Water Ball Valve Process Redesign

Zebadiah Domer, Xavier Kain, Shawn Ligocki, Konnor Simpson
Design Engineering Technology
Advisor: Timothy Jenkins, Ph.D.

INTRODUCTION

W-L Molding of Michigan, LLC was founded in 1945 and bought by the current ownership in 2013. The W-L Molding Team is committed to consistent quality and continuous improvement to deliver world class plastic products and services that will meet or exceed the customers' expectations. W-L Molding is the current sponsor for the Ball Valve Redesign Team and produces plastic balls for ball valves instead of metal, Figure 1. W-L Molding injection molds plastics resin into an almost round ball shape. Immediately, the parts are annealed for roughly an hour to stop the shrinking process of the plastic.

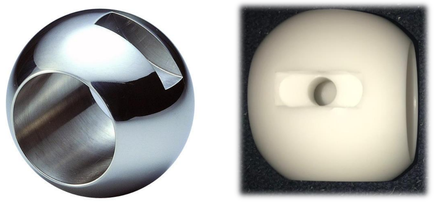

Figure 1: Metal and Plastic Ball Valve

PROBLEM STATEMENT

Following that, the molded parts go through a three-stage machining process to achieve its final shape. These three steps are boring, Figure 2, turning, Figure 3, and surface finishing, Figure 4. W-L Molding has come to Trine University looking for a resolution to the machining process so that the setup time that normally takes two and a half hours up to eight hours can be knocked down. Due to the high set up times the company is unable to take small batch size orders because the cost and time to set it up would not be profitable for the company.

Figure 2: Boring

Figure 3: Turning

Figure 4: Surface Finishing

CUSTOMER NEEDS/SPECS

A ball valve prior to the three-stage machining process can be seen on the right in Figure 5 and a finished ball valve can be seen on the left. Because of the need for this machining process W-L Molding Team has tasked the team members of the Ball Valve Redesign Team with the follow customer needs:

- Ease of Use
- Efficiency
- Minimal Manpower
- Ergonomic Design
- Size Capabilities
- 1 to 6-inch Ball Valves
- Reduced Setup Time
- Return on Investment

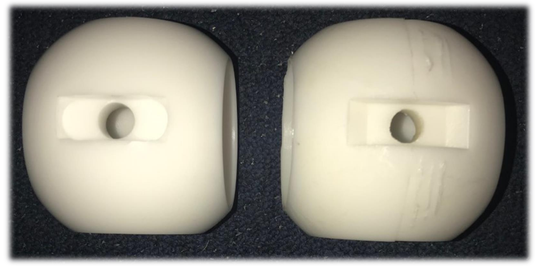

Figure 5: Machined & Unmachined Ball Valve

RELEVANT RESEARCH

The Ball Valve Redesign Team has conducted a multitude of outside research. This research involves looking up patents that are relevant to the project. The team has also looked down multiple different design avenues to figure out the most realistic options to choose from. Figure 6, shows one the patent for a universal workpiece holder the team feels is of great value to the research needed for the project.

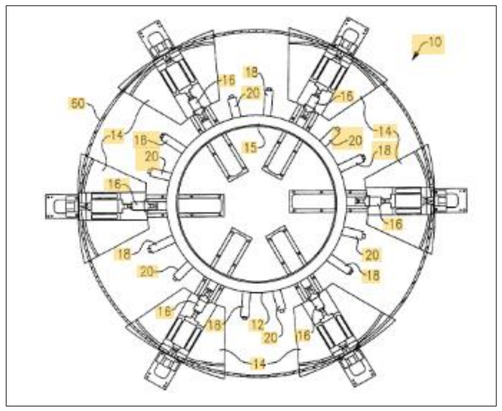

Figure 6: Patent Number: US6371468B1

DESIGN CONCEPTS

The design team split up the processes amongst the group members to be more efficient. One concept for the boring process clamping system is shown in Figure 7. This redesign should increase cycle time by reducing the time taken to clamp the part, as well as the travel taken during the boring process. The other concept the team worked on was the turning process as shown in Figure 8. The upper image shows the current setup and the proposed design should allow for easier setup between different ball valve sizes fine tuning the cutting blades.

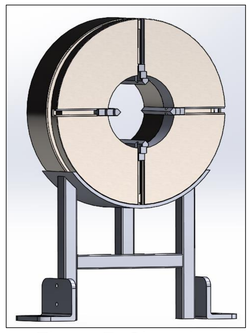

Figure 7: Clamping Mechanism Idea

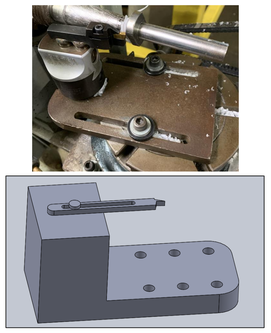

Figure 8: Current Machining Method and Concept Idea

FINAL DESIGN

The final designs for the first two processes are shown here in Figures 9 and 10. The new stand in Figure 9 will support the newly designed ball holding chuck. Figure 8 shows the current machining process used. The white part in Figure 10 shows the 3D printed prototype part the group tested and modified based on testing and feedback. Next to the 3D prototype in figure 10 is the tooling that will be incorporated with the revised design concept in Figure 10.

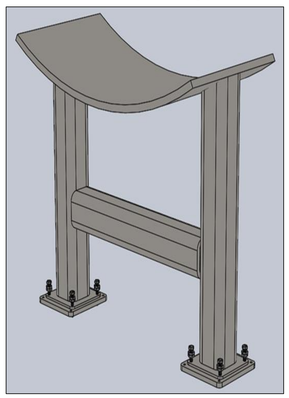

Figure 9: Clamping Mechanism 1

Figure 10: 3D Prototype and Final Design

FUTURE WORK

Due to the recent pandemic, the students were unable to manufacture all final design concepts. The students have supplied WL molding with contact information of possible manufactures as well as all final concept drawing to allow the sponsor to complete the manufacturing process.

CONCLUSION

The Ball Valve Redesign team believes that this project has given the team quite a few real-world examples of problems that come up in industry. Unfortunately, the team was not able to create a physical artifact of the final design for the first or second operation due to unforeseen circumstances. The team was thankful that the project provided learning, especially a project that pertains to a process that is very common to produce parts, machining. The team was able to review the current methods used by WL Molding and offer suggested refinements that should reduce both set-up and operation time in completing the polymer balls that the company makes for water valves. These legacy processes have been around for decades and being able to redefine the first two stages was a huge opportunity for the team.

LESSONS LEARNED

Looking back at the project the team has been given many lessons to take away from this project. The first lesson learned from the project was the ability to adapt to language barriers. The sponsor's primary language was not English which made some verbal interaction difficult at first. However, throughout the project the team handled this issue very professionally. The group also learned that the best solution to the problem may always not be available, whether the issue is cost, availability, or space. Sometimes alternatives must be chosen as the best choice. The obstacles the group had to overcome were obstacles that could commonly happen in the engineering industry. Having said encounters and learning how to overcome them will make the students better engineers in the future.

ACKNOWLEDGEMENT

Prof. Tom Trusty, Associate Professor and Chair, DET
Joe Thompson, Lab Technician, Trine University

Nigam Tripathi, Owner, W-L Molding
Anil Arakkal, Engineer, W-L Molding
Jignesh Doshi, Engineer, W-L Molding