SFSA Cast in Steel Competition

Bowie Knife Final Report

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Table of Contents

ABSTRACT

In the early 19th century, James Black created a different kind of knife for Jim Bowie. This knife was longer in length than the average knife and compared more to a mini sword. While the exact design and characteristics of the original Bowie knife was lost with James Black, the stories of the weapon captivated people. Our project was to capture the same aura surrounding the knife as James Black did many years ago but also commemorate the history associated with it. We created our Bowie knife model using Solidworks, cast it in IC440C Stainless Steel with the assistance of American Foundry Group, and polished it with our own tools.

1. INTRODUCTION

1.1 Project Management

ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Initial Proposition	15-Dec	5	1	4	100%
Design Brainstorm	5-Jan	3	4	3	100%
Research, Design, A	12-Jan	3	4	3	100%
CAD Model Creatior	27-Jan	8	7	8	100%
Final Design Submis	12-Mar	1	15	1	100%
Technical Report	15-Mar	3	16	13	100%
Video Production	12-Apr	4	20	9	100%
Submissions	12-Jun	1	29	1	100%

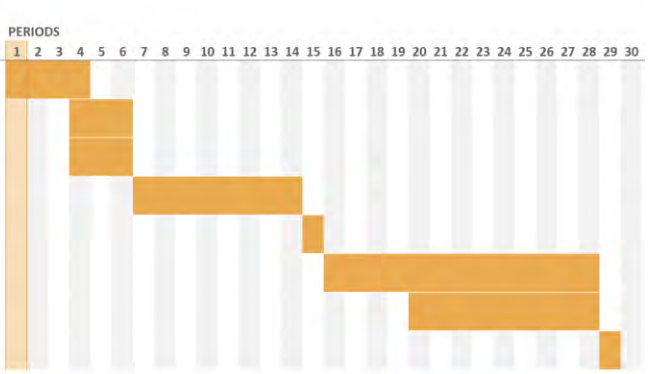

Figure 1: Project Schedule

Figure 1 shows the original Gantt chart for the Bowie Knife project. It began December 15th when we created the original proposition for the competition. Every period in the chat represents 1 week since the original 12/15 start date.

We started to brainstorm ideas for the design just after the beginning of the new year. Once we completed our research, we began making a rough draft of our 3-d model. We had to cut some ideas we wanted to incorporate such as serrations on the back of the blade and a separate pommel. Once all our team members decided on a final model, American Foundry Group helped us verify that the model would cast properly and made a few edits to ensure smooth flow. American Foundry Group 3-d printed our castings using a third-party company to cast our knives. Just after they place their order, Covid-19 struck the US and Texas State University closed. The schedule in Figure 1 then stretched out considerably due to not being able to meet. Our team received the knives back in mid-May. We were unable to heat treat the knives since we originally planned on doing it in university labs. While we tried our best to complete the

knives with personal tools that we owned, we were unable to complete them they original way we intended.

1.2 Literature Review

While the original craftsmanship of the Bowie knife was lost with James Black, early descriptions of the Bowie knife reveal that the blade was about 12 inches in length, 2 inches wide and ¼ inch thick. The knife also had a second sharpened edge from the point to the spine covered in soft brass or silver and a guard to catch other knife blades. Jim Bowie was attacked in 1831 by 3 assassins and was able to kill all 3 of them. In 1836, Jim Bowie died in the Alamo while repelling off Mexican forces with his Bowie knife. The popularity of the Bowie knife only grew with such a ferocious man and his legendary tales.

Figure 2: Krag Bowie bayonet US stamped on the reverse date 1900

From the mid 1800's to early 1900's, the Alfred Williams EBRO Bowie knife became the most popular in the USA. While James Black's Bowie knives were the original, he was attacked in 1839 by his father-in-law and former business partner and blinded. He was unable to continue his trade. In 1870, he attempted to pass down the secret to his son, but since being retired for so many years had forgot the secret. Rumors say that the original Bowie was made of Damascus steel, were extremely tough, flexible, and his technique was not replicated.

2. Design

2.1 Design Selection

Our version of the Bowie knife wanted to have the clip point, a bolster, and an integrally cast guard and pommel. Our blade is 11 inches long 2 inches wide and ¼ inch thick.

Figure 3: The Clip Point Bowie Knife

The clip point of the knife (marked with an arrow in Figure 3) was an early identifier of Bowie knives. The clip point allowed the user to pierce easier and deflect other attacks. The blade of another knife would slide down the false edge and spine onto the guard of the Bowie knife.

