DELRIN ROD CUTTER

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ABSTRACT

WL Molding of Michigan, LLC of Portage, Michigan was founded in 1945 and the current owner acquired it in 2013. WL Molding has maintained a commitment to the quality of products, customer satisfaction, and to the continuous improvement of the processes in an effort to create high quality plastic products. WL Molding currently sponsors both the Delrin Rod Cutter team and the Part Catcher and Transfer team. WL Molding produces a product made of three different pieces: two halves of the hinge connected by a pin. The team was requested to help aid the process in accurately cutting the hinge pins.

Figure 1: Delrin rods

CUSTOMER NEEDS/SPECS

A Delrin rod prior to the process that is currently employed has a length of five feet. It needs to be broken up smaller to fit in the hinges as shown in Figure 2. In an effort to achieve higher quality products, WL Molding provided the team with the following design needs from which the team derived the target specifications:

Needs:	Specifications:
• Full Automation	• Cut rod with no stoppage
• Small footprint	• Under two minutes per rod
• Safety of user	• Under 1' X 1' area
• Reliability	• Automatic feed device
• Precision	• +/- .002" tolerance

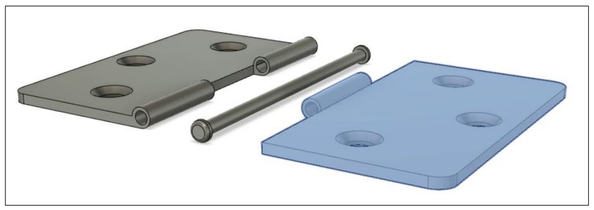

Figure 2: Exploded Hinge

DESIGN CONEPTS

The team designed multiple different concepts that could be used to solve the problem. The two top rated concepts are presented below. Figure 3 shows the first concept that the team designed with the thought of integrating the new machine into an existing line. The scope of the project changed so this concept was scrapped. Figure 4 shows the second concept that the team pursued. It contains an encasement made of steel angle iron and a steel baseplate. The cut is driven via a pneumatic cylinder modified to handle a blade. This provides the team with the necessary cutting tolerance.

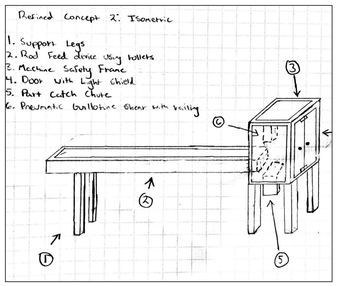

Figure 3: Concept 1

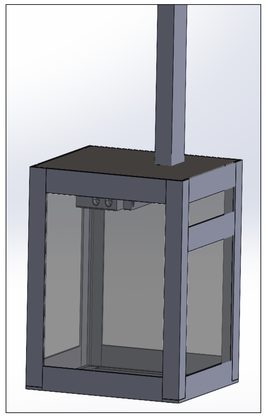

Figure 4: Concept 2

Figure 5 shows the third concept which is similar to concept two.. The frame is made from 80/20 aluminum channel. It contains a stepper motor to drive the rods and a pneumatic actuator to cut the product. The final product would fall into a part catcher bin and angled feed device would feed the rods into the cutting mechanism.

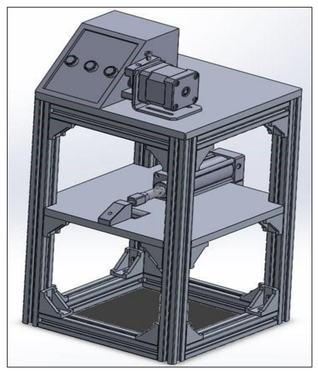

Figure 5: Concept 3

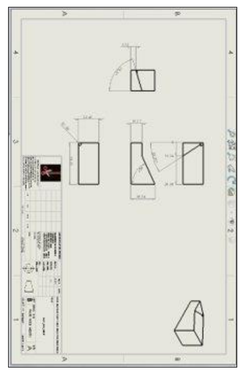

Figure 6: Feed Device

FINAL DESIGN

After consulting with numerous professionals on the machine build testing the rods shear strength, and providing several revisions to the proposed final product, the team decided to pursue the design shown in Figure 7. Figure 7 shows the design in its entirety. It features safety acrylic around the outside of the machine. A door is attached to the front of the machine for ease of access for maintenance purposes. The electrical safety box features a switch to turn off the power as well as the pneumatics to the machine. Figure 8 shows the Arduino board that is used to control the machine operation. A stepper motor, solenoid valve, and two switches are connected to the board to provide functionality to the machine.

