



Geometric Dimensioning & Tolerancing Casting Quality Tip Series

Case Study 1: Clarifying Datums and Defining Datum Targets

Problem: Figure 1A is an image from an original hand-drafted drawing of a casting. In the right view, Datum C is defined by the 15.50 inch width, but which edge? The edge in the foreground or the edge on the far side of the view? Notice also that Datums A and B are not defined in these two views (nor are they defined in the other two drawing views). As a result, a metalcasting supplier team was unable to proceed with tooling design and construction for the casting mold cavity or the machining fixture(s). Without clarification, the team risked dimensional and/or surface finish rejection of the First Article casting.

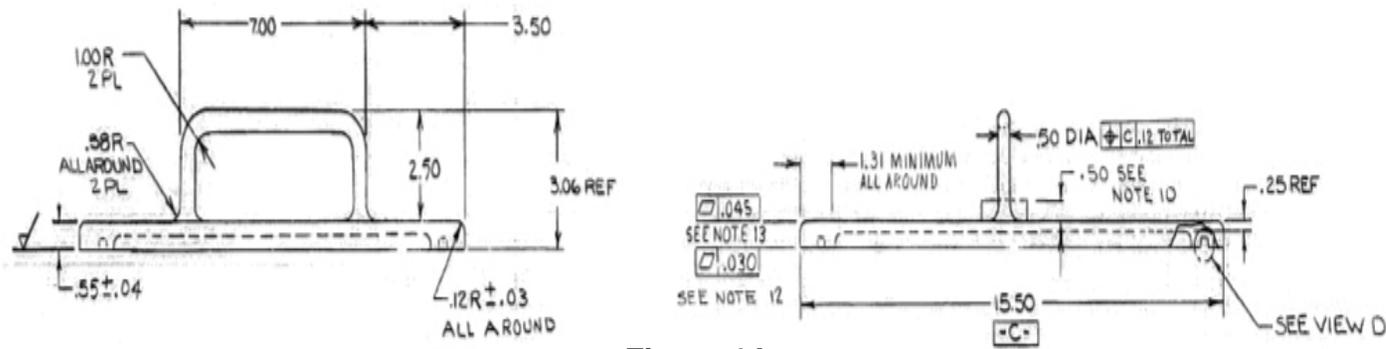


Figure 1A

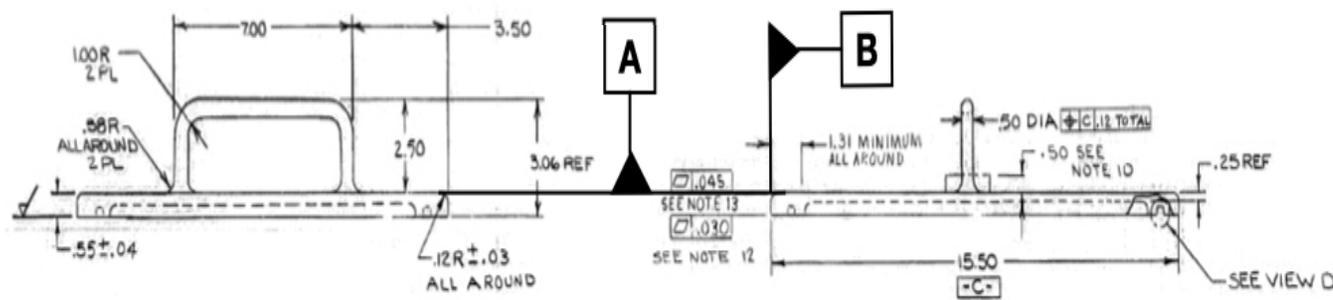


Figure 1B

Solution: Figures 1B and 1C illustrate the result of a quick scan of the views and drawing notes which enable the clarification of Datum C and the definition of Datums A and B.

Result: These simple GD&T upgrades to this drawing eliminate uncertainty about how the casting mold cavity should be designed and how the casting should be fixtured for machining to net shape... and how it should be set up for dimensional inspection.

So *where exactly* should the casting be touched on its 3 Primary Datums for the sake of accurate machining set-up and accurate dimensional inspection?

Since as-cast surfaces have inconsistencies (such as cut-off and ground surfaces where gating brought liquid metal into the mold cavity, edges of mold assembly parting planes, and draft), specific locations for touching need to be defined as well as the size of the Datum Targets that will touch the casting at those locations.

The answer is to define those Datum Targets, which is an important part of the ASME Y14.5 – 2018 GD&T Standard. Datum Targets eliminate the uncertainty of exactly where to touch the casting for machining fixture design and for First Article dimensional inspection.

