

Capacitor Assembly Automation



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UNISON™

Presentation Outline

- Introduction and Background Information
- Product Specs
- Problem Statement/Goal Statement
- Key Assembly Steps
- Design Process
- Improved Process with Updated Operations
- Time Improvements
- Proposed Floor Layout
- Challenges Faced
- Future Work
- Budget Report

Introduction and Background Information

- Unison Industries
 - Subsidiary of GE
 - Special in electrical components for jet engines, ignition systems and generators
 - 80% of jet engines are installed with ignition systems produced by Unison Industries
- Capacitor Assembly Automation
 - Making a manual process automated in order to reduce assembly time
- Options of fully automatic versus semi automatic
 - Fully automatic requires no operator
 - Semi automatic requires some use of the operator

Product Specs

- 4 individual sections
 - Layer of insulation paper and double sided tape in between
- Insulation material wrapped around whole assembly
- Maximum dimensions: 4.25"H x 2.6"L x 1.38"W

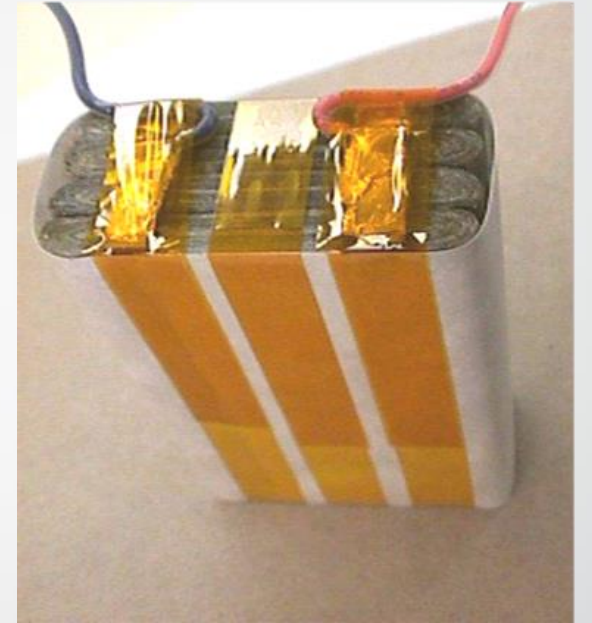


Figure 1



Figure 2

Problem Statement/ Project Goal

Problem Statement

- The current process of assembling capacitors takes approximately 27 min
 - The goal is to reduce this time to 15 min
- The assembly process has multiple steps involved
- Each step has been analyzed in order to choose the best ones to improve with either automation or a new manual process

Project Goal

- Goal Statement: To create a streamline process to reduce the overall assembly time by adding some automation and updating some current manual processes

Key Assembly Steps

1. Place a layer of double sided tape on each capacitor
2. Stack the 4 individual capacitors
3. Solder the electrical tabs
4. Insert the lead wires and form the safety loops
5. Wrap the capacitor stack with insulation paper
6. Wrap pieces of tape around the insulation paper
7. Final dimension check

- Improved Automated Step
- Improved Manual Step

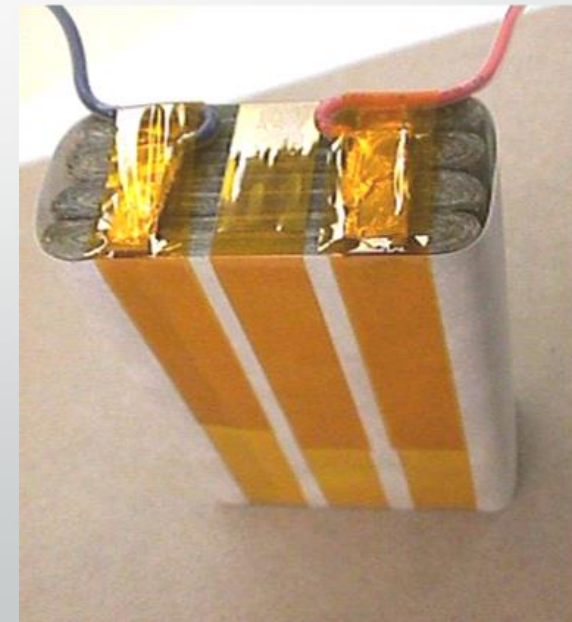
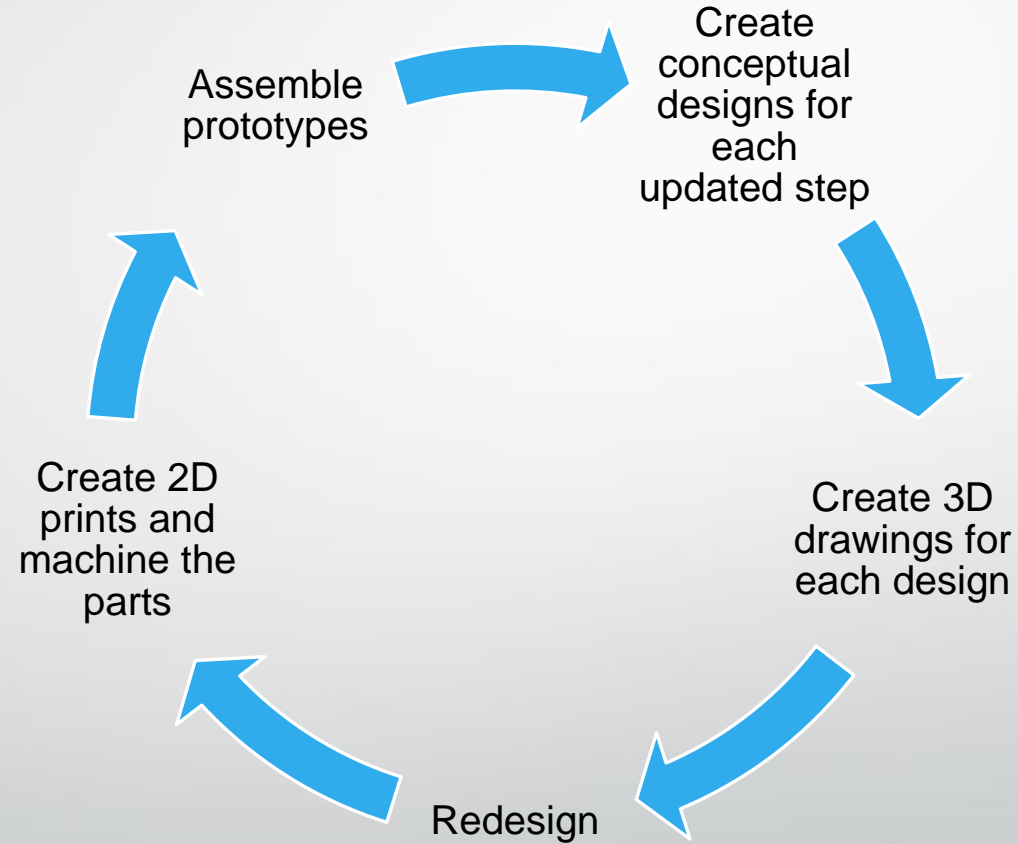


