged or inoperable trim station can either damage the casting making it unusable or leave the casting completely untrimmed.
- Double trim, due to sticking one or more castings in the top.
 - Both of the above are common on multi-cavity tools. It usually occurs when one or more castings sticks in the top die and is not noticed. The damage occurs during the next trim cycle when the remaining casting crashes against the untrimmed casting and drives the pressure pad against the positive stops. Broken springs and punches are generally the result.
 - A solution for the above is adding a full ejector plate system similar to that on a die cast die. Instead of having small springs in each individual pressure pad, they press against an ejection plate that pushes individual pins that pre-load the pressure pads. Larger springs can be used in this design since they are not subject to the same space limitations as those installed inside pressure pads. This results in a higher push out force than can be achieved with a conventional design improving the reliability as well as the assurance that no castings will be left behind, since by design it is an “all or nothing” set up.
 - An alternative to the above is using “knock out bars” or “bumper pins” similar to those used in a die casting die to push against an ejection plate. In this design, the entire ejection plate is actuated during the return stroke. All the pressure pads are actuated at once, ejecting the castings.
- **Knock out bars are especially adaptable to automated part removal and segregation.** (See the part segregation/automated part shuttle comments above.)

- Large gates, risers and overflows can be cut or broken in to smaller easier to manage pieces.

HOW CLOSE IS CLOSE?

Smaller castings are easier to tool for since the die cast tool expands less during operation. Larger castings can change dimensions dramatically sometimes greater than 0.100 in. (2.54 mm) as the die cast mold expands due to temperature. So the question becomes, how long do I wait before starting the trim operation?

- Problems trimming cold castings
 - Fits tighter on the nest resulting in stuck castings
 - Cored holes could be out of alignment (centerlines off) until the die cast tool reaches the proper temperature
 - Excess burr or flash left on the outside parting line leaves the false impression the trim is worn out or improperly fitted

Most decorative zinc die casters use a term "cookie cutter trim." The implication is that they leave no burr or flash on the casting. It is sheared to a smooth consistent profile. This is often times required for castings that are polished and buffed and chrome plated. This is easier to accomplish on zinc as it doesn't wear or stick to the cutters as much as an aluminum casting would.

While you have the casting firm and accurately fixtured in the trim die, look at the following items to see if they can be incorporated into your operation.

OTHER DESIGN OPTIONS:

- Piercing, this is not limited to stamping dies.
- Broaching
- Drilling, drill spindles can be added to trim dies to reduce handling and process steps.
- Tapping, especially of cast to size holes, or by using a "DRAP" (tap with a drill point).
- Testing for presence of features. This is done extensively in stamping tooling.
 - Visit a stamping specialty site for ideas on parts sensors appropriate for trim tooling. One such article appears on the Web site: <http://archive.metalmformingmagazine.com/2000/11/Pepperl.pdf>
- Dedicated trim machines. For complex, high volume castings, trim machines can trim features that would not be accessible in conventional trim presses.
- Built in sensors to test for leftover material in holes
- Air blow off: internal ports can be machined in the trim shoes, pressure pads, nests and cutting edges to remove flash, overflows and trimmings. This is particularly important if you want to automate the trim process.
- Internal lubrication, similar to above where the cutting edges or punches require frequent lubrication due to close tolerance trimming.
- Nitrogen cylinders instead of springs. Nitrogen springs offer increased reliability and a more consistent force over longer strokes. They are available individually charged or they can be connected to a common manifold. When connected to a manifold, pressures can be adjusted as needed. Also, the pressure can be exhausted for ease of maintenance.
- **Horizontal trim, often used with robotic load/unload.**
- **Drop through options - Both offer reduced material handling:**

1) Castings drop straight through the trim to container or

conveyor.

2) Castings stay on top, scrap drops through to container or conveyor

■ **Create work cells with other processing operations near. These could include the following:** (The object is to eliminate forklift handling until ready for shipping.)

- Drilling
- Gage operations
- Milling
- Spot-facing
- Insert loading
- Boring
- Lathe operations
- Leak testing
- Tapping
- CNC operations

■ Hard gaging

■ Air gage

■ Electronic gage

■ Fixture gage

■ Vision systems:

- In-line X-ray/fluoroscope
- Vibratory
- Ball burnishing
- Tumbling
- Wash/dry stations
- De-burring
- Sub-assembly
- Inspection
- Packing

SOLUTIONS/RECOMMENDATIONS FOR MORE EFFECTIVE Al, Mg & Zn TRIM OPERATIONS:

■ **Analyze your defects and returns for cause**

- Perform Pareto analysis to determine where the largest problems are so you can prioritize your efforts.
- Measure the distance between operations. Seek to reduce the movement to the minimum practical distance. Tables, short conveyor or chutes are the goal.
- Optimize the trim press operation.

■ Periodically certify your trim press operators.

■ Have a written training procedure.

■ There may be as many procedures as there are different designs of trim presses and tooling.

■ If press controls vary, try to standardize them as much as possible.

■ Perform monthly viscosity and filtration test on the water glycol hydraulic fluid.

■ Clean the hydraulic after-cooler so you maintain 110 to 120 degrees fahrenheit (43 to 49 degrees celsius).

■ Level the press to reduce mechanical strain on components.

■ Replace any illegible switch labels and warning signs.

■ Insure guards are in place and securely mounted.

■ Cycle check all applicable safety interlocks including "two hand, anti-tie-down, anti-repeat," safety-ratchet and operator pull backs.

■ Reduce movement by setting the upper limit switch.

■ Repair inoperable rapid approach.

■ Repair high pressure trim so there is little or no hesitation when the casting is trimmed or side punches cycle.

■ Repair leaking piston and rod seals on the main ram to eliminate staining castings.

■ Repair damaged electrical conduit fittings as well as limit switch and valve covers.

■ Establish a regular P.M. (Preventive maintenance) program for the trim die. This should consist of a complete tear down and clean and replacement of worn or damaged springs, bushings and punches.

As always, the task can appear overwhelming, but by taking things one step at a time, and doing something every day, you can accomplish pleasing results in a few months. 