

# SFSA Cast In Steel 2026 – Horseman Axe

## Technical Report

Georgia Southern – Southern Steel



Team Members:

Bri Beasley, Zacharie Laurent, David Dang

Advisor Name:

Dr. Mingzhi Xu

Foundry Partner:

Carolina Metal Casting

## ABSTRACT

This report presents the design, casting, and evaluation of a horseman axe produced by Georgia Southern engineering students for the Cast in Steel competition. The Steel Founders' Society of America (SFGSA) has created this competition to encourage students to learn about making steel products using the casting process and applying the latest technology available. The axe was designed using SolidWorks and manufactured using a no-bake sand casting process with 8630 alloy steel. MAGMA simulation software was utilized to optimize gating and solidification behavior to minimize defects. Post-casting processes included machining, assembly of axe, and heat treatment consisting of oil quenching and tempering. The resulting microstructure was tempered martensitic, providing a balance of hardness, toughness, and wear resistance. Performance testing demonstrated the axe's capability across multiple materials including wood, ice and metal. The final axe was 20.75 inches, 2.86 lbs, and consisted of the 8630 steel axe head and a hickory wood handle surrounded by an aluminum pommel, paracord and twine.

## HISTORY OF HORSEMAN AXE

The horseman's axe dates back to the late Middle Ages and was commonly used by mounted cavalry [1]. These axes were designed for combat, featuring curved blades and compact geometry for maneuverability. This project adapts the historical design using modern materials and manufacturing processes.

Larger two-handed polearms are commonly designed to be used with both hands for better reach, power, and control [1]. Unlike these axes, horseman axes feature a shorter handle and a lightweight head, allowing riders to deliver quick, controlled strikes while maintaining balance and mobility. The blade geometry often included a curved cutting edge for slicing attacks, paired with a rear spike or beak designed for piercing armor or delivering concentrated impact forces [1].

In addition to overall geometry, the effectiveness of a horseman's axe is strongly influenced by its individual components and their functional roles. The blade is the primary cutting surface, designed with a sharpened edge and curved profile to maximize slicing efficiency and energy transfer during impact [1]. Many designs also incorporate a spike or beak, which concentrates force into a small area which makes it effective for piercing or delivering high-pressure impacts. The eye, located at the center of the axe head, serves as the interface between the metal head and the handle, and must be designed to securely transfer loads without loosening or causing failure during repeated use. The handle provides leverage and control, allowing the user to generate and direct force efficiently. Its length and alignment directly influence swing dynamics and accuracy. Together, these components function as an integrated system, where proper design and balance are critical to achieving both performance and durability. These functional considerations influenced the design choices made in this project, ensuring that each feature contributes to the overall effectiveness of the axe.

Figure 1 shows the anatomy of an axe illustrating key components including the blade (bit, toe, and heel), eye, poll

(butt), and handle features such as the shoulder, belly, grip, and knob. These elements define the functional geometry of the axe, where the blade enables cutting, the spike provides impact capability, the eye secures the head to the handle, and the handle facilitates control and force transfer during use [1].

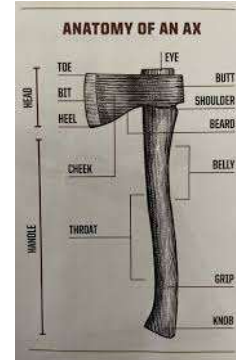


Figure 1. Diagram of Anatomy of Axe [4].

Historically, variations of the horseman's axe were used across Europe and parts of Asia, with designs evolving to meet the demands of different combat scenarios. Many featured asymmetrical heads, combining a broad cutting surface with a pointed extension to increase versatility [1]. This dual-function design allowed the weapon to perform both cutting and penetrating actions, making it effective against a range of targets including armored opponents and wooden structures.

The design developed in this project was inspired by historical references and modern interpretations of cavalry axes, emphasizing aggressive blade geometry and functional aesthetics. Key features such as the extended spike, curved blade profile, and compact form factor were intentionally incorporated to reflect traditional designs while adapting them for modern manufacturing. The final geometry balances historical authenticity with engineering considerations. This ensures effective force transfer, durability, and manufacturability using casting processes.