Figure 3

Design Steps



Updated Assembly Process: Tape Rolling

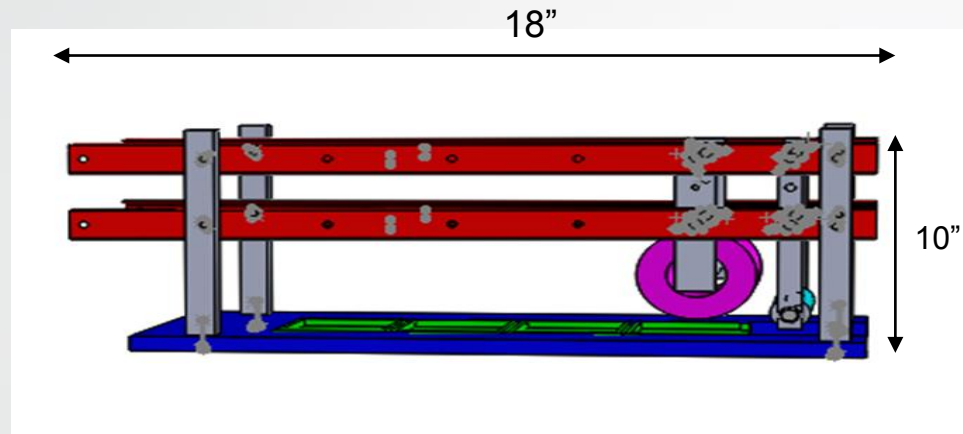


Figure 4

- Powered by motor
- Tape (blue) rolls onto individual capacitors
 - Roller (green) rolls behind the tape to ensure tape sticks
- Saves time by:
 - Reducing number of times the layer on the tape needs to be pulled back
 - Guided slots make the cutting process easier and more efficient

Tape Rolling Con't

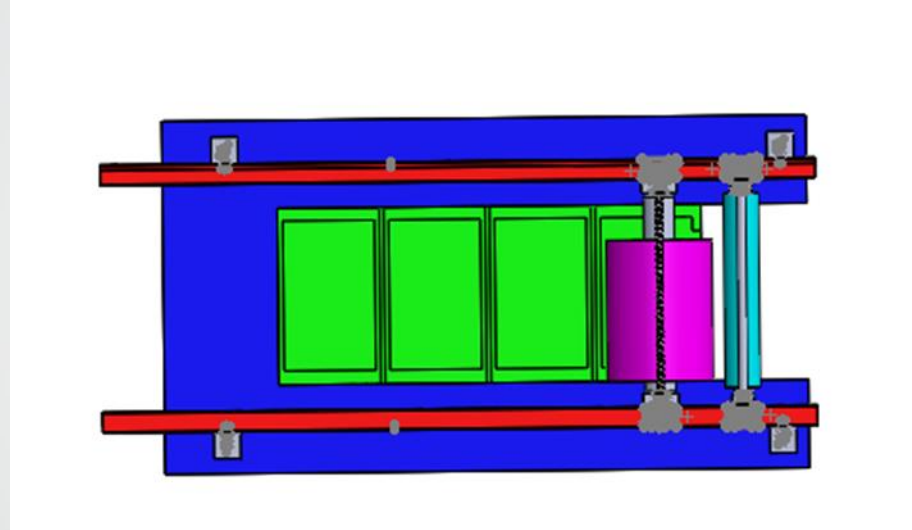


Figure 5

- After tape is placed on capacitors, operator will peel back sealing layer
- After this, the operator will cut the tape in between the sections
 - Scissors will be guided by grooves in the plate