2.2 Alloy Selection

We initially decided to use WC9 carbon steel. We like the idea of having tungsten carbide in our knife. One of our professors advised us against it because it is extremely tough and will destroy many tools trying to sharpen it. We then decided to use IC440C Stainless Steel for our knife. We selected this alloy along with other teams from Texas State because it is corrosion resistant and very tough. With all 3 teams selecting the same material, it would also allow American Foundry Group to cast all the knives at the same time.

2.3 Production Selection

When we analyzed the two best forms of casting the Bowie Knife (Investment Casting vs. Green Sand Casting), we weighed out the pros and cons for each. With sand casting, we have a strong familiarity with it (primary casting technique at Texas State), could have a permanent mold, and have a decent surface finish. However, we believed that the investment casting

method would be easier for the bowie knife. With investment casting, we would be able to retain all the details we envisioned for our knife, it would have a fine surface finish, and we would not have to have a parting line. After creating an initial model for the knife, American Foundry Group was able to run the model in MAGMA and show us were we needed to add risers, change our geometry, and also show what areas could have heat defects.

3. MANUFACTURABILITY

3.1 Design Analysis

Our Bowie knife went through many iterations. Our group spent a total of 25 hours working on our models, making sure that all the requirements for the knife were met. We 3-d printed a 75% scale replica of our knife and was able to get a feel for how it felt in the users hands.

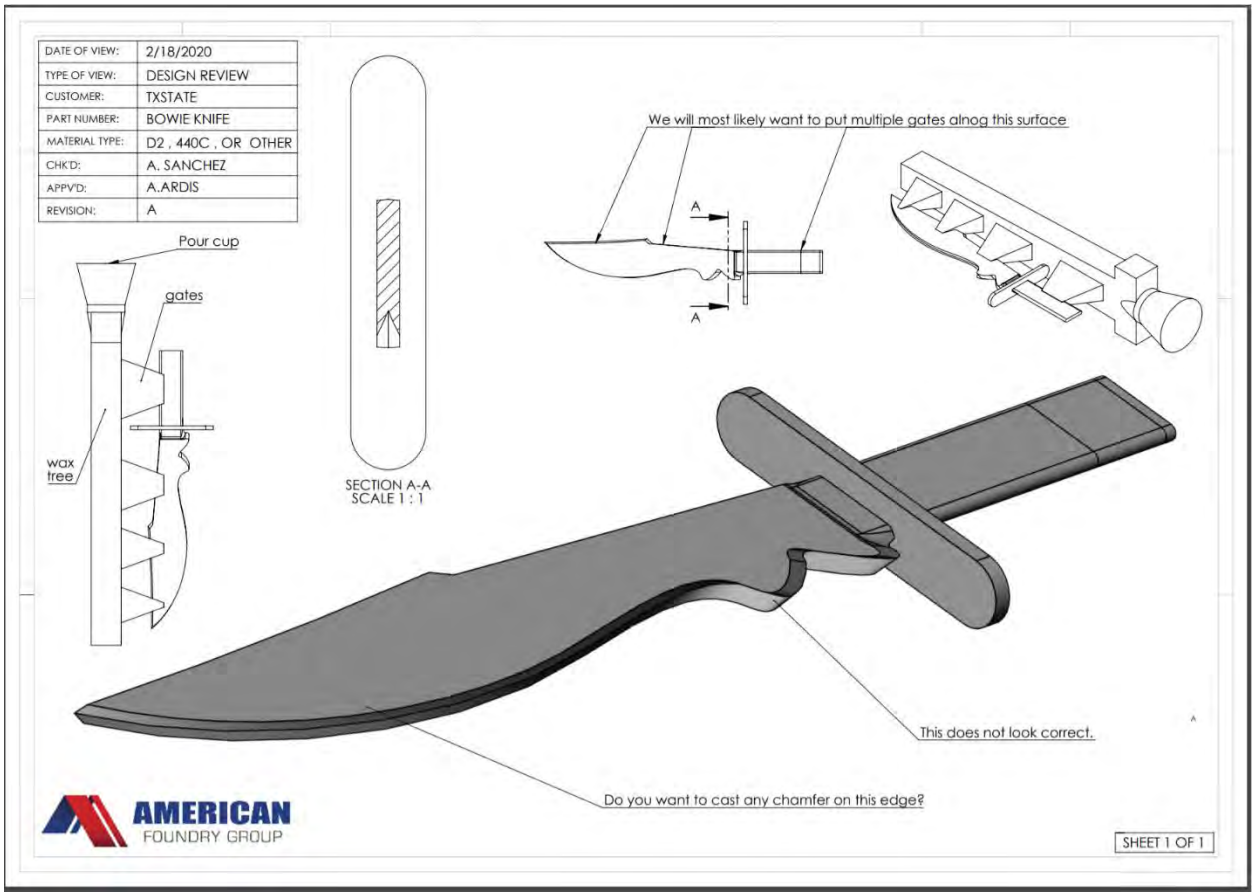

Figure 4: Initial Bowie Knife model (With Guard and Risers)

