AMC
AMERICAN METALCASTING CONSORTIUM

Geometric Dimensioning & Tolerancing
Casting Quality Tip Series

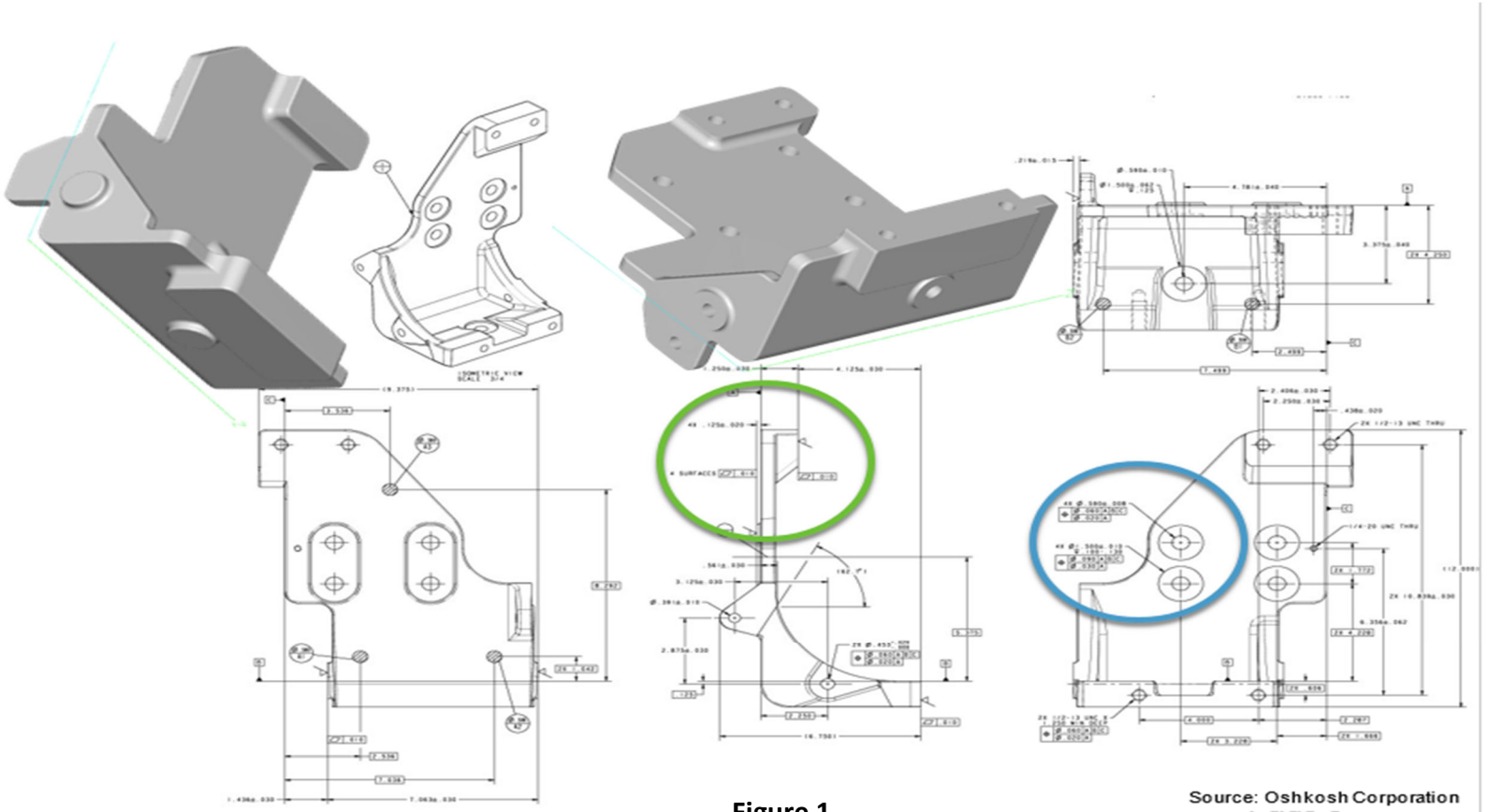
Case Study 2: Eliminate Machining Notations - Just Define Tolerances and Surface Texture

Problem: Figure 1 is a 2005 casting design, represented as two solid models and two .dwg files derived from the 3D CAD software. Having separate "as-cast" drawings and "final, machined net shape" drawings is a common, but suboptimal design practice. A drawing change for any reason would be a good opportunity to eliminate the "casting drawing" that goes with the un-machined solid model, allowing the "machining drawing" to become the single "Here's what we want" toleranced .dwg file. The single drawing increases the supplier's options for manufacturing. In other words, it takes advantage of the GD&T fundamental principle soundbite, "The geometrically toleranced drawing is a contract for inspection, not a recipe for manufacture."

