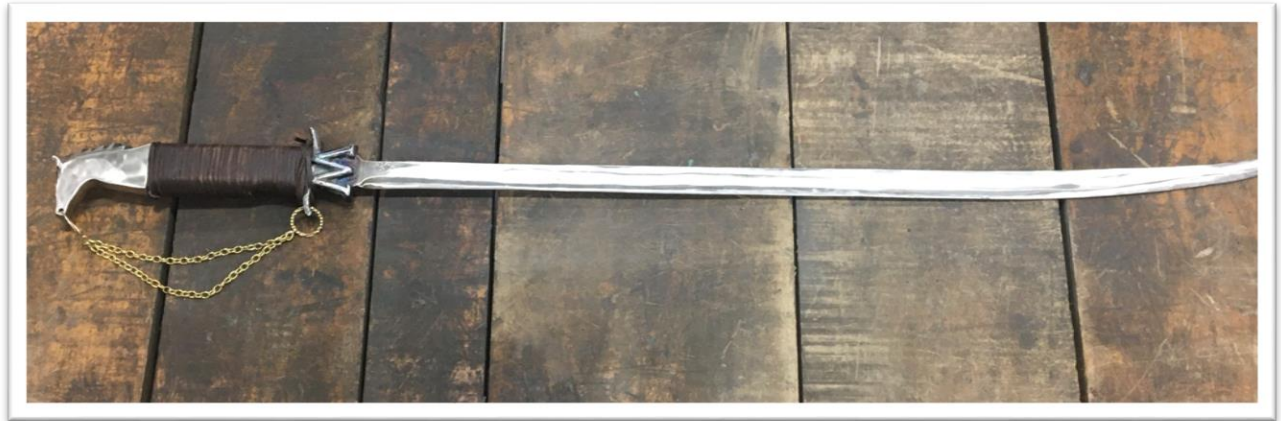


SFSA Cast in Steel 2025 – George Washington’s Sword Technical Report

Western Michigan University – Broncos



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Introduction

This technical report documents the design, modeling, and casting process of a historically inspired sword created by the Western Michigan University chapter of the American Foundry Society (AFS) for the 2025 Steel Founders' Society of America (SFSA) Cast in Steel competition. The design closely mirrors George Washington's historically significant "Bailey Silver and Ivory Hilted Cuttoe," integrating both historically accurate features and university specific elements. Advanced engineering software, including SolidWorks, ImageJ, and MagmaSoft, was utilized extensively to ensure precision in dimensional modeling, structural integrity, and optimized casting processes.

Historical Background

"The Bailey Silver and Ivory-Hilted Cuttoe"

Everyone knows of George Washington as a Founding Father and the 1st president of the United States, but what about his weapons? George Washington's swords have their own stories laced with all-American symbolism. The Swords that we took inspiration from were a part of Washington's collection and had a lot of detail and craftsmanship put into them. One of the swords we pulled information from was formally known as "Washington's Battle Sword", or "The Bailey Silver and Ivory-Hilted Cuttoe", it has a green and ivory wrapped grip with a beautifully shaped cross guard. The cross guard also contains images of animal heads that go along with the theme of our sword. The use of silver on this sword is to convey loyalty and vigilance, which are qualities that are looked highly upon in military leadership and battle. We designed the shape of the blade to mirror Washington's Cuttoe. Using ImageJ, an image processing software, we drafted a 3D model in SolidWorks of the blade and used it for our casting and final product.

Bailey and Washington

The cuttoe was forged by circa 1778 in Fishkill, New York by John Bailey, an immigrant cutler from Sheffield, England. Washington was born in Virginia when it was a colony of England, which gave him roots in the young nation and grit. Even though Bailey was from Britain, he

immigrated to New York early in his career and made very decorative yet functional swords that were highly coveted amongst the ranks of the Early American Military. Washington carried this sword at his side during the latter half of the American Revolutionary war, his high standards were met with this sword. Washington was likely proud of the irony of wielding a sword crafted by Brit on soon to be American soil.