Tape Rolling to Stacking

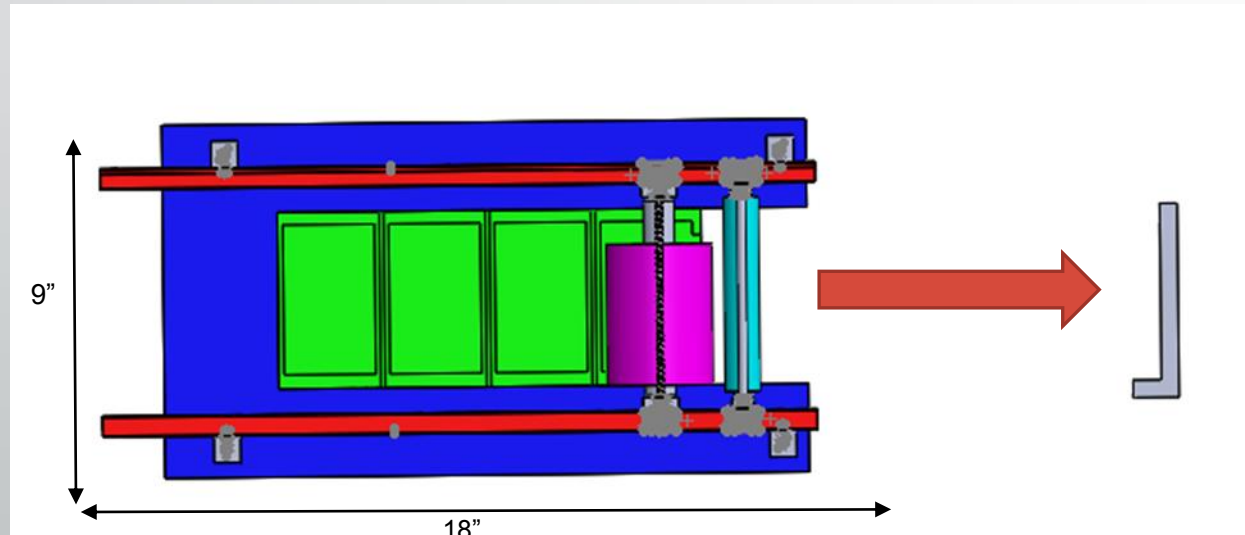


Figure 6

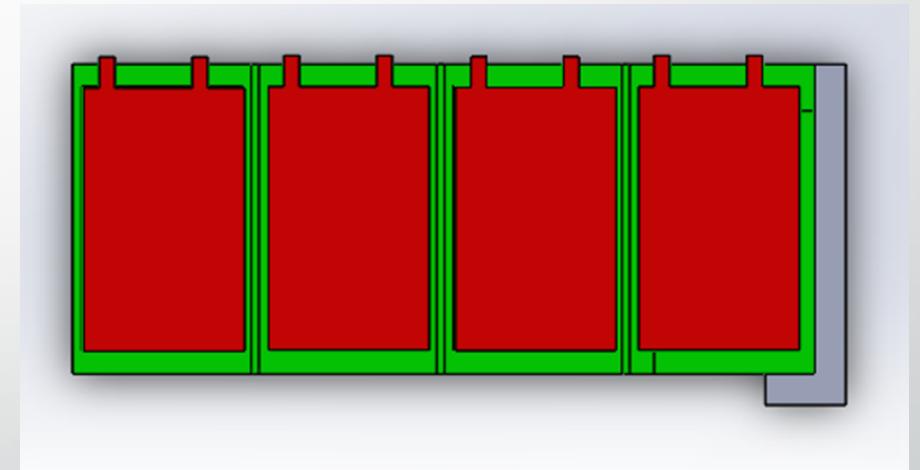


Figure 7

Stacking

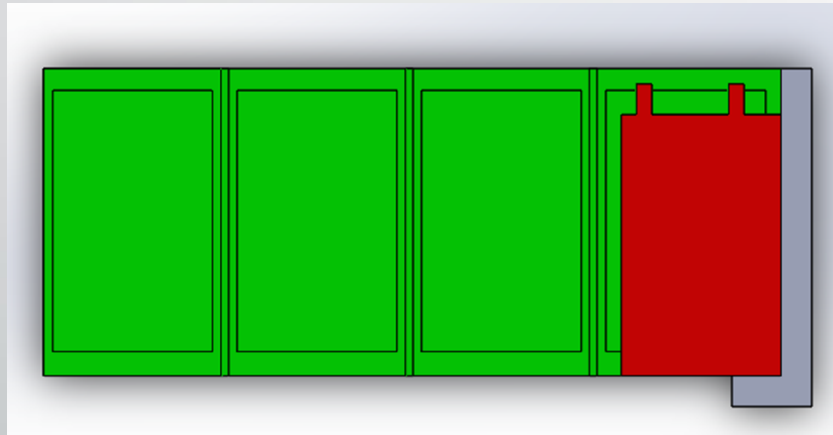


Figure 8

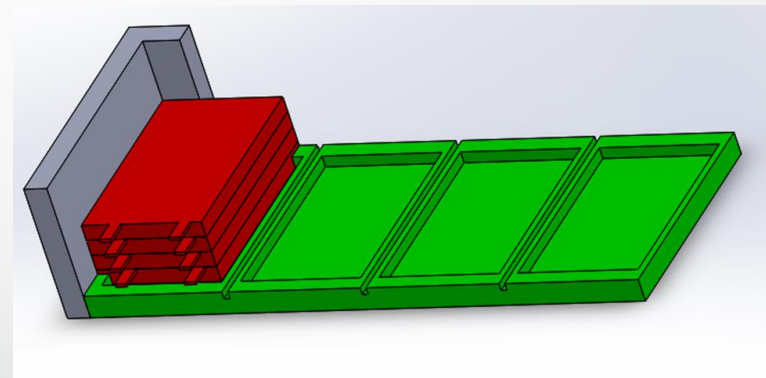


Figure 9

- L-Gauge will guide the stacking of the capacitors
- Saves time by making the capacitors easier to align

