

Accessible Drawing Device - 2D Translation Stage

Mary Cariola Group

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Problem Description/ Requirements

Problem: Not all students are able to hold writing utensils on their own to write on paper.

Requirements:

- Transportable and able to be angled
- Compatible with provided buttons, compatible with most standard writing utensils
- Childproof/includes safety cover
- Easy to replace paper
- Non digital/no screen

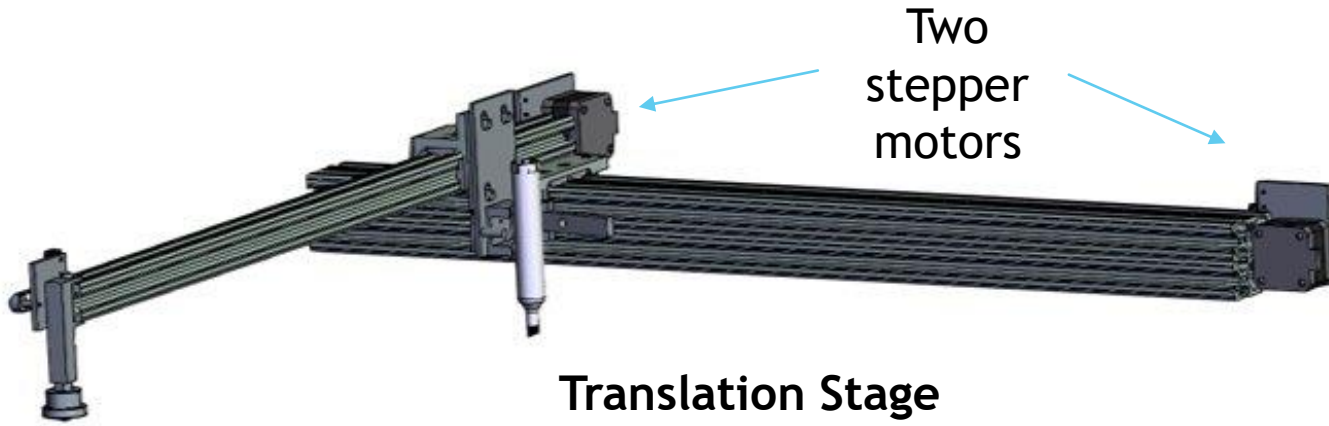


Specifications

Specification	Required Value
Paper Width Range	11.5 to 24 inches
Paper Height Range	8 to 18 inches
Base thickness	1/8 inch
Max Weight	20 lbf
Tilt Angle Range	0 to >45 degrees
Motor Torque	4.43 lbf*in
Power supply	Voltage: 5V



Concept/Design Discussion



Two
stepper
motors

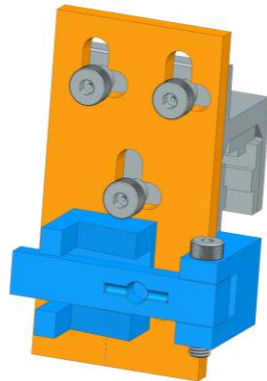
Ball
transfer

Translation Stage

- 8020 rails
- Sliding carts
- Custom brackets and mounts for pulleys, belts, and limit switches

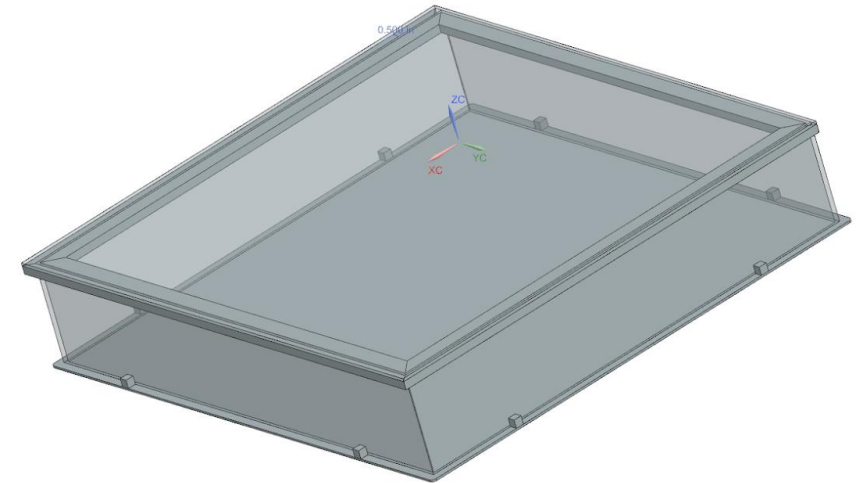
Pen Holder

- Adjustable height
- Spring to hold pen in place
- Rubber on “V” piece
- Some 3D printing, some metal for robust design