The Silver Lion Headed Cuttoe

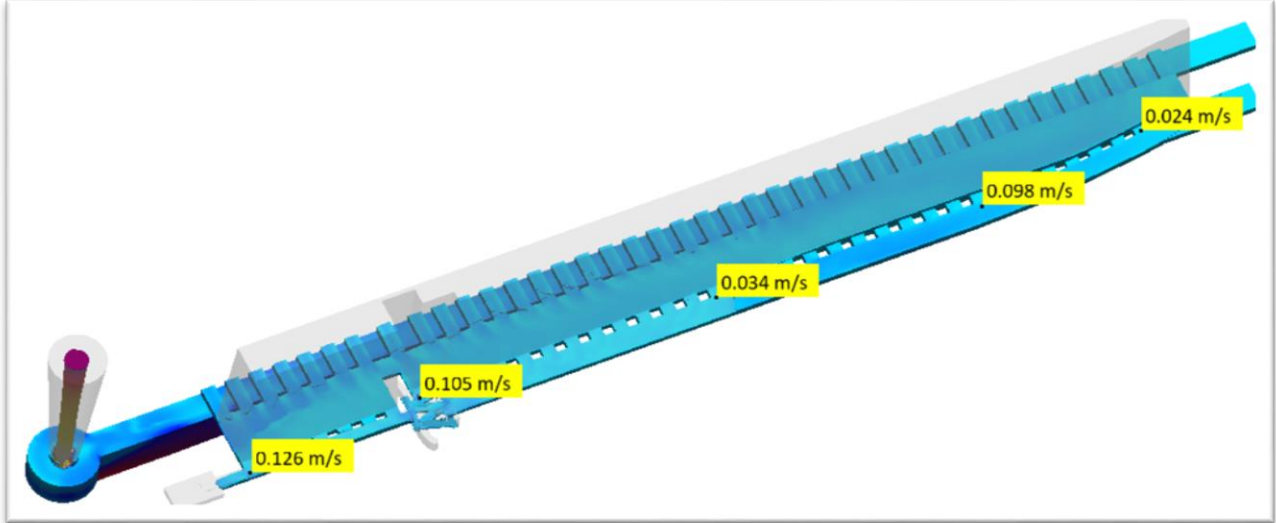
Likely forged in the early 1760s, this sword was a staple of strength and patriotism because George Washington first acquired it in Pennsylvania in opposition to English imported goods. Additionally, like many Americans at the time, the Silver Lion Headed Cuttoe was born in the colonies but is crafted in a European style. The lion-head pommel was quite popular in Europe and its reputation was brought to the colonies during a great feat of defiance. Even the grip produced from animal bone looks quite uncanny when compared to authentic ivory. The cuttoe may have even been made with the first president in mind, if its excessive length is any indication, but its original maker has long since been shrouded in mystery.

Metallurgical Decisions

For the blade material selection, 4140 steel was chosen due to its optimal combination of strength and toughness. The presence of carbon alloying in 4140 significantly enhances strength properties, making it highly suitable for blade applications that require durability and edge retention. As a part of the 41-series steels, 4140 offers substantial toughness, essential for resisting fracture or deformation during use.

Initially, our team considered using tooling steel, primarily due to its recognized hardness and edge-holding capabilities. However, after discussions and consultations with a local industry expert, we recognized that tooling steel's properties, while beneficial in certain specialized applications, were not necessarily optimal for our specific sword-casting objectives. This local expert provided valuable insight into our material selection process, assisting in clarifying unknowns and guiding our decisions based on practical experience and industry standards. In previous competitions, the selected metal did not need to maintain an edge as effectively as

required for the current sword design.

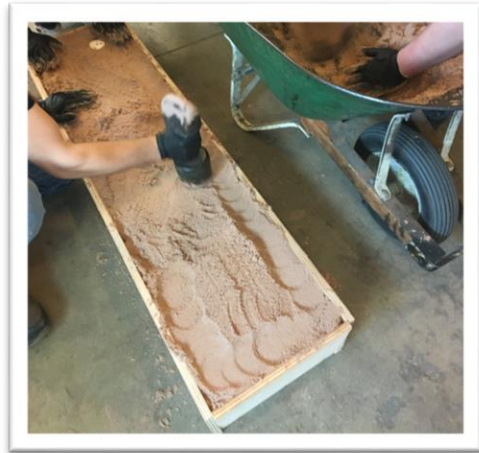
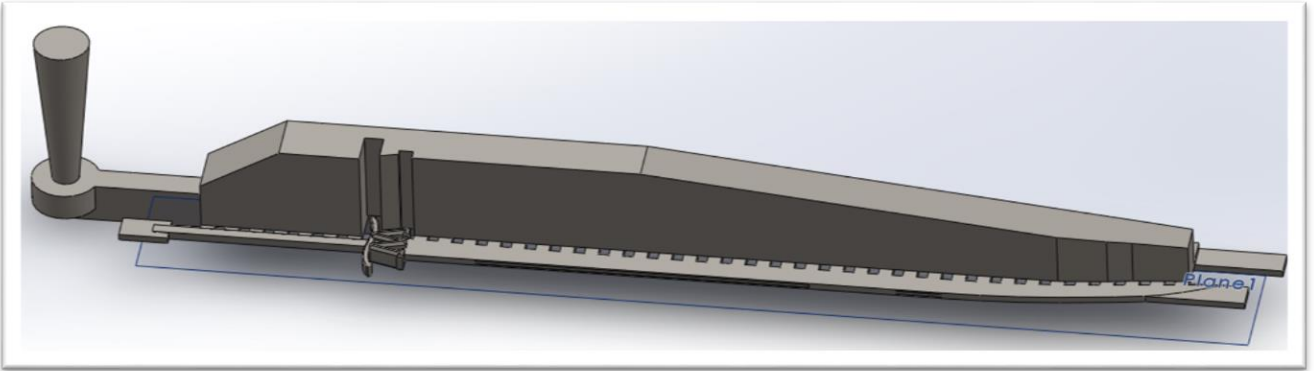