## INTRODUCTION

Casting is a critical manufacturing process capable of producing complex geometries with high efficiency [3]. This project focuses on designing and manufacturing a historically inspired Horseman Axe using modern engineering tools. The goal was to integrate simulation-driven designs with traditional casting methods to produce a durable and high-performance tool.

Casting processes vary significantly in terms of mold material, precision, and production cost. Green sand casting is one of the most widely used metal casting processes due to its low cost and simplicity. The mold is formed from a mixture of silica sand, clay (typically bentonite), and water, which gives the sand its "green" or moist condition [3]. This mixture provides sufficient strength and plasticity to retain the shape of the pattern while allowing gases to escape during pouring. A pattern is pressed into the sand to create the mold cavity, after which molten metal is poured directly into the mold. Once

solidification occurs, the mold is broken apart to retrieve the casting. Although green sand casting is economical and suitable for high-volume production, it generally results in lower surface finish and dimensional accuracy compared to processes such as no-bake or investment casting [3]. However, its ease of use and adaptability make it a foundational process in metal casting applications.

The no-bake sand casting process, also known as chemically bonded sand casting, utilizes a mixture of silica sand and a liquid resin binder that hardens at room temperature without the need for external heat [3]. In this process, the sand and binder are mixed and packed around a pattern to form the mold cavity. A catalyst is then added to initiate a chemical reaction that causes the mold to cure and gain strength. Once hardened, the mold maintains excellent dimensional accuracy and surface finish compared to traditional green sand molds [3]. Molten metal is poured into the prepared mold, and after solidification, the mold is broken to retrieve the casting. The no-bake process is particularly advantageous for producing complex geometries and larger castings due to its superior mold strength and stability, though it typically involves higher material costs and longer preparation times than green sand casting.

Lost foam casting is a pattern-based casting process in which a foam replica of the final part, typically made from expanded polystyrene (EPS), is used to form the mold cavity [3]. The foam pattern is coated with a refractory material and then embedded in unbonded sand to provide support. During pouring, molten metal is introduced directly into the mold, causing the foam pattern to vaporize and be replaced by the metal. This allows for the production of complex geometries without the need for cores or parting lines. Lost foam casting offers advantages such as reduced machining requirements and high design flexibility; however, careful control of gas growth and pouring conditions is necessary to prevent defects such as porosity or misruns [3].

Investment casting, also known as lost-wax casting, is a precision casting process used to produce components with excellent surface finish and tight dimensional tolerances [3]. The process begins with the creation of a wax pattern that replicates the final part geometry. Multiple wax patterns may be assembled into a tree and repeatedly coated with a ceramic slurry to form a hard shell. Once the ceramic mold is formed, the wax is melted and removed, leaving a hollow cavity. Molten metal is then poured into the preheated ceramic mold. After solidification, the ceramic shell is broken away to reveal the casting. Investment casting is ideal for complex and high-precision components, though it is generally more expensive and time-intensive than other casting methods.

The mechanical properties of steel are strongly influenced by heat treatment, which controls the resulting microstructure. At elevated temperatures, steel transforms into austenite, a face-centered cubic (FCC) phase that allows carbon to dissolve uniformly within the iron matrix [3]. Austenitization typically occurs above the critical temperature range, where the structure becomes homogeneous and suitable for subsequent transformation. After austenitization, steel can undergo different

heat treatment processes such as full annealing, normalizing, and quenching [3]. Figure 2 below shows the temperature ranges for heat treating steel based on carbon content.

Figure 2 shows the heat treatment temperature ranges for steels as a function of carbon content. The chart illustrates regions for full annealing, normalizing, and quenching processes. The diagram shows critical transformation temperatures ( $A_1$ ,  $A_3$ , and  $A_{cm}$ ) and recommended operating ranges for each heat treatment method. This chart is used to guide the selection of appropriate heat treatment parameters to achieve desired microstructures and mechanical properties.