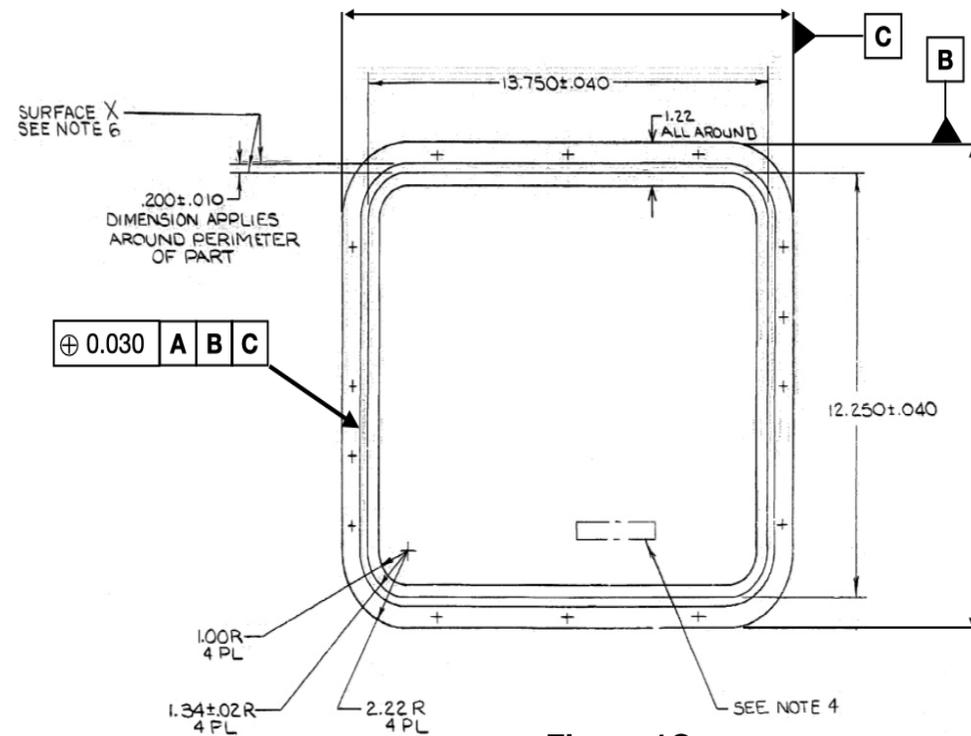


Figure 1C

Figure 2 is an excellent example of using the Standard correctly to establish Datum Targets for the machining of a large cannon muzzle brake.

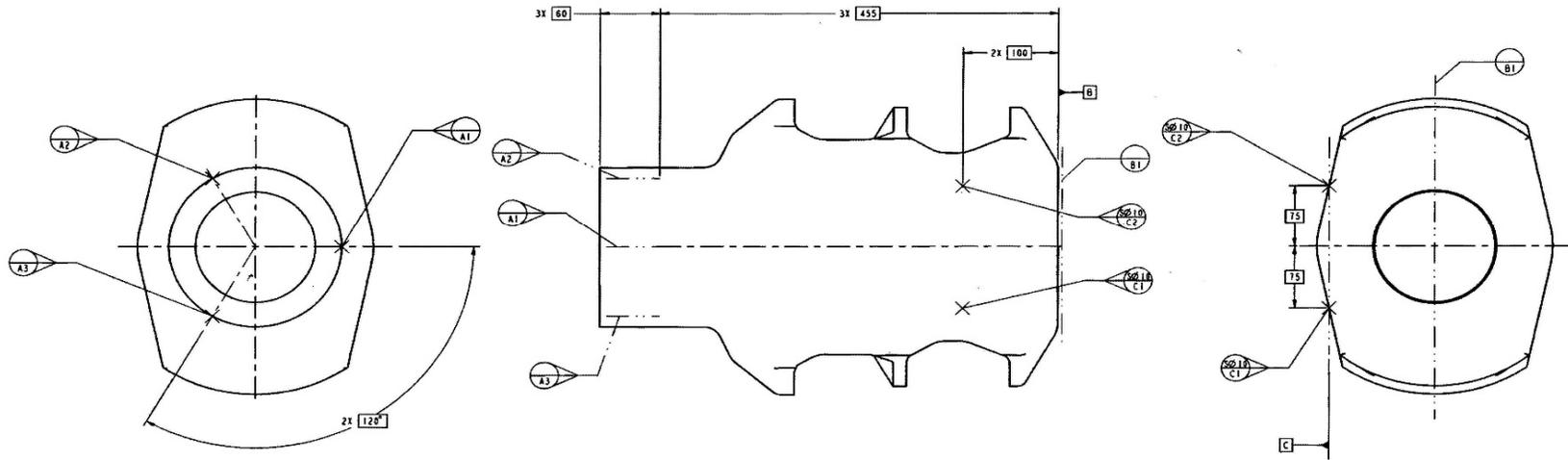


Figure 2

Source: US Army Benet Labs; Dick Farrara

The Primary Datum, A, is the cylindrical feature at the left end of the muzzle brake. There are 3 Targets defined at 120° increments and located 60mm from the left end of the casting. The size of the Targets is not defined in the Target symbol because the Targets are the jaws of a 3 jaw chuck to be set up on the inspection table or to be part of the machining fixture. Similarly, there are two Secondary Datum C Targets whose positions and sizes are shown in the middle and right-hand view. The diameter of those Targets is defined in the Target symbol, $\phi 10$ mm. The Tertiary Datum is the face of the right-hand end of the casting, Datum B, and a single Datum Target locks the casting into position for either machining or inspection. Since Datum B is a flat face, the Target is a simple flat plate. Since these Datum Targets are defined in the initial design drawing set, the mold cavity-making process choice and the design of the mold cavity tooling can be sure to avoid those target positions with the surface inconsistencies that would otherwise upset consistent machining and dimensional inspection set-up.

Specific to the example on Page 1, Figures 1B and 1C, Figure 3 is a sketch of Datum Targets that define *where* to touch Datums A, B, and C. The purpose of these Datum Targets is to check the casting for flatness and edge profile during as-cast finishing, setting up for machining, and setting up for dimensional inspection. Defining the Targets also shows the metalcasting supplier team *where not* to put process features like parting lines and gating contacts on the casting surfaces.

Especially significant is the size and position of the Datum B targets. The tooling design for this air-set sand casting places Datum A on the bottom of the mold cavity. The side walls are therefore drafted at 2°, typical for the air-set sand molding process. To eliminate variation in casting position, the Datum B and C Targets are smaller, 0.18 inches in diameter than the Datum A Targets at 0.35 inches. *It is critical* that the elevation of the Datum B and C Targets be exactly the same with respect to Datum A. That prevents the draft from affecting the X-Y position of the casting for Z direction machining... and dimensional inspection.

