

Casting & Forging Facts

Billet refers to a semi-finished solid metal form typically rolled into common shapes such as rectangular bars and cylindrical rods. Examples include the raw material from which the Assigned Parts were created earlier in the semester, as well as virtually every piece of material on the large material rack in DML.

Casting is pouring molten liquid into a mold where it is subsequently allowed to cool & solidify before ejection for use. Casting is used for producing parts to near-net (i.e. near-final) shape. The molds can range from very cheap sand molds to elaborately machined chromium-steel molds costing well into the 6 figure range. Since molten metal is poured into the mold, the final shape can be quite intricate and can contain both external and internal (i.e. hollow) features. Due to the fact that almost all metals shrink when cooled, the mold design can be a complex undertaking and the final surface finish and feature tolerances are lower than many common machining processes (i.e. casting produces rough surfaces and tolerances in range of $\pm 0.020''$ to $\pm 0.060''$). However, important features can be finish-machined after the casting is removed from the mold. The casting process is used for complex (i.e. hollow parts or parts with lots of complex contours) low volume parts as well as high volume production.

Forging is the repeated deformation of heated solid metal to refine the grain structure and improve part strength without adversely affecting the material's ductility. Due again to metal shrinkage when cooling, die design can be a complex undertaking and the final surface finish and feature tolerances are lower than many common machining processes. However, like cast parts, important features can be finish-machined after the forging is complete to meet higher tolerance feature requirements. Forging produces the strongest metals used in industry today. Forging is used for both low and high volume part production.

Relative Strengths

<u>Process</u>	<u>Relative Strength</u>
Forging	10 (strongest)
Billet	7
Casting	4 (weakest)

More Information (NOT NEEDED FOR DML FINAL EXAM, SO IGNORE IF NOT INTERESTED)

Casting

The three most common types of casting include sand casting, investment casting and die casting. [Sand casting](#) typically uses two mold halves formed around wooden or metal part patterns. Once green (i.e. moist) sand is tightly compacted around the patterns, the mold halves are separated and the mold is fired to cure the sand into a solid mold. The mold halves are then brought back together, where the molten metal is poured inside, allowed to solidify and removed from the mold halves via vibratory methods. A new mold must be produced for each cast part.

[Investment casting](#) (aka the lost wax process) begins with a wax pattern made by using a die; the patterns are mounted with others on a “tree” or assembly; the tree is covered with stucco (ceramic slurry); the wax is removed in a steam autoclave and the ceramic shell is fired to cure it completely; then the molten metal is poured into the shell mold and allowed to cool; and the final part is removed via vibratory methods. As in sand mold casting, new molds must be produced for each set of cast parts.

[Die casting](#) uses an automated machine to inject molten metal under high pressure into intricately machined alloy steel mold halves. Once the molten metal cools and solidifies, the die halves are separated and the cast part removed by mechanical ejection pins or a robotic arm. The high pressure reduces porosity and improves part strength. This is the most advanced (and expensive) method of casting currently used today.

Forging

Two general classifications of forging processes exist: open and closed die forging. [Open die forging](#) refers to the use of hammers, punches and accessories to forge the metal into general shapes called forged billets for subsequent machining to final size.

[Closed die forging](#) refers to the use of custom made, specialized dies with the desired final shape that enclose the heated metal during the forging process, forging the metal into a desired final shape. Closed die forging is generally used for mass production of identical parts requiring high strength, such as tools (i.e. [wrenches](#), [ratchets](#) & [sockets](#)) or internal engine parts (e.g. connecting rods, pistons and valves).