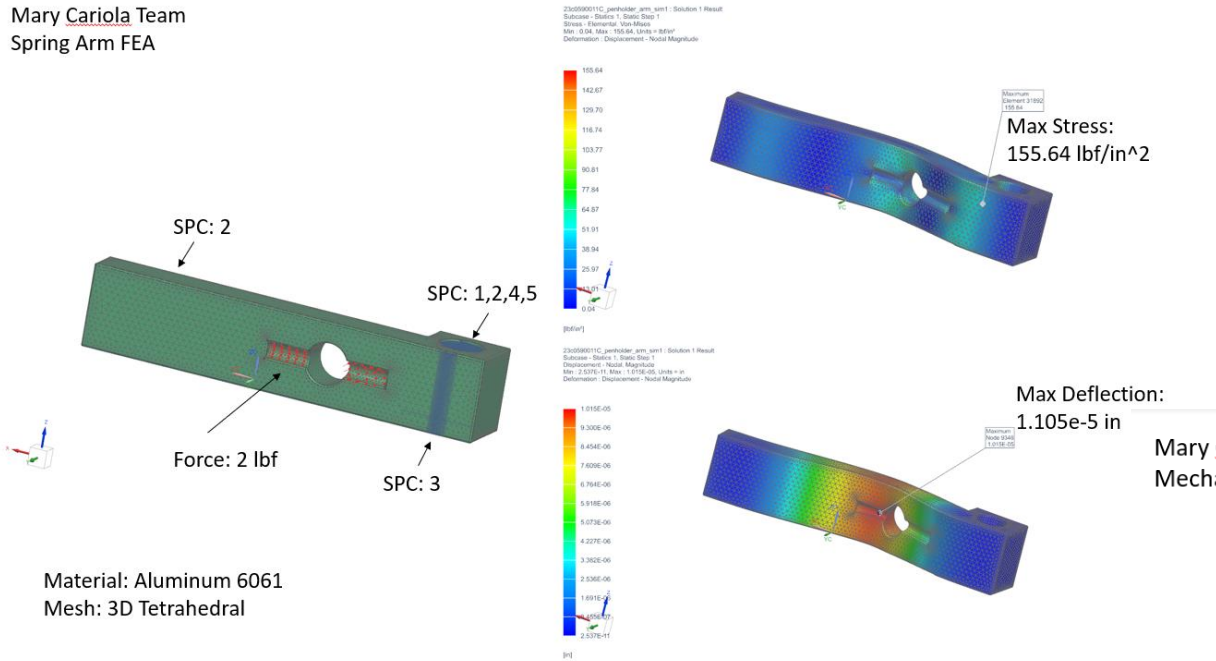
Base and Safety Cover

- Sliding, removable polycarbonate lid
- Small “stoppers” to keep cover in place
- 3 wooden sides for structure, front panel polycarbonate for visibility

