BAE Mod-wire

Mechanical Engineering

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Abstract

The team's goal was to automate one or more steps of BAE Systems' mod-wiring process. Currently, an experienced worker can take a shift or more to mod-wire one CCA by hand.

The team used 80/20 to design and partially build a wire bender. A feeder was made from a continuous servo and a set of rollers coated with a tacky material to grip wire. The original MIG welder feeder was improved, but feed tolerance was not met for all wires.

A functional GUI creates, stores, loads, edits, and deletes wire geometries and material types. This GUI also runs the wire bender in a test mode.

The results of the first iteration of the project are promising but do not meet all project requirements. The most expensive components for building a wire bender are purchased: a straightener, framing components, and linear actuators.

Customer Needs and Requirements

- Eliminate or automate at least one step of the current mod-wiring process
- Deliver a cost-effective machine that reduces labor while maintaining consistency
- Form wire geometries that meet distance tolerances based on circuit board design
- Follow facility requirements and safety standards

The wire bender must:
- Cost less than $5,000
- Form 4 – 9 bends with 26- to 30-gauge insulated and magnet wire that is 2 – 7"
- Strip 1/16 to 1/8" of insulation from either end of insulated wire
- Leave no visible denting, crushing, or gouging
- Straighten wire within 1 / 32" over 2"
- Feed wire segment lengths accurate within 1 / 32" (0.8 mm)
- Form bend angles accurate within 3°
- Enclose moving parts and turn-off if the enclosure is removed
- Store wire geometries
- Run on a 110 V, 15 A power supply, battery power, or be cost effective for 220 V
- Use the Python and Java coding languages if at all possible

Concept Selection


KS-W010 Wire Bender from Kingsing
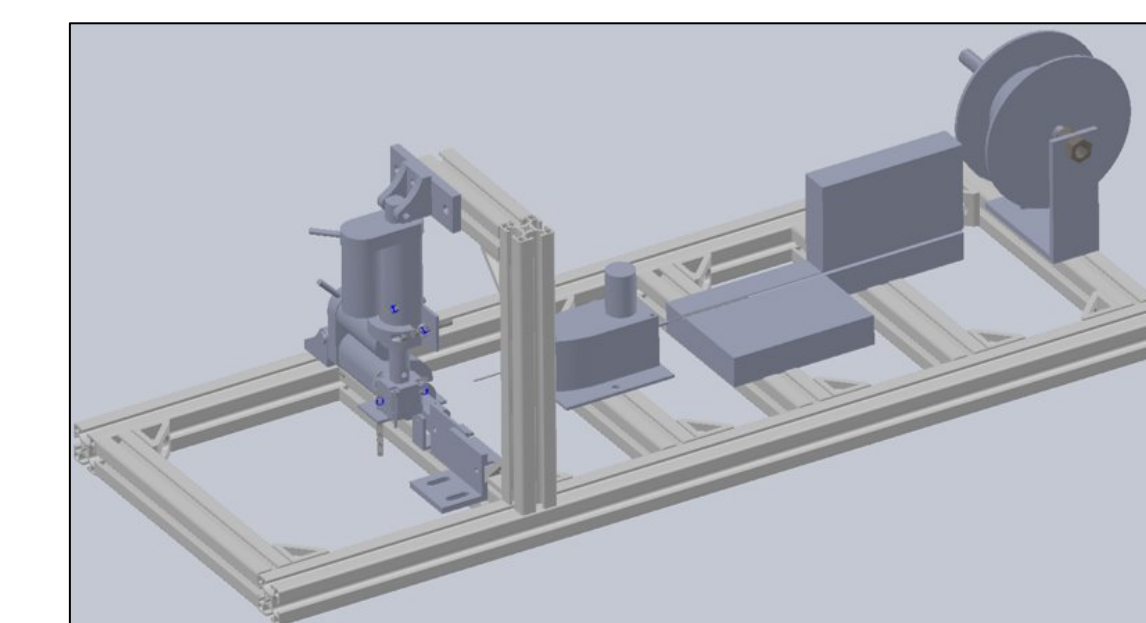
Original Concept Wire Bender