Solution: Notice in the green circle that the finish machining symbol represented by ✓ can be removed (Figure 1), and the 0.010 inch flatness requirement speaks for itself. How the net shape result is accomplished can be a cost -saving consequence from a thoughtful "metalcasting supplier team", typically a metalcaster, a mold cavity tooling builder, and a machine shop. Capable metalcasting supplier teams collaborate regarding GD&T's 3D zones and surface appearance notes to innovate ways of complying with tight tolerances with mold cavity-making choice, tooling design and construction, and application of Additive Manufacturing to directly create more accurate mold cavity elements.

Also in Figure 1, notice in the blue circle are the size, and position of 4 drilled and countersunk holes. Although not legible, the position, size, and depth of the countersink could be an as-cast feature opportunity.

The RMS specification of a machined surface can be replaced by NAS 823, a visual and tactile comparator plate for as-cast surface finish.



Source: Oshkosh Corporation

Figure 1

Result: Because of the elimination of the machining symbol, the single drawing enables advancements in more accurate metalcasting mold cavity-making processes, plus application of additive manufacturing technologies, for both tooling construction AND direct mold cavity element construction *with fewer dimensional degrees of freedom (the minimum number of independent variables required to define the position or tolerance) like draft.* The single drawing says, "Here's what we want, the metalcasting supplier team, and you are free to meet our tolerance requirements as you see fit."

To illustrate what is possible with "best" tolerances among all major mold cavity-making processes, Figure 2 is a matrix of tolerance capability, from coarsest, biggest castings at the upper left to smaller, more accurate castings at the lower right.

Within each rectangle defining a mold cavity-making process, the vertical space indicates the capability of tooling design and construction to improve "best" tolerance capability. As an example, in the Green Sand category, larger, manually-molded castings with simple tooling have a "best" tolerance of +/- 10mm, but highly automated mold machines and highly engineered tooling designs and materials enable +/- 1mm!

The values in orange are the best of each process' tolerance capability when there are no mold cavity construction "degrees of freedom," such as mold and core match planes.

You might wonder why the tolerance values are expressed in the "old school" +/- measurements. The best tolerance form to express fundamental mold cavity tolerance capability is the traditional +/- nomenclature. However, when evaluating a geometrically toleranced drawing, the conversion from size, profile, and position tolerances to old school +/- tolerances is easy to do.