Stacking to Soldering/Attaching Lead Wire

- After stacking, the operator will move the capacitor to the next work station
- At this work station, a second operator will began soldering the tabs, attaching lead wires and forming the safety loops
 - These are intricate processes and will not be updated

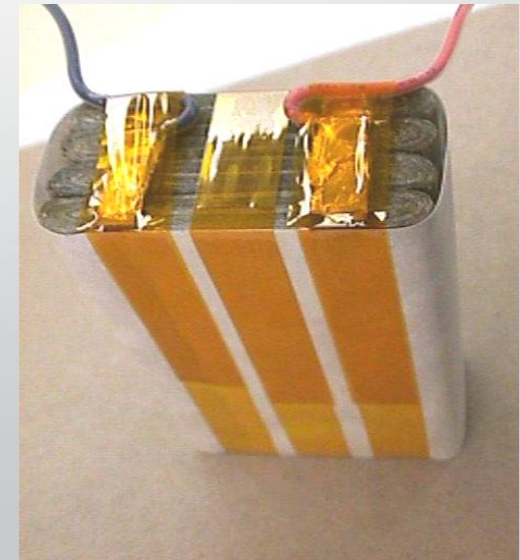


Figure 10

Soldering/Attaching Lead Wire to Insulation Paper Wrapping

- After soldering, operator will bring the capacitor to the next work station
- The next operator will then load the capacitor into the paper wrapping machine to begin that process

