Assembly Process Automation

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ABSTRACT

WL Molding provides several different industries with small, medium, and large sized plastic injection molded parts. The process that will be improved requires four parts to be injection molded and then assembled into two identical assemblies as in Figure 1. The current process requires the operator to remove parts from the injection molding machine and then create the assemblies by hammering in a pre-cut rod between the two hinge parts. The process is currently too slow, as many of the operators cannot complete both assemblies before the injection molding machine finishes with the next batch of parts.

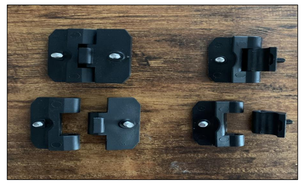

Figure 1: Parts to be assembled

The design team has been tasked with creating a new assembling process that is faster than the current method. The new process will be faster, more efficient, and easy for one person to operate while saving the company time and money. The process will also be safe for the operator to use. Through visual inspection of the process, interviews with members of WL Molding, and concept generation, the design team has generated three concepts that will be able to meet the needs and specifications for the problem.

CUSTOMER NEEDS/SPECS

WL Molding needs a way of assembling two sets of hinges during the time it takes for the injection molding machine to complete a cycle. The manual process is hard for the operators to complete on time, so an automanual process is desired to ensure timely assembly. The customer needs and specifications are shown in Tables 1 and 2.

Table 1: Needs

Customer Needs
Machine is safe
Machine is efficient
Machine is low maintenance
Easy to operate
Machine can operate both assemblies
Machine operates quickly

Table 2: Specifications

Customer Specifications
Max PSI of 55
Uses only 1 operator
12 seconds per part
2 complete hinges in 25 seconds
Force of 15 pounds or less
Part nest holds all parts of two separate assemblies
Height is under 2 feet

DESIGN CONCEPTS

The design process was broken down into subproblems for the machine such as the frame, part securing, safety, and power transmission. The team developed three different designs with different styles of operation and different cost structures. The team wanted to give the sponsor the choice of how much human interaction was desired in the process and how much the sponsor would want to spend based on the design and amount of automation involved. The three designs are shown in Figures 2 - 4.

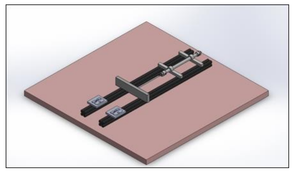

Figure 2: Horizontal Pneumatic Concept

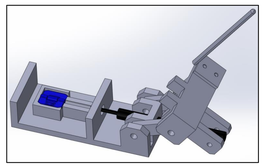

Figure 3: Horizontal Manual Concept

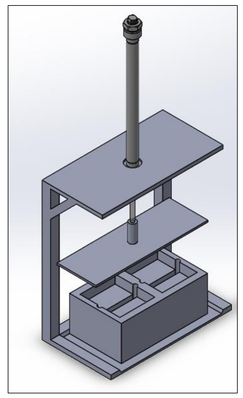

Figure 4: Vertical Pneumatic Concept

The team presented the designs to WL Molding who liked where the team was going but wanted to refine the concepts. The sponsor wanted a combination of the three designs. The result is shown in Figure 5. The main updates for the concepts are the 45-degree angle, a push operation button, and a frame standing structure. After another design meeting with the sponsor, WL Molding wanted to impliment a door that allows the operator to walk away from the machine during the process, this refinement is shown in Figure 6. This last design also uses 8020 extrusion for the frame.

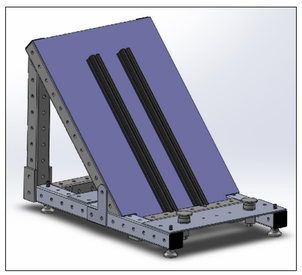

Figure 5: Initial redesign

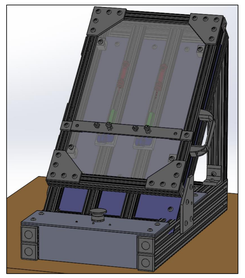

Figure 6: Final redesign

TEST RESULTS

The testing for the machine is broken down into different sections: frame and structural testing, pneumatics testing, and electrical testing. The frame and structural integrity of the machine must be tested in many ways to ensure that it is strong enough for the application. Testing the pneumatic equipment is crucial for the functionality of the machine, the team tested the pneumatics before it was installed so that time wouldn't be wasted in disassembling the machine to make fixes. Lastly, the electronic equipment within the machine must be tested to ensure that the status/safety lights function properly and to check that the door will not operate when opened. Figure 7 provides a setup of the actual machine for testing.

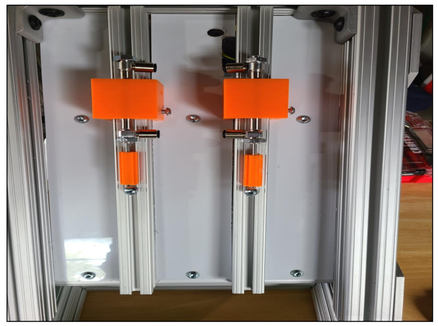

Figure 7: 3D Printed Actuator Mounts and Delrin Rod Holders

FINAL DESIGN

After combining the three initial designs and consulting with the sponsor, the team was on the right track. The final design was changed to allow the operator to insert the parts, close a door, and then walk away from the machine. Figures 8 and 9 show the design without and with the door. The design is meant to save the operator time from the manual process using pneumatic components.

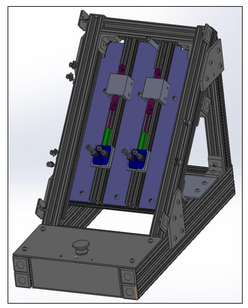

Figure 8: Final Design without Door

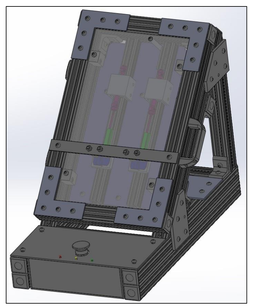

Figure 9: Final Design with Door

CONCLUSION

The Assembly Automation team has assembled a pneumatic press machine that includes two pneumatic actuators to push a two Delrin rods into two hinge assemblies, one rod for each assembly. The team used different engineering design phases to produce an efficient, easy to operate, and safe design for the assembly of the hinges. The design incorporates 3D printed parts, as well as an 8020 frame that is angled for easier operation for the worker. The design allows for the operator to insert both halves of the hinge into a part nest, insert a Delrin rod into the rod holder, close the door and push the start button. Once the cycle is done then the operator can open the door and take the assembled parts. Figure 10 shows the press assembly and the team believes this solution will meet WL Molding's needs.

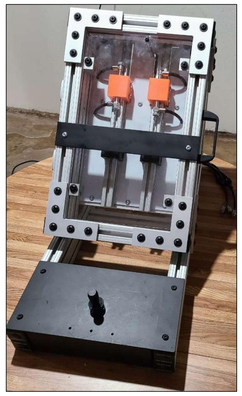

Figure 10: Final Machine Prototype

LESSONS LEARNED

Throughout the project the team learned:

- The importance of time management
- Communication between the team as well as with the sponsor and advisor
- The understanding that the project may change at any stage of the design process and the team must be prepared for that
- Documentation is critical

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W-L MOLDING OF MICHIGAN, LLC