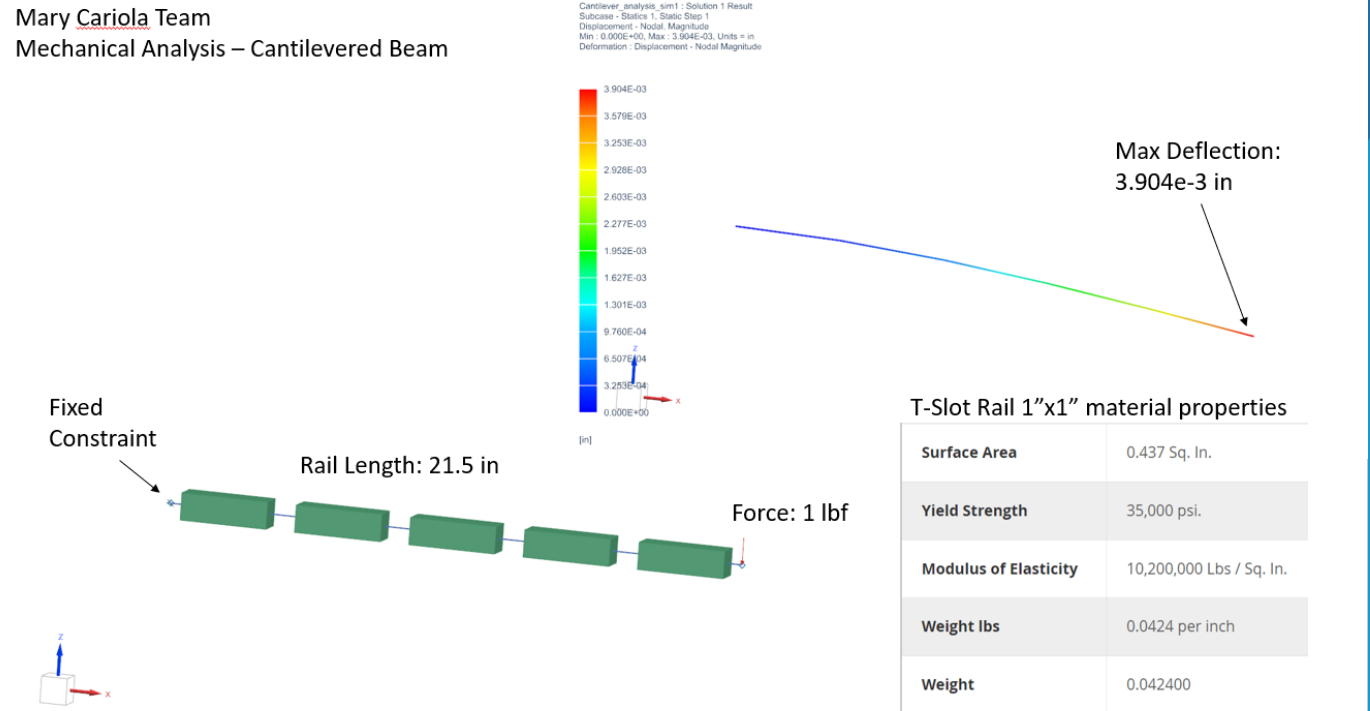


Important Analysis and Simulation

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Spring Arm FEA



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Mechanical Analysis – Cantilevered Beam



T-Slot Rail 1"x1" material properties

Surface Area	0.437 Sq. In.
Yield Strength	35,000 psi.
Modulus of Elasticity	10,200,000 Lbs / Sq. In.
Weight lbs	0.0424 per inch
Weight	0.042400

Fastener
Torque
Calculation

$$F_i = \{0.90F_p\} (1)$$

$$F_p = A_t S_p (2)$$

$$F_p = 0.00909(55 \text{ ksi}) = 0.49995 \text{ ksi} \cdot \text{in}^2$$

$$F_i = 0.00909(0.49995 \text{ ksi} \cdot \text{in}^2) = 0.449955 \text{ ksi} \cdot \text{in}^2$$

$$T = kF_i d (3)$$

$$T = 0.2(0.449955 \text{ ksi} \cdot \text{in}^2)(0.138 \text{ in})$$

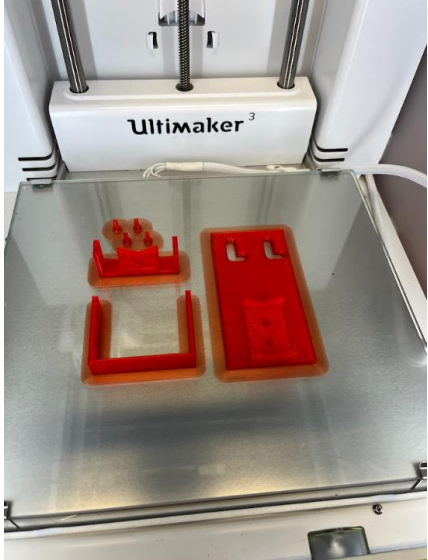
$$T = 12.418758 \text{ lb}_f \cdot \text{in}$$