Paper Wrapping/Tape Wrapping

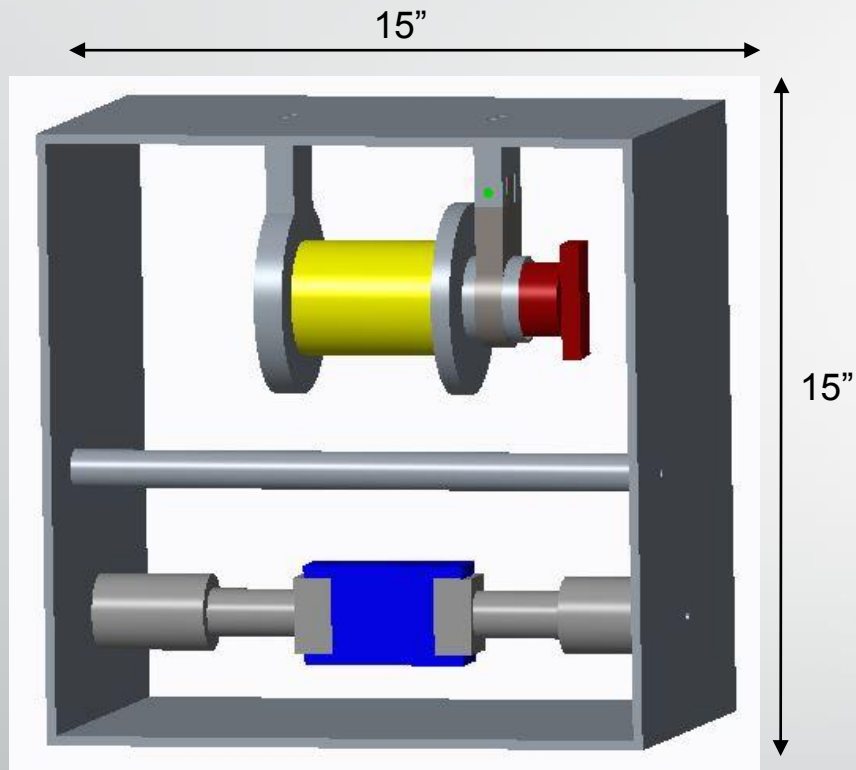


Figure 11

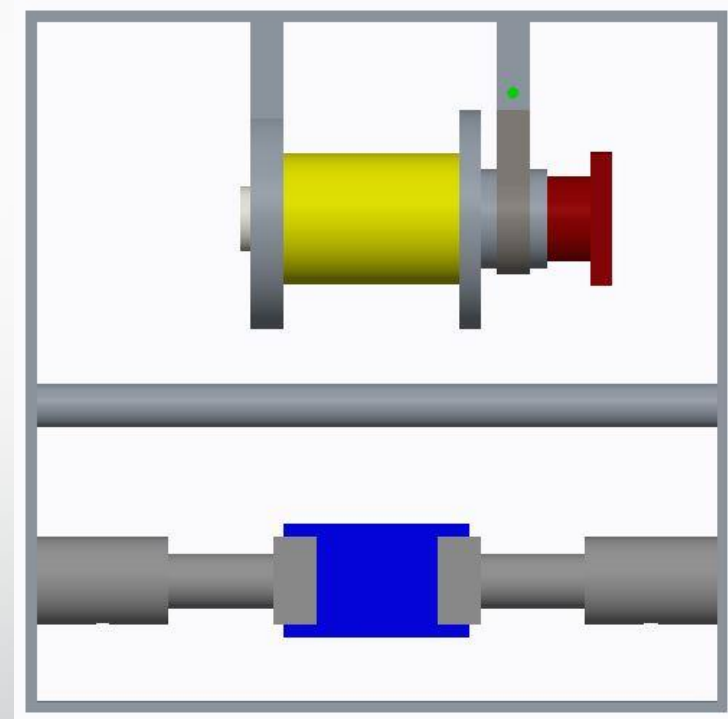


Figure 12

Paper Roll

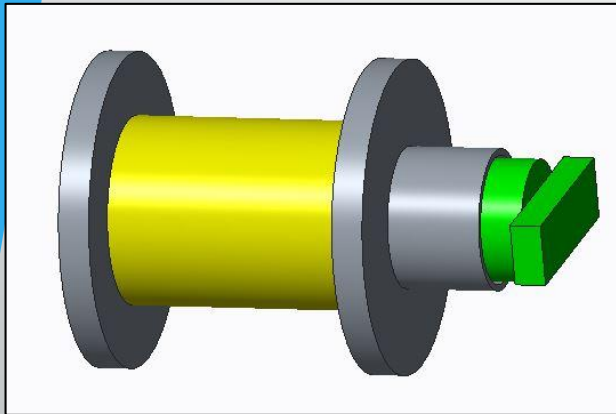


Figure 13

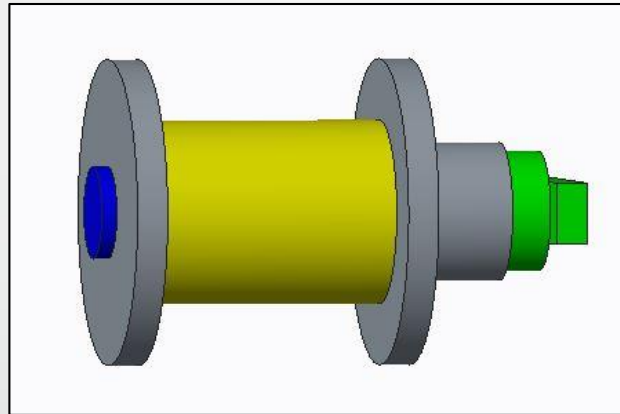


Figure 14

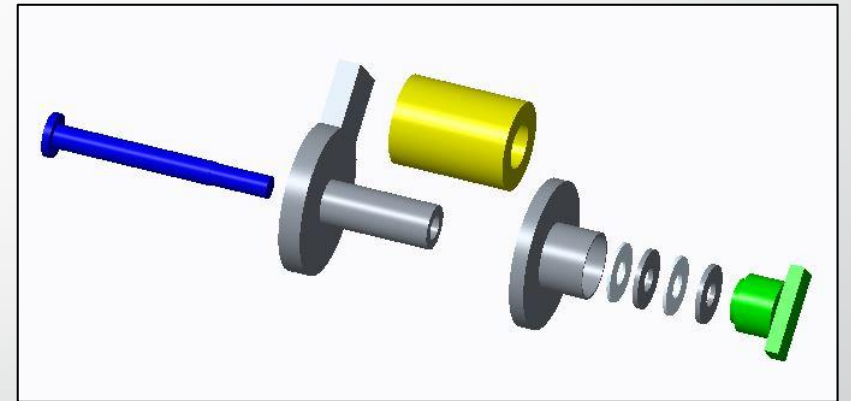


Figure 15

Paper Wrapping to Dimension Check

- Immediately after wrapping the paper and tape, the operator will unload the capacitor and place it into the gauge block for the final dimensional check
 - Maximum dimensions are 1.38" x 2.60" x 4.25"
- Saves time by checking all dimensions at once