Initially, buying a wire bender was pursued. A purchase order for the KS-W010 wire bender sold by Kingsing was sent to BAE Systems, and the team went on Winter Break confident it would be at Trine University when they returned to campus. A couple weeks after Winter Break, it was determined unfeasible to purchase the KS-W010 wire bender because Kingsing is not an approved vendor for BAE Systems. With 14 weeks left before Senior Design Exposition, the team immediately began building a wire bender.

Design Solution

The final design is a tabletop unit with a de-reeler, straightener, feeder, cutter, and bender. It has an 80/20 frame with plexiglass shielding. It has a collection tray for finished wires, a sliding tray for a keyboard and mouse, an electrical box mounted behind the frame, a monitor mounted to the top crossbar, and handles to carry it. This was pursued for manufacturing. The bender, electrical box, and plexiglass were not realized.
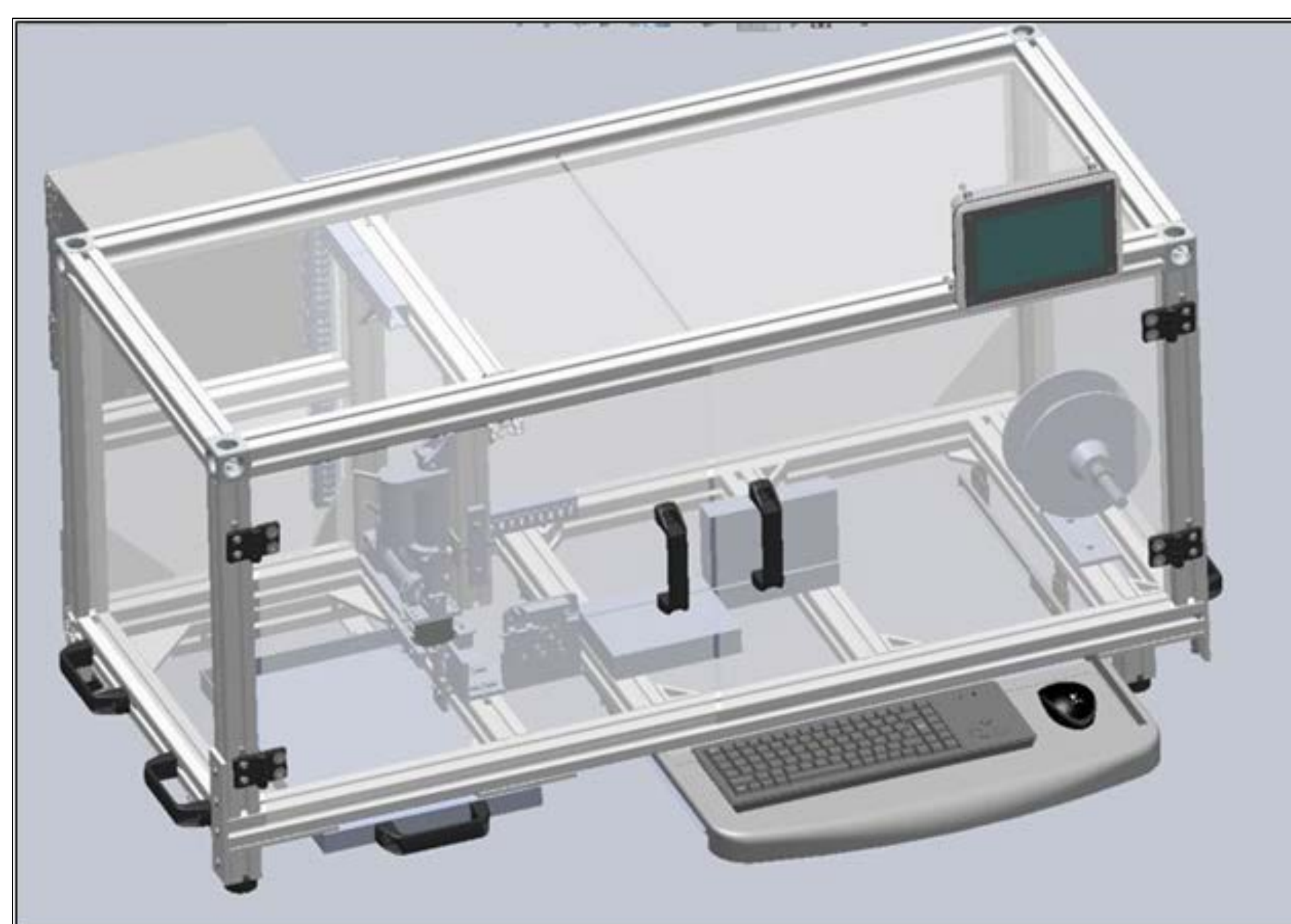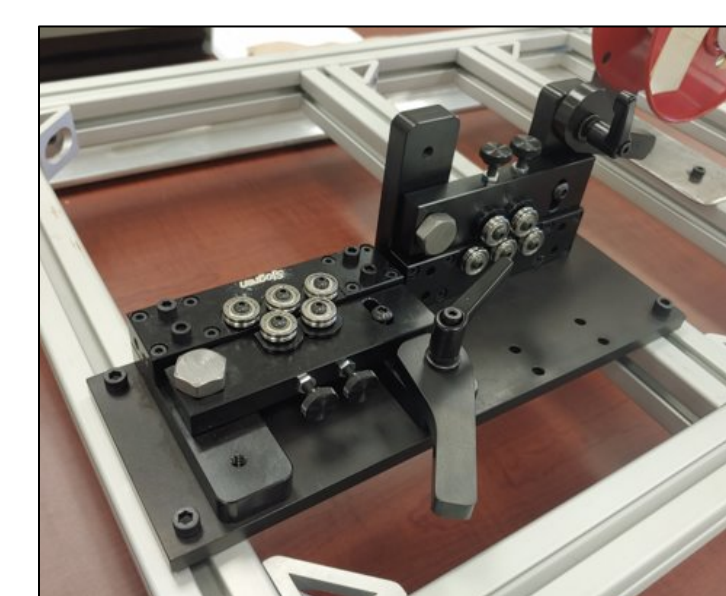