Manufacturing

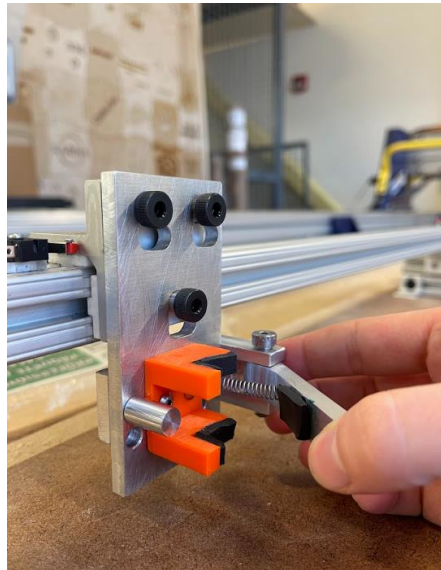
Item Manufactured	Material	Method	Justification
Pulley mount	Aluminum	Mill	Easy and fast to make by team
Limit switch mount	Aluminum	Mill	Easy and fast to make by team
Motor mount	Aluminum	Mill	Easy and fast to make by team
Slide bracket	Aluminum	Mill	Easy and fast to make by team
Pen holder assembly	Aluminum, PLA	Bill Mildenberger, 3D printing, Mill	Design is complex and had enough money in budget for Bill to manufacture. Some adjustments needed to be made so 3D printing and milling by team was quicker and cheaper
Base	Plywood	Table saw, sanding, hot glue	Cut base to size on table saw, sanded corners and hot glued the stopper pieces
Safety Cover	Polycarbonate, plywood	Bill Mildenberger, wood gluing, nail gun	Paid for Bill to make the cover, due to complexity in solvent welding. The design was changed, so the team added an extra 1 inch to the base to make it taller for time and money reasons.



Pen Holder



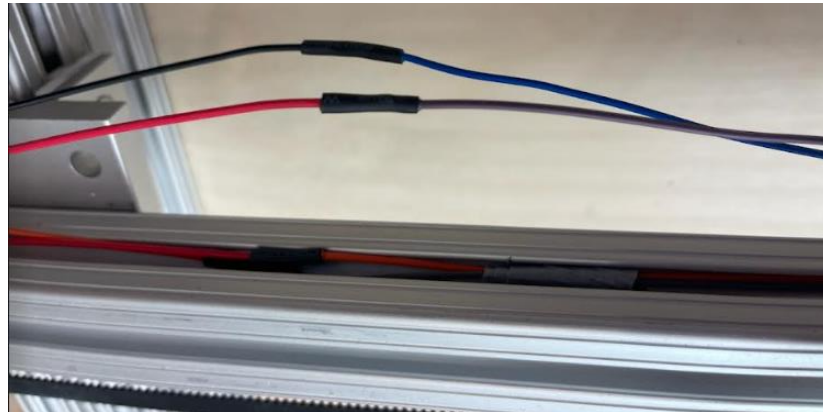
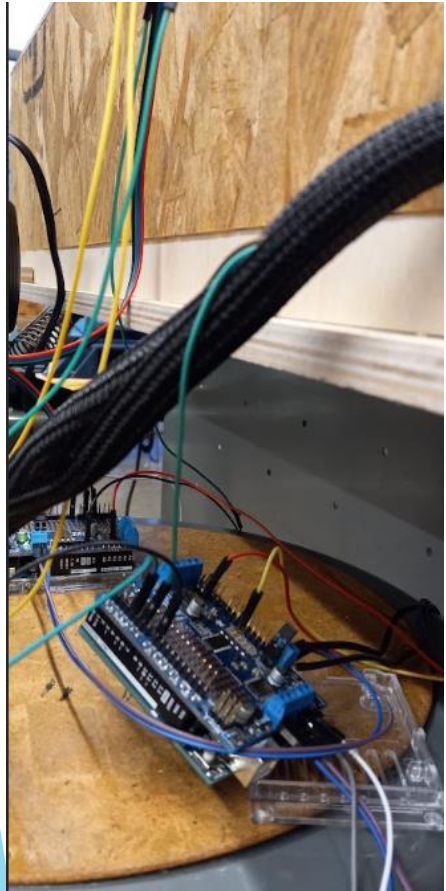
3D Printed Prototype