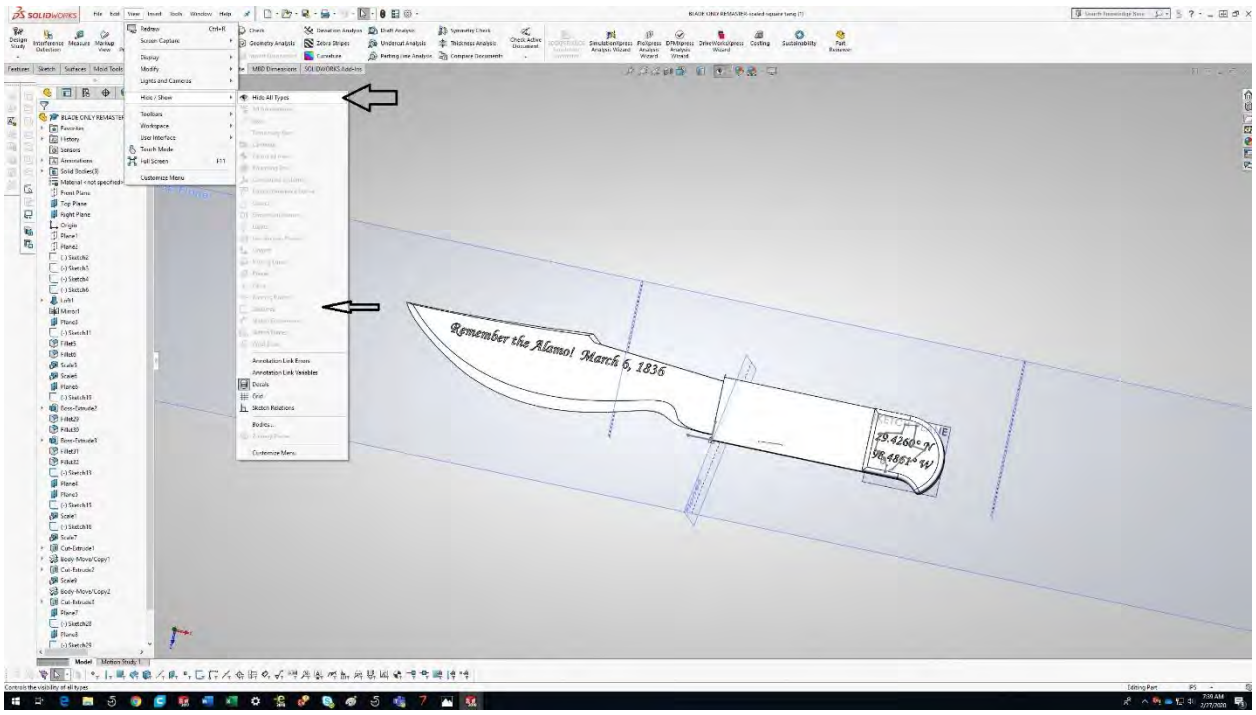

Figure 5: Bowie Knife 3-d model, future iteration (No Guard)

While Figure 4 shows our initial design, Figure 5 shows how we changed our blade. We decided against having a bottle opening design near the guard for a few reasons. It ended up looking very tacky and would have issues coming out cleanly in an investment casting. The new edge allows a larger area for the blade to contact objects and provides enough support.