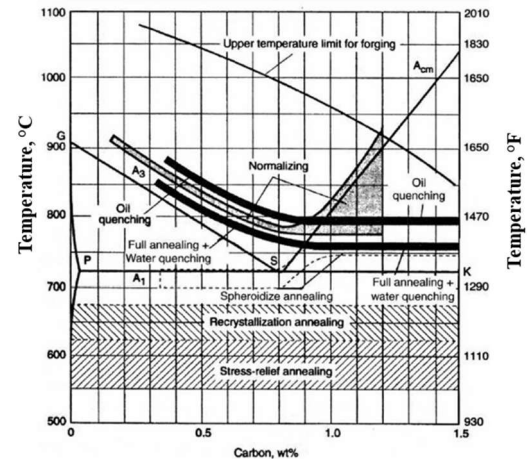


Figure 2. Heat Treatment Temperature Ranges for Steel as a Function of Carbon Content [2].

Full annealing is a heat treatment process used to soften steel, improve ductility, and relieve internal stresses developed during casting or machining [3]. In this process, the material is heated above its critical temperature to form austenite and then cooled slowly, typically inside the furnace. The slow cooling rate allows for the formation of coarse pearlite and ferrite, resulting in a soft and easily machinable microstructure. While full annealing is beneficial for improving workability and reducing residual stress, it produces relatively low hardness and strength [3]. This makes it unsuitable for applications that require high wear resistance or impact performance, such as cutting tools.

Normalizing is a heat treatment process in which steel is heated above its critical temperature and then cooled in air. Compared to full annealing, the faster cooling rate produces a finer and more uniform pearlitic microstructure, resulting in increased strength and hardness while maintaining moderate ductility [3]. Normalizing is commonly used to refine grain size and improve consistency throughout the material, particularly after casting processes. However, the mechanical properties achieved through normalizing alone are generally insufficient for applications requiring high hardness and edge retention, such as an axe.

Quenching involves heating steel to its austenitizing temperature followed by rapid cooling in a medium such as oil, water, or air [3]. This rapid cooling suppresses diffusion and

results in a diffusionless transformation of austenite into martensite, a body-centered tetragonal (BCT) phase characterized by high hardness and strength due to carbon atoms trapped within the lattice. While this transformation significantly improves strength and wear resistance, martensite is inherently brittle and contains substantial internal stresses [3]. To address this, quenched steel is typically subjected to tempering, during which the martensitic structure partially decomposes into tempered martensite consisting of a ferritic matrix with finely dispersed carbide precipitates [3]. This process reduces internal stresses and brittleness while maintaining a desirable combination of hardness, toughness, and wear resistance.

The severity of quenching refers to the rate at which heat is removed from the material, which directly influences the resulting microstructure and the likelihood of defects [3]. Water quenching provides the highest cooling rate and results in maximum hardness, but it also introduces a higher risk of distortion, cracking, and residual stress due to rapid thermal gradients. Oil quenching offers a more moderate cooling rate, reducing the likelihood of cracking while still achieving sufficient hardness for alloy steels such as 8630. Air cooling provides the slowest cooling rate and results in lower hardness but improved dimensional stability.

## MANUFACTURING METHODOLOGY

The manufacturing of the horseman axe followed a structured workflow integrating design, simulation, casting, and post-processing operations. The process began with CAD modeling in SolidWorks, where the geometry of the axe was finalized with attention to blade curvature, edge thickness, and mass distribution. The design was then exported into a stl format file for pattern fabrication.