Fully Functional Wire Bender

Manufacturing

De-reeler
- 2 nylon washers
- Spring and wingnut

Straightener
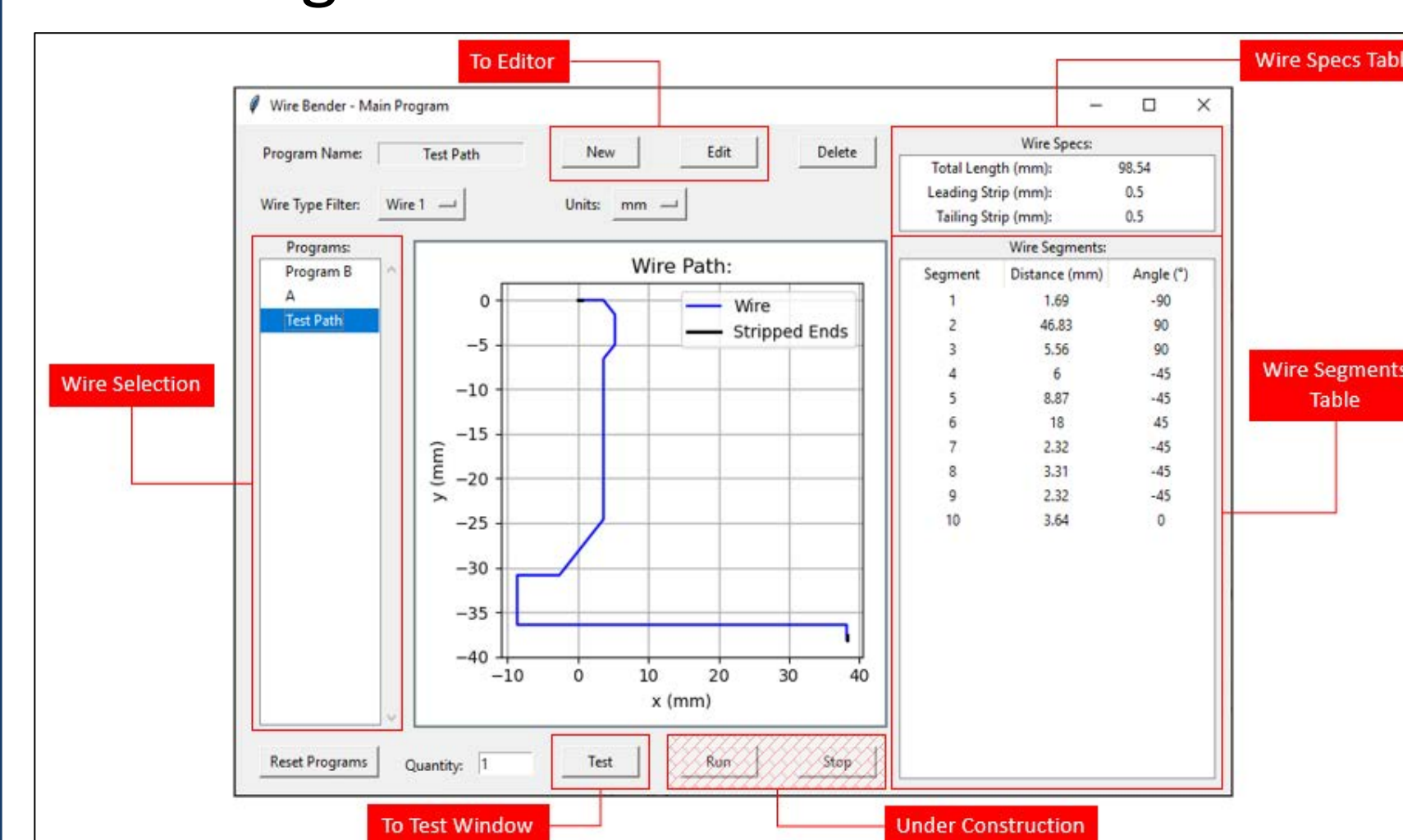- PB-5 2-axis from Sjogren
- Testing needed