Casting Process

Our sword cast started as a whiteboard drawing, then into its concept design phase. Once we understood our limits for detail and size relative to our casting capabilities and Cast In Steel guild lines, we began modeling what would be our sword and pommel. We put in the effort to create a simple yet proficient design for our sword in SolidWorks. Moving away from modeling software, we began to run MagmaSoft simulations to try and understand the properties of our sword design.

There were possibilities of heat treating and forging out our blade during the early stages of our casting process but that was swept away with time as we were trying to create an optimal gating design for our sword. We ran into some microporosity issues during the first couple rounds of testing which led us to the design we have now. At this point, we were no longer going to forge the blade of our sword, so we wanted to make sure microporosity did not prove to be a problem in our final product. The sand mold for the sword was made from alpha set, a sand that is resin-bonded and worked well with us during the entirety of the cast.

Once the part was cast and cooled over the weekend, we began degating the sword from the rest of the pour. We used a bandsaw to cut away material and ended up with the rough casting of our sword. Wire wheels and angle grinders helped us finish the blade and we used a belt sander for our final sharpening. Toward the end of our sword assembly.



Design Process

Programs & Decision Making

At the beginning of our design process, we were excited to work in elements of our school's character into the design of our sword. The swords in President Washington's collection have a wide variety of detailed and artistic hilts and this gave us a lot to work with. We enacted a voting process during our concept design phase when it came to general features of the sword, this way the final product can be as close to the best interest of everyone in our chapter as possible. For our modeling software we used SolidWorks and Magmasoft was used for pouring simulations as we were casting the sword in-house. To accurately measure the dimensions of Washington's blade, we used a very high-resolution image from the Smithsonian's website along with the ImageJ program to create a model of the blade in SolidWorks.

Rain Guard

During our concept design phase we all wanted to have the WMU “W” somewhere in the middle of the sword along the cross-guard area, we would eventually end up deciding to place the “W” above the cross-guard as all the variability in depth between the blade, cross-guard, and “W” would lead to porosity during the casting process. Choosing to place the “W” where traditionally a rain-guard would be, helped make our sword more unique to WMU. The concept of having detail symmetrical to the cross-guard was inspired by “The Bailey Silver and Ivory-Hilted Cuttoe” from Washington’s collection. Furthermore, the “W” placed above the handle helped balance the overall body of the sword by bringing the center of gravity closer toward the handle.

Pommel

Washington acquired a very stylish and striking sword dubbed “The Silver Lion-Headed Cuttoe”. This sword caught our eye during the concept design process as. Given the animalistic design of the lion pommel, we could parody the head and replace it with a Bronco, our school mascot. During the design process, the pommel slowly gained an upright posture to keep a more aesthetic side profile.

The sword pommel was to be practical in both functionality and design while considering casting capabilities. The mane on the Bronco was originally going to have a lot of volume with a taper off into the grip, once we had concept modeling done, the visual balance of the pommel compared to the rest of the sword looked better with a more simplistic Bronco head and mane. We outsourced casting for the pommel to our foundry partners at Shellcast Inc. The opportunity to get a part of our sword professionally cast allowed us to yield detail on the ears, making the pommel more effective when pommel striking and half-swording. We put a channel through the pommel so we canpeen it onto the tang of the sword. Structurally, this method ensures the pommel remains tightly assembled over time.



Grip

The grip was originally going to be as close to Washington's battle sword as we could make it. Ivory obviously is not an option, and when we were browsing for grip material, we thought leather would be a very practical and We landed on using micarta for the structural properties, and leather wrapping for easy, comfortable handling.

Final Product

A beautiful piece of work consisting of 2.44 lbs of stainless steel, our blade's final dimensions are 30" in length, 0.2" in thickness, and 1" in width (at widest point). The grip is comprised of 4" long canvas micarta rod that's 1.5" in radius bound in thick, authentic leather. The horse-head pommel was grinded to a smooth, shiny finish to match the blade's, as well as metallic rings and chain directly connecting the pommel to the tilde. Both the colors of the leather and the chain were chosen to represent "Bronco Brown and Gold", as recognized in WMU's Alma Matre. The sword was dropped off to the post office for shipping on March 21, 2025 at 6:56 PM.



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Appendix