3.2 Final Design

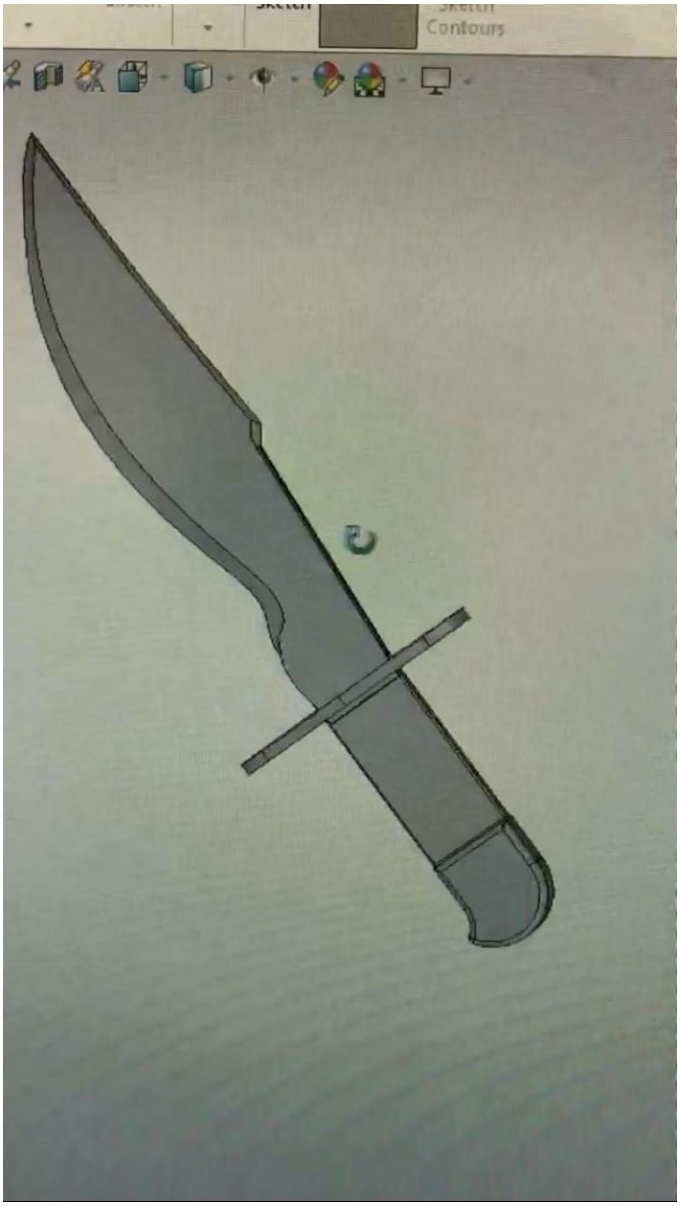

Figure 6: Final Design of our Bowie Knife (No engravings)

Figure 7: Final Bowie Knife

The final design of our knife included an integrally cast tang, guard, and pommel. The blade is 10 3/4th inches long, features a false edge like early Bowie knives, and has "Remember the Alamo March 6, 1836" engraved along the spin of the blade. On one side of the pommel is the state of Texas while the Coordinates of the Alamo (29.4260° N, 98.4861° W) are engraved on the other side. We originally planned on having a wooden handle, but due to limitations of equipment, we decided on wrapping the handle with leather strips.

3.3 Production

Since we used investment casting, American Foundry Group sent the complete model to a third-party company to create 3-d prints of our knives with the attached gates and risers. We do not have picture of the prints before the pour nor the picture of our knives in the casting. Our investment casting would look like Figure 7. A long vertical shell containing a low heat substance to form our knives.

Figure 7: An Investment Casting Process (Similar to the Bowie Knife)

Figure 8: Raw Bowie Knife Castings received from AFG

We received the Bowie Knives from AFG in mid-April. We originally planned on heat treating the knives ourselves with Texas State University lab equipment, but since the university closed because of Covid-19, we were unable to get the knives heat treated. We would have Austenitized the knives to 1030ºC and keep that temperature uniform for about an hour. The we would have quenched the knives in room temperature oil followed by tempering to 150ºC uniformly for another hour. This process would have given us the best combination of hardness and toughness in our knife.

Figure 9: Bowie Knives in the process of "at home" Polishing and Grinding

Figure 10: Final Bowie Knife

Since we were unable to preform heat treatments and machining with equipment at Texas State, we had to result on our own tools and methods. We initially sanded the blade down with a palm sander then used a station grinder for the edge. After, a polishing compound was applied to the blade. Using a whetstone, we then hand grinded the blade as much as we could.

4. QUALITY & PERFORMANCE

We were unable to conduct any form of tests on the knives. If we were able to, we would have completed a Rockwell Hardness test and a chemical composition test. If we had extra knives, we would have taken a metallographic sample and verified its microstructure. It would

have been beneficial to an x-ray radiography to look at the porosity of the knife, however Texas State does not have the equipment to do so.

5. CONCLUSION

The Bowie Knife allowed us to express our knowledge and our culture as Texas State University students. We were so excited going into the competition. We worked countless hours discussing design of our model in January and February. It was a real shame that such drastic circumstances fell upon our group and the world. There are many things that we wish we could have done differently to our knives, report, and video. The lack of heat treatment and tools to finalize the knife really hindered our result. During the time in the competition, one of our group members was directly affected by Covid-19 while another's family was affected. We hope for the health and well being of all those in the competition, facilitating the event, and those who are responsible for transporting the knives safely.

The competition has been a blast and we are grateful to be able to work through this experience. Unexpected problems may arise that we must work around and as engineers, we must make the best out of those situations. Thank you to Steel Founders' Society of America for putting on this competition. I hope that future competitors do not have to deal with the same circumstances we had to.

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