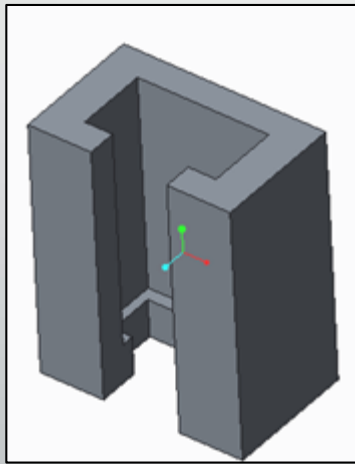


Figure 16

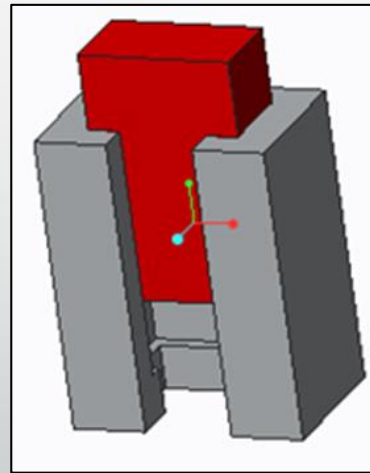


Figure 17

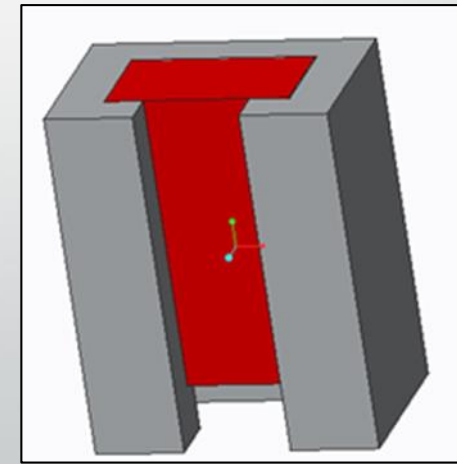


Figure 18

Original Designs vs Final Designs

Tape Roller

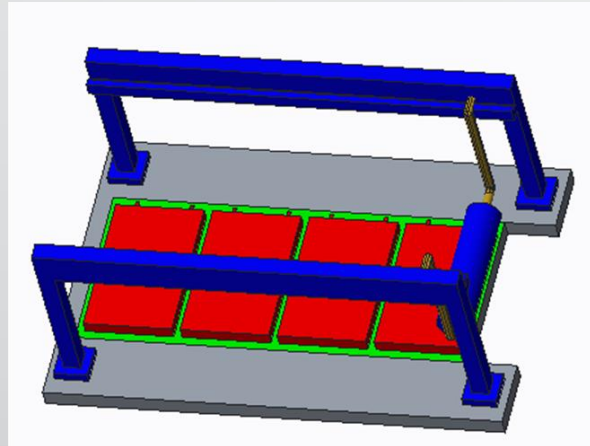


Figure 19

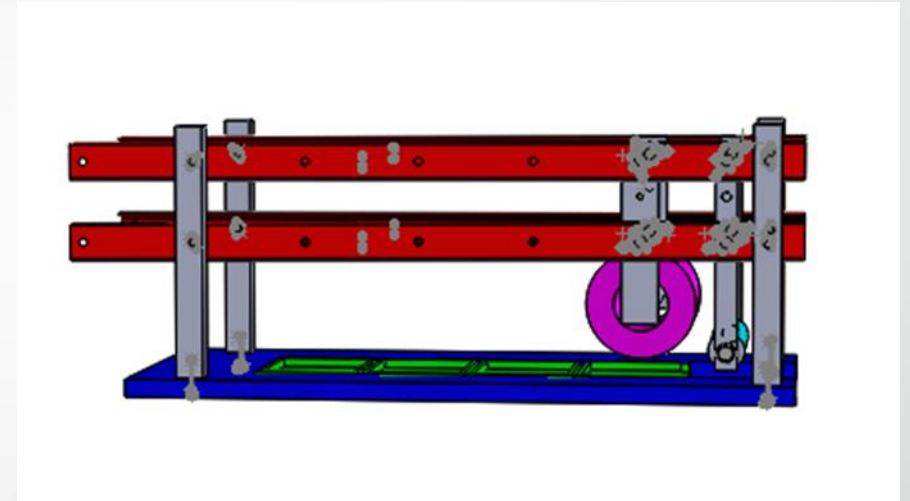


Figure 20

L-Gauge

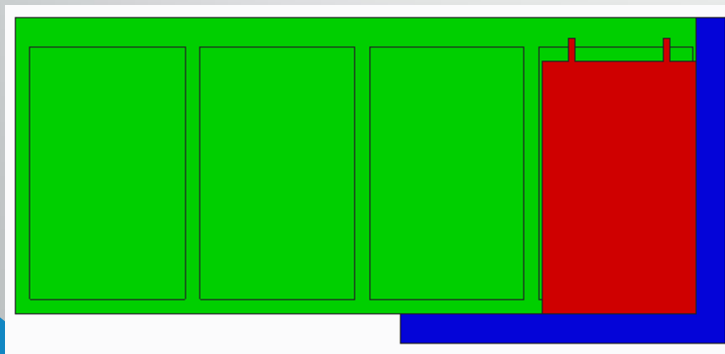


Figure 21

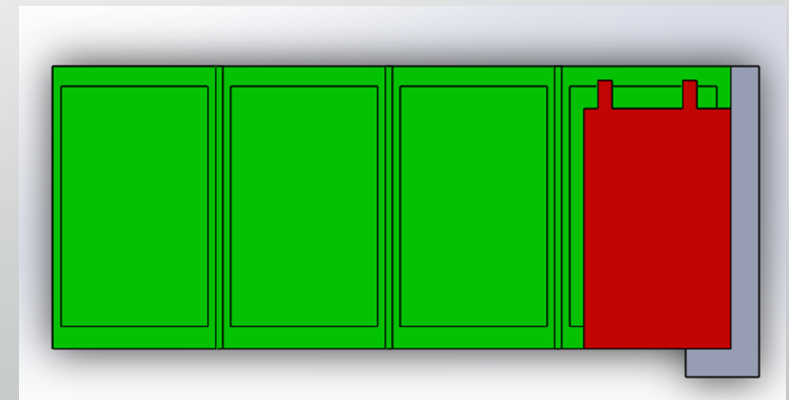


Figure 22

Original Designs vs Final Designs

Paper Wrapper

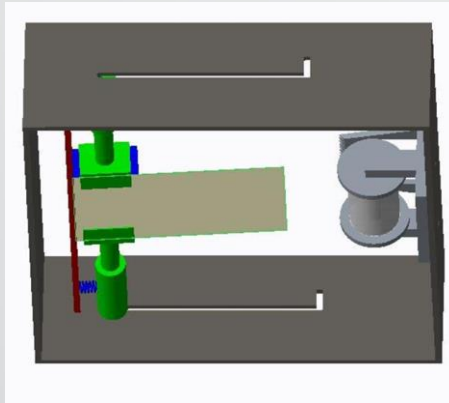


Figure 23