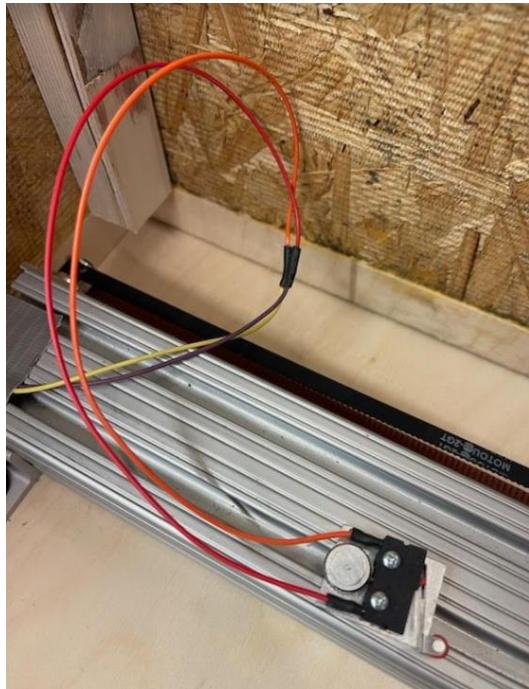
Final Piece

Base and Safety Cover

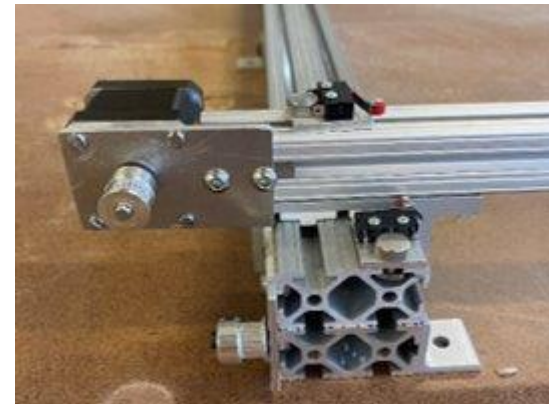
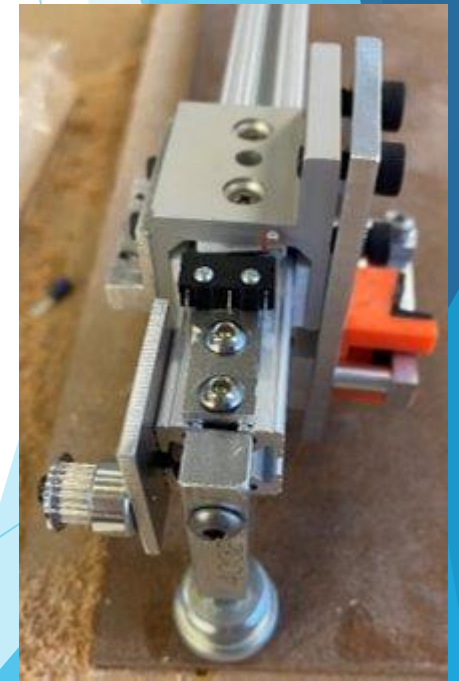




Circuits and Assembly



Soldering and heat gun for permanent connections

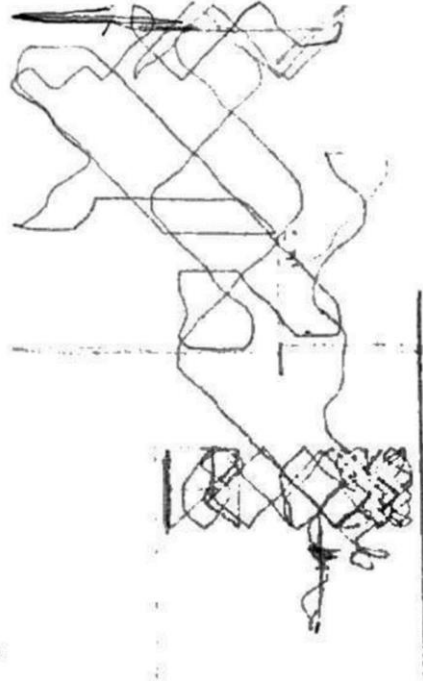


Brackets and Mounts

Testing

Specification	Required Value	Measured Value	Pass/Fail	Test Method
Paper Width Range	11.5 - 24 inches	11.5 - 22 inches	Fail	Tape Measure
Paper Height Range	8 - 18 inches	8 - 17.5 inches	Fail	Tape Measure
Base thickness	1/8 inch	1/2 inch	Fail	Tape Measure
Max Weight	20 lbf	29.8 lbf	Fail	Digital Scale
Tilt Angle Range	0 to >45 degrees	0 to 70 degrees	Pass	Tilt Test

Conclusions and future work



Mary Cariola Team
First Drawing 4/24/23

Final Assembly