The SolidWorks model of the horseman axe was developed with manufacturing constraints and casting performance as primary considerations. The geometry incorporates smooth transitions and controlled curvature throughout the blade and spike to promote uniform metal flow and reduce stress concentrations during solidification (See Figure 3). Fillets were strategically applied to internal corners to minimize the risk of hot spots and shrinkage defects, while maintaining the aesthetic inspired by historical designs. The blade was designed at 1/4 inches thick with gradual variations rather than abrupt changes to support directional solidification and improve structural integrity. Additionally, draft angles of 3° or more were incorporated where necessary to facilitate pattern removal from the mold without damaging the cavity. The decorative features and surface contours were designed with sufficient depth and radius to ensure they could be accurately reproduced in a no-bake sand mold without erosion or loss of detail. The details were designed to mimic the eagle head of Georgia Southern's college mascot (See Figure 4).

Figure 3 shows the SolidWorks model of the horseman axe featuring a Georgia Southern eagle-inspired design. The axe head incorporates elements resembling an eagle's head and beak, with the forward spike forming the beak and the blade representing the wing profile. Decorative contours and engraved

features were integrated to enhance the visual identity while maintaining functional geometry. The design balances aesthetic inspiration with manufacturability, ensuring proper material flow, structural integrity, and compatibility with the selected no-bake casting process.

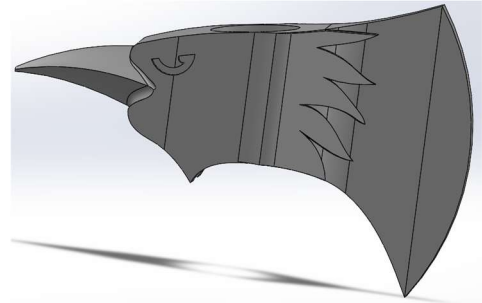


Figure 3. Final SolidWorks Design of Horseman Axe.

Figure 4 shows the Georgia Southern University (GSU) eagle logo used as the primary design inspiration for the horseman axe geometry. Key visual elements, including the beak profile, eye shape, and feather contours, were translated into the axe head design to create a cohesive aesthetic. These features influenced the curvature of the blade, the geometry of the spike, and the overall form of the axe while maintaining functional performance and manufacturability.



Figure 4. Georgia Southern Eagle Logo [5].

The overall geometry also accounted for post-casting machining, including location of gates and risers. These design decisions ensured that the SolidWorks model was not only visually representative of a traditional horseman's axe centered around the Georgia Southern theme but also optimized for manufacturability using the selected casting process.

A physical pattern was produced using additive manufacturing (3D printing), allowing for precise replication of the complex geometry (See Figure 5). This pattern was used to create the mold cavity in a no-bake sand system. The sand mixture consisted of silica sand combined with a chemical binder that hardened at room temperature, producing a rigid and dimensionally stable mold.

The gating system was designed and optimized using MAGMA simulation software. Multiple iterations were evaluated to minimize turbulence, air entrapment, and shrinkage defects. The final gating design included a downsprue incorporated from FOSECO riser sleeves, gates, and extra risers in areas with higher probability of shrinkage positioned to

promote directional solidification and adequate feeding of molten metal.

Figure 5 shows the 3D printed pattern assembly of the horseman axe showing the mold cavity geometry with integrated gating system and core components. The assembly includes the sprue and riser features used to direct molten metal flow and promote proper feeding during solidification. The assembly also includes the core used to form the internal eye of the axe. This printed pattern was used to create the no-bake sand mold, ensuring accurate reproduction of complex geometry and alignment of internal features.



Figure 5. Half of 3D Printed Mold Cavity.

The no-bake sand casting process was selected for the horseman axe due to its ability to produce complex geometries with improved dimensional accuracy and surface finish compared to traditional green sand casting. The axe design includes sharp edges, intricate contours, and varying cross-sections, which require a mold with high strength and stability to maintain detail during pouring. No-bake molds, formed with chemically bonded sand, provide superior rigidity and reduce deformation, allowing the blade features and fine details to be accurately reproduced, as seen in the final casting. Additionally, the process offers better control over mold integrity and reduced moisture-related defects such as gas porosity, which are more common in greensand molding. Compared to investment casting, no-bake casting provides a more cost-effective and scalable solution for steel components of this size while still delivering sufficient precision. Overall, the selection of no-bake casting enabled a balance between quality, complexity, and practicality for manufacturing a durable, high-performance axe.