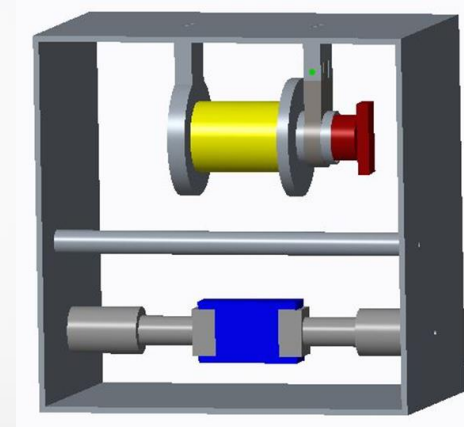


Figure 24

Gauge Blocks

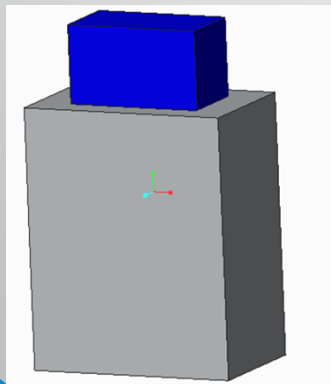


Figure 25

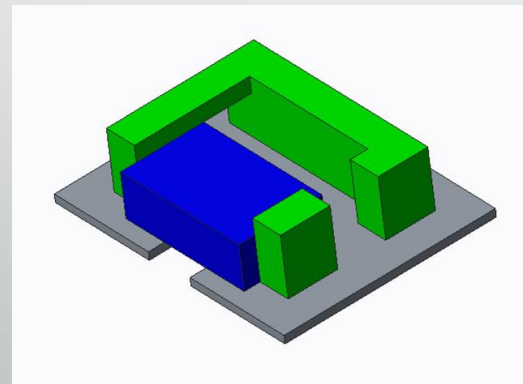


Figure 26

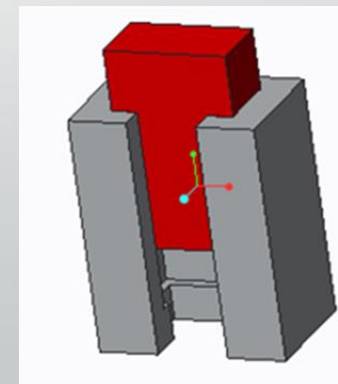
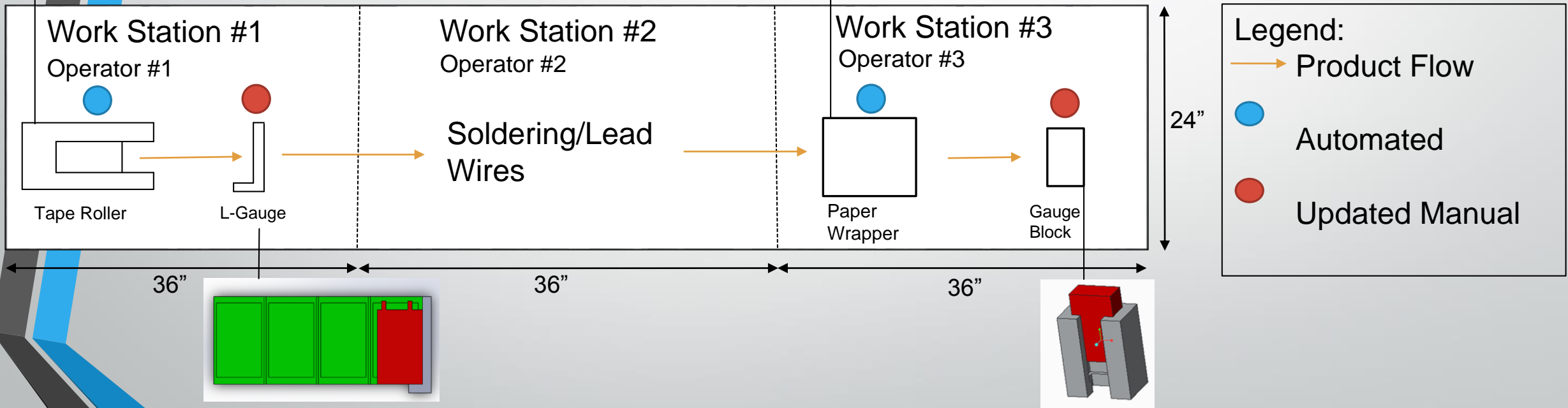
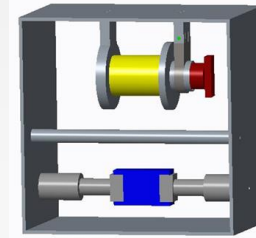
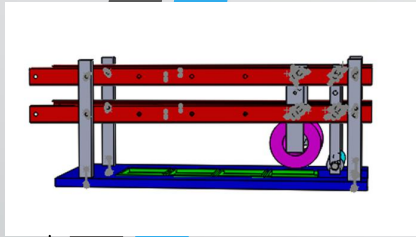


Figure 27

Estimated Times

Assembly Step	Current Time	Improved Time
Tape Roller	2 min 15 sec	35 sec
Stacking	25 sec	12 sec
Paper Wrapping	2 min 50 sec	1 min 25 sec
Dimension Check	1 min 4 sec	15 sec