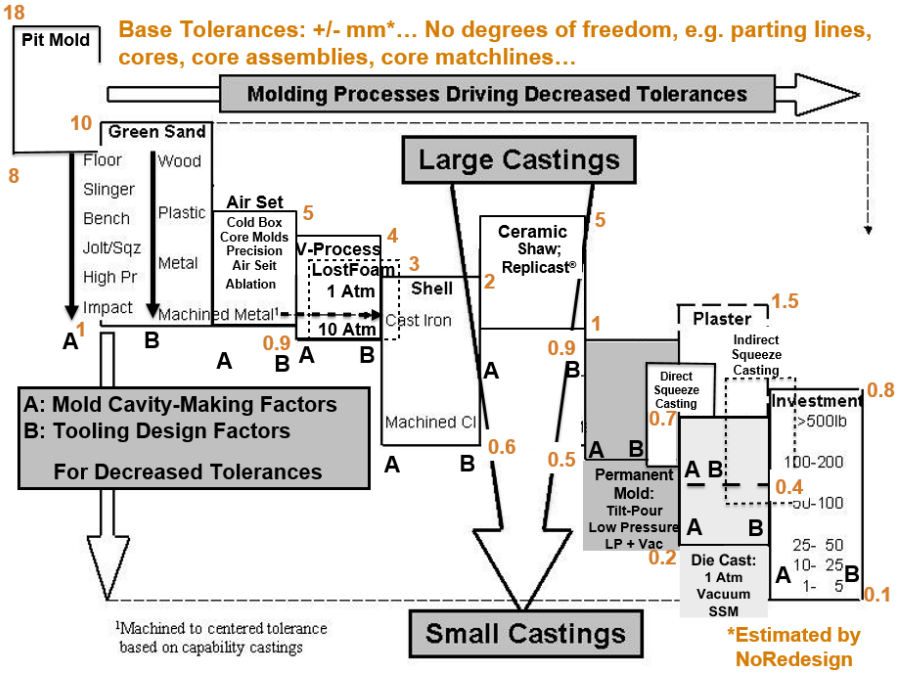
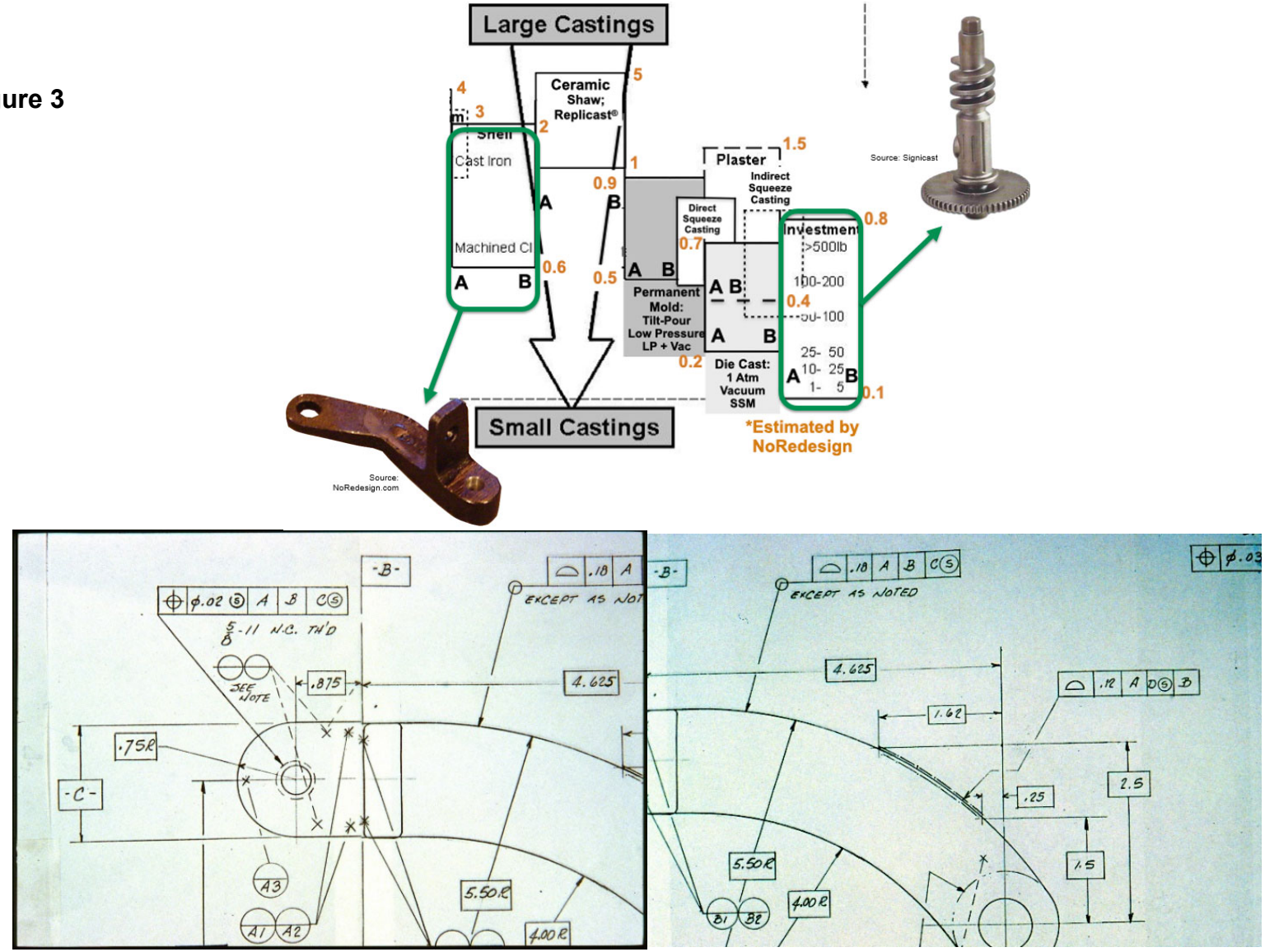


Figure 2

Figure 3 highlights two parts that were made via casting. The top graphic highlights the casting processes used as well as the +/- "best" tolerance capabilities. The part on the left of the top graphic shows a bracket casting created using the shell process. Its assembly datums (the right angle feature and 2 slotted holes) are all net shape, as cast. There is only one drilled shoulder bolt hole.

Below, the GD&T on the drawing that enables so much of the net shape to be as-cast is shown. The part on the right of the top graphic is an investment cast power train gear component. This casting is net shape and has no machining. Both parts are remarkable examples of as-cast tolerance capability.

Figure 3



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