The Manufacturing Processes Involved in Producing PGA Tour Quality Golf Irons

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**Summary**

There are two main categories of golf irons: cast and forged. This distinction is based on the manufacturing process used to produce the club. Cast irons are generally used by amateur “weekend golfers”, as the air pockets caused by casting lead to reduced feel due to the inconsistent vibrations. The forging process is usually used to produce higher quality irons as the consistent grain throughout produces greater control over one’s shots. Both processes involve multiple steps and lend themselves to different applications within the golf iron industry.

**Discussion**

Golf irons can be manufactured in several different ways, namely by forging and by casting. These two different processes are both complex and require precision, as in a game like golf where the slightest mishit can lose a professional golfer millions of dollars, any tolerances not met or defects in a club head can lead to that product being unusable. Golf irons are made from stainless steel, chrome plated steel, titanium, or tungsten; stainless steel being the most common for modern clubs [2]. Mizuno, whom many consider to produce the highest quality irons, recently progressed from 1025 Mild Carbon Steel to 1025E Pure Select for their tour quality irons [5]

Casting is the most widely used process to manufacture golf irons. The first step in the process is to create a wax replica, or pattern, of the clubhead, as pictured in Figure 1a. This pattern is then dipped into hot wax to create the pattern for the gates and runners through which the molten steel will flow. This expendable pattern is then dipped into a ceramic and sand mixture to create the mold, and the wax is then melted out of the mold (Figure 1b.). Steel is then heated to over 1600° C and slowly poured into the mold, which has also been heated so that it can withstand the heat of the molten steel (Figure 1c.). After the clubheads have set for approximately 5 hours, a pneumatic hammer shakes off the mold to reveal the iron inside. Then, the finishing operations such as grinding the runners off and sandblasting the surface are completed to produce the final product (Figure 1d.) [1]. Sandblasting the surface allows the club to create more spin when it strikes the golf ball, leading to better control over the ball’s flight.

A picture containing indoor, keyboard

Description generated with high confidenceA picture containing motorcycle, green, outdoor

Description generated with very high confidenceFigure 1a. [1] Figure 1b. [1]

A picture containing ground, floor, table, sitting

Description generated with very high confidenceFigure 1c. [1] Figure 1d. [1]

Forged irons are not as common, but are becoming more popular. Most golf club producers use the forging process for their highest quality clubs. A forged golf club starts out as a 10-inch steel billet (Figure 2 Step 01.), or in the case of Mizuno irons, steel with a trace of Boron. This boron increases the strength of the billet, allowing Mizuno to create more complex shapes than the forging process can usually produce. Once the billet is fed into the machine, it is heated to 1200° C and stretched and bent to the angle required to form the clubhead with a hosel (Step 02). Most companies weld a hosel onto the clubhead, but producing them as one piece ensures consistency in the grain. The heated and bent billet is then hammered into a mold of the club by a pneumatic hammer to produce the rough shape of the iron (Step 03). This is called the primary forging stage. The forged metal is the cooled and the flash is trimmed during what Mizuno calls the “cookie cutter stage” (Step 04). The clubhead is then reheated and enters the precision forging stage, where it is pressure squeezed to form the exact shape required for the golf club (Step 05). The club then requires significant amounts of finishing work, including grinding, plating, and sandblasting (Step 06) [5].

A close up of a device

Description generated with very high confidence

Figure 2 [5]

There are several significant differences between forged and cast golf irons that lead to differences in performance. Cast irons tend to have more air pockets from the pouring process, while forged irons are solid and have consistent grain. This leads to forged irons producing better “feel” as the vibrations are consistent throughout the club, and an experienced golfer will be able to diagnose problems with his or her swing more easily, while an amateur golfer will not be able to tell a significant difference. Another difference is that the casting process lends itself to more complex geometries, so clubs that are more “forgiving”, with different weight and material distributions at different points on the club face to make up for mishits, can be produced more easily by casting than by forging.

**Economic Aspects**

Casting and forging both have relatively high tooling costs, especially when using high powered pneumatic hammers for forging. Casting generally leads to reduced labor cost as it is a near net shape process, and the high production rate also lends to lower cost per part at high quantities. Forging requires more labor as the parts need to be grinded and plated, and this is especially so at the Mizuno plant where each hammer throughout the forging process is operated by a trained professional that has worked for at least 3 years at Mizuno, and then has trained for an additional 5 under a master operator. The higher costs for forging golf irons leads to higher prices for these clubs, but as they are usually used by professional golfers and more serious amateur golfers, the customers are willing to pay for the better quality.

**Engineering Relevance**

The significance of this topic for a beginning engineer is the idea that very similar products can be made by varying manufacturing processes depending on the requirements of the customer and manufacturer.

The significance of this topic for an experienced engineer is that casting and forging processes lend themselves to different products. Casting can be used to make more complex irons but may lead to reduced quality, while forging can generally only make simpler shapes but the consistent grain structure leads to higher quality products when vibrations need to be considered.

**Learning Path**

I learned that the different forming processes used to manufacture golf irons can lead to products that look similar but perform differently.

I became interested in the difference between cast and forged irons when I bought my most recent set of golf clubs, and this homework gave me the perfect opportunity to deep dive. I knew that forged irons were supposed to give better “feel”, but it was interesting to learn why this is true. I started with a Youtube search, as I am a very visual learner, and found tens of videos that described the manufacturing process of golf clubs. I found an excerpt from a film called “The Art of Forging” where an engineer from Mizuno described their forging process, and this led me to the Mizuno website where they had an in-depth description of every facet of their manufacturing process.

**References**

[1]*How It's Made: Metal Golf Clubs*. 2018.

[2]*Hit the Iron: Manufacture of a Forged Iron Head*. 2018.

[3]"Mizuno: The Art of Forging", *Mizuno Golf*, 2018. [Online]. Available: https://golf.mizunoeurope.com/art-of-forging/. [Accessed: 19- Sep- 2018].

[4]*Cast vs Forged Irons: What's the difference?*. 2016.

[5]*Mizuno: The Art of Forging*. 2016.