Figure 6 shows the cope half of the no-bake mold made for casting the axe. A FOSECO riser sleeve was used as the pouring basin and downsprue and used to compensate for shrinkage upon solidification. An extra riser was designed near the spike of the axe to compensate for past shrinkage seen in earlier versions with previous gating systems. Vents were manually drilled into cope half to add an exit path for air to escape.



Figure 6. Cope of No-Bake Mold.

Molten 8630 alloy steel was prepared in an induction furnace and poured into the mold under control conditions. Pouring temperature and rate were monitored to ensure proper mold filling while reducing oxidation and gas defects. After solidification, the casting was allowed to cool before shakeout and removed from the mold.

Figure 7 shows the casting in the mold solidifying. The casting was still extremely hot when engineering students checked to confirm a full pour. The final chemistry was taken with a lollipop sample using an optical emission spectrometer.



Figure 7. Hot Steel Solidifying

Figure 8 shows an engineering student cutting off the gating system on solidified casting. Post-casting processes included removal of gating material, surface cleaning, and machining of critical features. Students used angular grinders, dremels, and polishing wheels to clean up casting. After the overall structure of axe was looking good, engineers shot blasted the axe for 10 minutes in 2-minute increments.



Figure 8. Engineering Student Grinding Gating Off.

Quenching was selected for the horseman axe due to the need for high hardness, edge retention, and impact resistance.

Unlike annealed or normalized microstructures, which prioritize ductility and ease of machining, a quenched and tempered structure provides the strength required to maintain a sharp cutting edge under repeated loading conditions. The martensitic transformation achieved through quenching allows the blade to resist deformation and wear, while subsequent tempering improves toughness and reduces the risk of cracking. This combination of properties is essential for a functional axe subjected to both cutting and impact forces.

Figure 9 shows the engineers quenching the steel after austenitizing steel in the oven at 925°C for 1.5 hours. Austenitization temperature was defined using chart shown in Figure 2. The carbon content in the steel was ~0.4 wt% and the quenching method was with oil. These parameters were used to obtain the minimum austenitization temperature of 875 °C.



Figure 9. Quenching Steel in Oil.

The axe was tempered immediately after quenching in oven at 500 °F for 1.5 hours. This improved the axe’s toughness and reduced the chance of blade cracking due to the formation of martensite. The pommel and guard were later casted in aluminum to ensure the axe remains lightweight. Once all components of the axe were created and post-processed, the assembly of the axe took place.

## RESULTS AND PERFORMANCE EVALUATION

Table 1 shows the final chemistry of 8630 steel poured for the axe casting. The measured composition ranged from -12.0% to +36.7% relative to target values, with carbon showing the greatest positive deviation and manganese showing the greatest negative deviation. All measured chemistry was taken from an optical emission spectrometer.

Table 1. Chemistry of 8630 Steel.

Chemistry	C %	Si %	Cr %	Mn %	Ni %
Target	0.30	1.60	2.10	1.00	0.35
Measured	0.41	1.49	1.90	0.88	0.40

Figure 10 shows a casting defect of shrinkage in earlier designs and the MAGMA simulation for the gating system. In Figure 10b, the red circles outline where the simulation software predicted the area near the riser’s gates would be one of the areas that solidified last. Figure 10a confirms this prediction by the large amounts of shrinkage found at the bottom of the riser and inside the casting where the gate was located.



Figure 10a. Shrinkage Defect in Earlier Design.

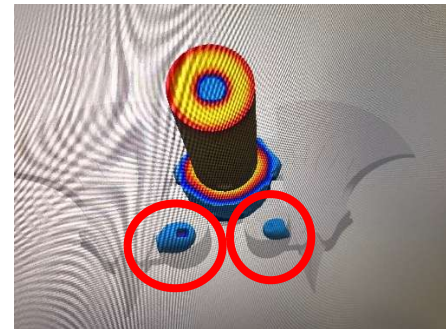


Figure 10b. MAGMA Simulations for Gating.