Feeder
- Began as a MIG Welder Feeder
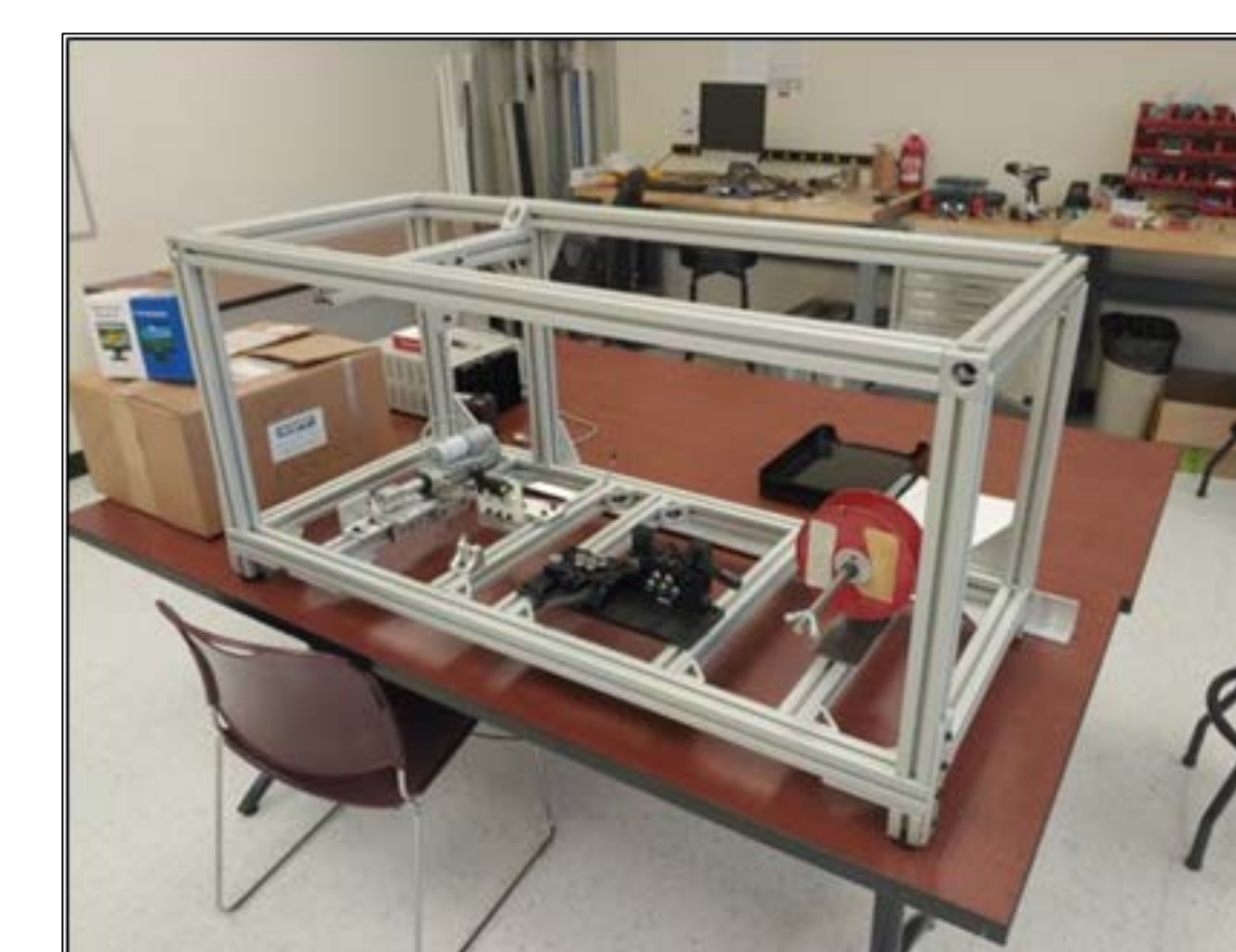- Continuous servo
- Latex coatings were promising

Cutter
- V-shaped blades from Schleuniger
- Cuts cleanly
- Stripping must be explored

Graphical User Interface
- Creates, stores, loads, edits, and deletes wire geometries
- Wires are stored as text files in a folder on the raspberry pi
- Displays wire geometry

Final Build
- The de-reeler and straightener are functional
- The cutter works but not stripping
- The bender is conceptual
- An electrical box was ordered but did not arrive in time

Testing and Validation

Test 1: The Feeder
- Ramp motor up and down to feed an amount of wire
- Feeding done with multiple material coatings on the drive roller
- Measure wire fed and look for a low standard deviation

Drive Roller Coatings

Feeder Results:
- Adding coatings reduced standard deviation for each wire
- 2.92 to 0.526 mm for the brown insulated wire
- 3.89 to 0.709 mm for the magnet wire
- 5.38 to 0.99 mm for the white insulated wire

Test 2: The Straightener
- Hold a wire segment against fine grid paper
- PB-5 2-axis model is not tested but appears promising

Test 3: The GUI
- Passes the "Sniff" Test – the user can only input appropriate values to entry fields
- A sample wire geometry was created successfully, stored, and loaded

Acknowledgments