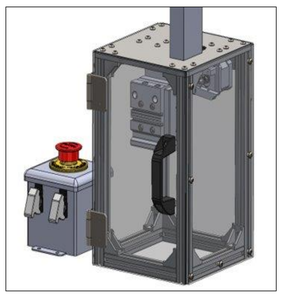

Figure 7: Final 3D Model

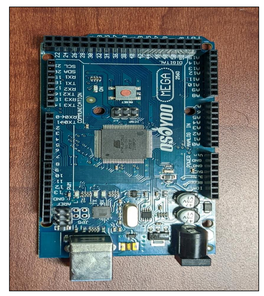

Figure 8: Arduino Board

Using the technical drawings from the CAD model, the team developed a final product shown below in Figure 9 and 10. Due to supply chain issues and time constraints, several of the pieces were produced using additive manufacturing to test the design. After testing the team found that the motor was to turn 220.52 steps for the 1.5-inch cut and 257.28 steps for the 1.75-inch cut to achieve the tolerance of plus/minus two thousandths of an inch.

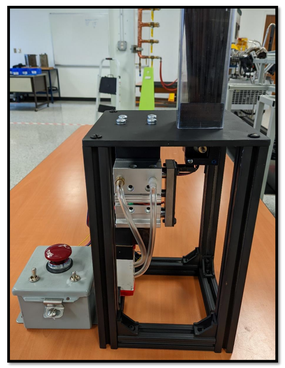

Figure 9: Final Product

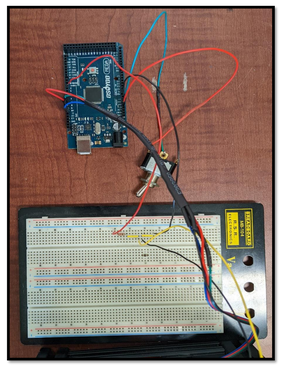

Figure 10:Electronics

CONCLUSION

The Delrin Rod Cutter Team successfully tested a machine that cuts Delrin rod for WL Molding. In addition, halfway through the project the team learned that the Delrin supplier could cut the rods to length in the manufacturing line. Due to this, this project is currently being developed as a secondary option with higher tolerances. The machine cuts rods effectively and quickly which eliminates wasted labor and time during assembly. Figure 11 and Figure 12 show the basic programming structure that allows the machine to index for both rod lengths.

```
void loop() {
  digitalWrite(7,HIGH);
  digitalRead(6);
if(val==HIGH){
  const int stepsPerRevolution = 220.52;
  Stepper myStepper(stepsPerRevolution, 8, 9, 10, 11);
  myStepper.setSpeed(60);
  Serial.begin(9600);
  Serial.println("clockwise");
  myStepper.step(stepsPerRevolution);
  delay(3000);
  digitalWrite(2, HIGH);
  delay(3000);
  digitalWrite(2, LOW);
```

Figure 11: Program for 1.50

```
else(val==LOW);{
  const int stepsPerRevolution = 257.28;
  Stepper myStepper(stepsPerRevolution, 8, 9, 10, 11);
  myStepper.setSpeed(60);
  Serial.begin(9600);
  Serial.println("clockwise");
  myStepper.step(stepsPerRevolution);
  delay(3000);
  digitalWrite(2, HIGH);
  delay(1000);
  digitalWrite(2, LOW);
}
```

Figure 12: Program for 1.75

LESSONS LEARNED

Throughout the course of this project, the team learned several important lessons in engineering as well as professional practices. Some of these lessons are as follows:

- The importance of time management.
- The customers needs can change over time, and it is up to the engineers to accommodate this change.
- It is important to never make assumption about what has already been completed.
- The design process is always changing and communicating during this process is crucial to a successful design.

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