Figure 11 shows another design challenge with manufacturing the horseman axe. The failure was in the langlets that were designed to act as support for the handle (See Figure 11b). The handle chosen for this project was an off-the-shelf hickory wooden handle. Hickory wood has characteristics of being hard, dense, and shock resistant. The known attributes for this wood are great qualities for making a strong durable axe. The langlets were casted in aluminum to ensure they were lightweight. Engineers faced problems with the strength of the langlets while trialing design and inserting aluminum pins. Figure 11a shows how the langlets cracked in the middle and engineers confirmed this component in the design was flawed.



(a) (b)  
Figure 11. Langlet Design on Axe.

Figure 12 shows Southern Steel's first successful axe head manufactured in the Georgia Southern foundry. The overall design concept of the GSU eagle came out good, but the weight of the casting was too heavy. The axe head weighed about 2 lbs alone. During testing, engineers complained that the axe was no longer a one-handed axe but now required two hands to swing. This was not an ideal situation for the team, so reducing the axe head's overall weight and blade thickness was crucial. The eye hole was also increased to allow for the axe to sit further down on the handle.



Figure 12. First Successful Axe Head Manufactured.

Figure 13 shows the testing off the axe. Engineers tested the axe with steel drums to measure impact strength, ice blocks to test sharpness of blade, wood to show cutting efficiency, metal bars to test durability, and fruits to measure cut precision. The overall goal of testing was to destroy the axe as much as possible to identify any stress or failure points in current axe design. The thought process was that if the axe could be destroyed at Georgia Southern, then it definitely would not withstand testing in the upcoming competition. Figure 13b shows an impact marking from the axe circled in red.



Figure 13a. Testing on Ice Blocks.



Figure 13b. Results of Testing on Metal Bars.

Figure 14 shows the final manufactured axe. Figure 14a shows the polished axe after going through a series of post-processing techniques. This final axe was oil quenched, tempered, grinded, shot blasted and polished to obtain final aesthetic. Figure 14b shows the final assembly of the axe. The final axe was 20.75 inches, 2.86 lbs, and consisted of the 8630 steel axe head and a hickory wood handle surrounded by an aluminum pommel, paracord and twine. The pommel was casted in aluminum for its low-density properties.



(a) (b)  
Figure 14. Final Horseman Axe.

## DISCUSSION

The final casting was successfully produced with minimal visible defects which indicated an effective gating design and solidification control. Visual inspection of the axe showed no major shrinkage porosity, cold shuts, or misruns, particularly in critical regions such as the blade edge and spike. These areas were typically prone to defects due to varying section thickness. The addition of risers near high-risk areas, such as the spike, contributed to improved feeding of molten steel and reduced shrinkage.

The final results demonstrate that the integration of simulations and a controlled casting environment significantly improved the quality of the final product. The use of MAGMA simulation allowed for the identification and modification of potential defects prior to manufacturing. This reduced the need for an abundance of trials with different design iterations and contributed to a more efficient production process.

The selection of 8630 alloy steel played a critical role in achieving the desired mechanical performance of horseman axe. Its high hardenability enabled the formation of martensite during quenching, while tempering provided the necessary toughness to prevent failure caused by brittleness. This balance is essential for an axe that will endure both high-impact loading and repeated cutting stresses. Performance testing demonstrated that the axe was capable of effectively cutting wood, fracturing ice, and withstanding impact against metal surfaces without chipping or cracking. No significant deformation or structural failure was observed after testing, confirming that the material and heat treatment selection met the functional requirements of the application.

From a manufacturing perspective, the no-bake sand casting process proved to be well-suited for this application. The process provided sufficient mold strength to accurately reproduce intricate features such as the eagle-inspired geometry. The process also maintained dimensional stability during pouring. Compared to green sand casting, the improved surface finish and reduction of defects justified the usage of this process. Surface finish was consistent with the expectations for a no-bake sand casting process. There was minor roughness that was later removed during shot blasting and polishing of axe. Key features such as the eye, blade curvature, and decorative elements were successfully reproduced without significant distortion.

