The Design and Creation of a Viking Axe

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ABSTRACT

A competition was held to create an axe using modern tools like computer modeling, alloy development and selection, and additive manufacturing to design and produce a functioning Viking axe. The axe was required to have a cutting edge of 6 to 12 inches with a handle between 18 and 30 inches. The axe was then judged based on sharpness, edge durability in chopping, and robustness as a weapon. An investment casting shell was designed and manufactured by the University of Northern Iowa and cast at InvestCast. The associated methodology to produce the weapon is described herein.

INTRODUCTION

Vikings were a Norse people that existed mainly from the 8th to 12th century. They are known to have sailed across Northern Europe and raid coastal areas. The need for a robust and effective weapon was extremely prevalent for the Viking people. One of the most iconic of these weapons is the axe.

The axe designed for the Steel Founders' Society of America (SFSA) Cast In Steel competition was inspired by an axe uncovered at a burial site in Denmark, shown in Figure 1. It is estimated that it was used near the late 10th century. The blade is triangular in shape, yet asymmetrical. The blade is angled slightly downward to both facilitate a slicing action when wielded and to maintain a more secure grip when "grappling" over an obstacle. It also displays an original design fashioned from period Celtic artwork on the surface of the axe.

Figure 1: Dane Axe

DISCUSSION

This axe created by the team at University of Northern Iowa was made from AISI 4140 chrome molybdenum steel. This grade was chosen for its toughness, high fatigue strength, and impact resistance. It was then cooled in air until room temperature as it would have been done in the 10^{th} century.

The design of the axe, shown in Figure 2, was designed using SolidWorks and then simulated using MAGMASOFT Foundry Process software to develop a gating and feeding system. It was then printed using a 3D Systems ProJet 660IC wax printer. Two printed expendable patterns were then attached to a common sprue/riser for casting. This is shown in Figure 3.

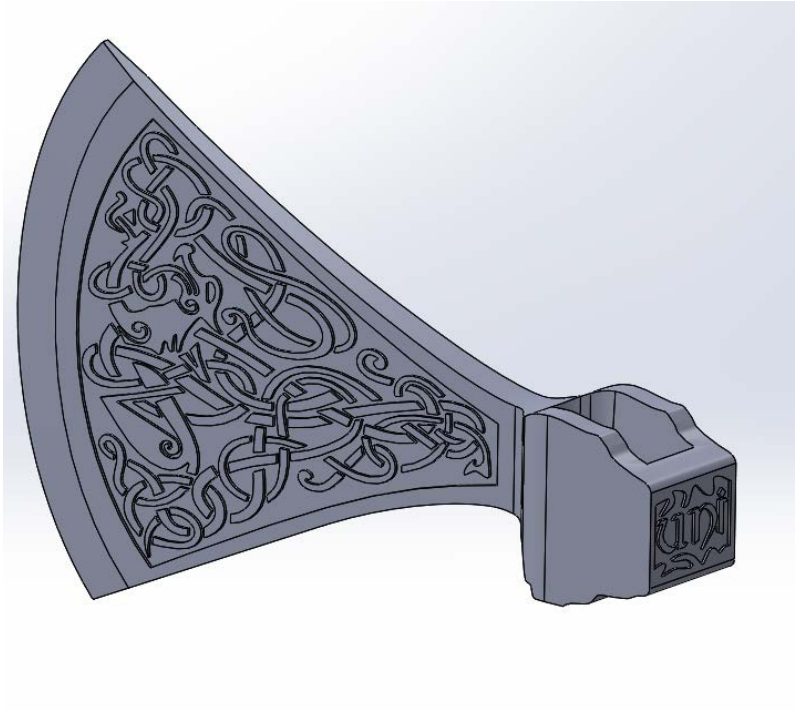

Figure 2: SolidWorks design of the Viking axe

Figure 3: Wax pattern

The pattern tree was shipped to the foundry partner, InvestCast, in Minneapolis for casting. The wax patterns were coated in a ceramic slurry consisting of zircon and a binder. Two prime coatings were applied and dried. The ceramic shell was then increased in thickness by coating in successively coarser sizes of fused silica until a sufficient shell thickness was obtained. The dried and completed shell was then heated in an autoclave, exposing the wax pattern and shell to both high temperatures generated by steam and high pressure. The combination of high temperature and pressure allow the wax to be melted from the ceramic shell, reducing the tendency for the shell to crack with expanding wax. The shell was then cleaned, inspected, and readied for firing.

The shell was fired to approximately 2500°F, which created a ceramic bond in the refractories, thereby increasing its strength. The shell was filled with the steel alloy and allowed to cool. After cooling, the shell was removed, and the axe casting was sand blasted. The gating tree was removed, and castings shipped to UNI for finishing.

The castings were received and ground to final shape using an 80-grit silicon carbide flap wheel mounted on a 4-1/2in angle grinder. The cutting edge was obtained by using a 1000 grit whet stone and leather strop. Testing of the material was obtained by file testing. The hardness of the axe was estimated at between 45 and 50 on Rockwell C scale, which is slightly softer than a modern axe, but seemed appropriate since this axe would be used as a lethal weapon rather than for chopping wood. The hardness would also allow for greater impact to experienced before fracture of the cutting edge.

The axe handle was formed from a commercially available sledge hammer handle and shaped to fit the axe head. Several wood wedges were used to secure the axe head to the handle. A leather cord was attached for purely aesthetic reasons, and to match designs discovered during research. Figure 4 shows the competed axe before shipment.

Figure 4: Completed axe

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