Despite the overall success, there were several limitations identified by the team. Total production time was increased due to the need for intensive post-processing and machining of axe head. Additionally, while the gating system performed effectively in the end, further optimization could reduce excess material like the extra risers to improve yield. Future work may include additional simulation iterations, refinement of riser placement, and exploration of alternative heat treatment parameters to further enhance performance.

A major challenge engineers faced was in shrinkage defects. To improve the defect shown in Figure 10, engineers increased the thickness of gates. Originally, gates were calculated based on the weight of casting. After pouring and solidification, it was confirmed that there was discrepancy in the calculations. The gates were not large enough to allow for casting to solidify first and simultaneously the risers to compensate for shrinkage. Once engineers adjusted the design, four axe heads were poured successfully.

Another issue that arose during the manufacturing of the horseman was the weight of the axe mentioned in Figure 12. The original weight of the axe casting was ~2 lbs. This forced the axe to go from a one-handed axe to a two-handed axe which is not ideal for the characteristics of a horseman axe. To compensate for weight, design engineers adjusted the original SolidWorks

design by decreasing the blade thickness and by decreasing the length from the tip of the blade to center of the eye hole. With these changes, engineers were able to reduce the weight by almost 20%.

The final major issue that the team experienced was from the manufacturing of the langlets shown in Figure 11. As seen in Figure 11b, the langlets were to design to act as support for the overall structure of the handle. The team's goal was to prevent the wooden handle from snapping due to the amount of force applied while striking. A major issue with the design was the thickness and strength of the langlets. To ensure the weight of the axe was below regulations and that the axe felt comfortable in hand, the langlets were manufactured as thin as possible. With this design concept in mind, disadvantages arose in the strength and durability of langlets. Upon inserting the aluminum pins to hold the langlets in place, too much pressure was applied to them and they snapped. To compensate for issue and to keep design concept, linseed oil was coated around the wooden handle. The oil seeped into the wooden fibers making the handle stronger and more durable.

## CONCLUSION

Overall, this project successfully demonstrated the design and manufacturing of a horseman axe through the integration of modern engineering tools and traditional casting methods. The use of SolidWorks for geometry development, partnered with MAGMA simulation for gating optimization, enabled the production of a high-quality casting with minimal defects. The no-bake sand casting process provided the necessary mold strength and accuracy to reproduce complex geometry, while the use of 8630 alloy steel and a detailed heat treatment process resulted in a tempered martensitic microstructure with desirable mechanical properties. The final product exhibited strong performance across multiple test conditions, including cutting, impact, and durability evaluations which confirmed the effectiveness of the design and material selection. The final axe was 20.75 inches, 2.86 lbs, and consisted of the 8630 steel axe head and a hickory wood handle surrounded by an aluminumommel, paracord and twine. This project highlights the importance of combining simulation, material science, and manufacturing processes to achieve reliable and high-performance casting components. Overall, the results validate the chosen approach and demonstrate its applicability to similar casting and tooling applications.

## REFERENCES

- [1] Craig Johnson, "The Arms & Armor Horseman's Axe," Arms & Armor, Apr. 6, 2020, <http://www.arms-n-armor.com/blogs/news/horseman-s-axe>
- [2] Kalpakjian, S., and Schmid, S. R., *Manufacturing Engineering and Technology*, 7th ed., Pearson, Upper Saddle River, NJ.
- [3] Krauss, G., *Steels: Processing, Structure, and Performance*. Materials Park, OH: ASM International, 2005.
- [4] Love Bushcraft, "Anatomy of an Axe – Understanding the

Parts,” Facebook, Mar. 2, 2025  
<https://www.facebook.com/groups/555175736681437/posts/959745022891171/>

[5] SportsLogos.Net, “Georgia Southern Eagles Secondary Logo (2010–2016),” accessed Mar. 26, 2026