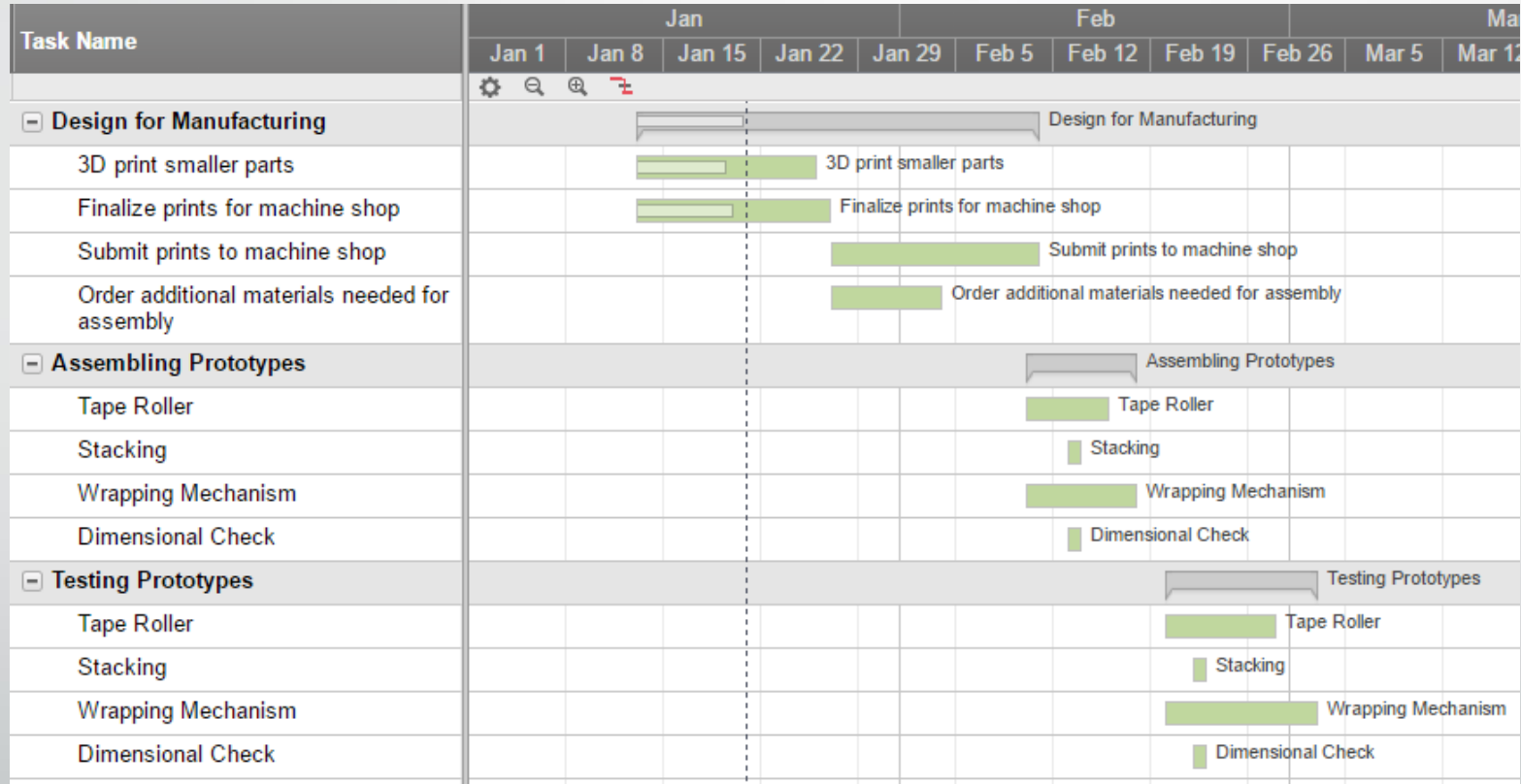
Proposed Lean Floor Layout



Challenges Faced

- Creating the initial designs
 - Understanding the current process well enough to improve it
- Redesigning the L-Gauge and Gauge Block to make them more user friendly
- Redesigning the Tape Roller to make the parts machinable
- Finding a machine shop to create the parts for the Paper Wrapper
 - 3D printed most of the parts
- Redesigning the tape roller to prevent the roller arms from swinging

Gantt Chart



Future Work

- Add motors to tape roller and wrapping design
- Automate the tape wrapping
- Possibly automate the stacking design with a robot
- Update the remaining assembly steps

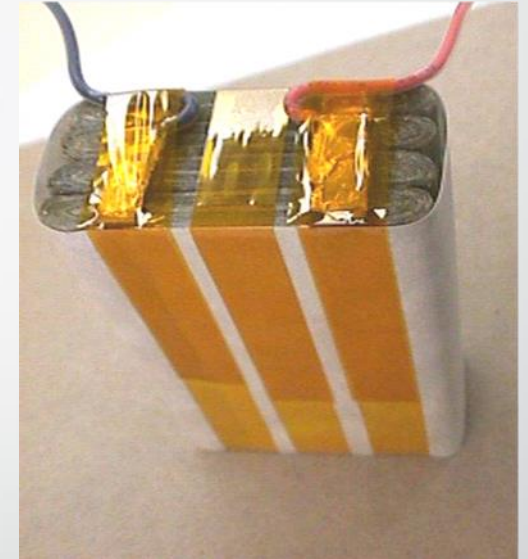
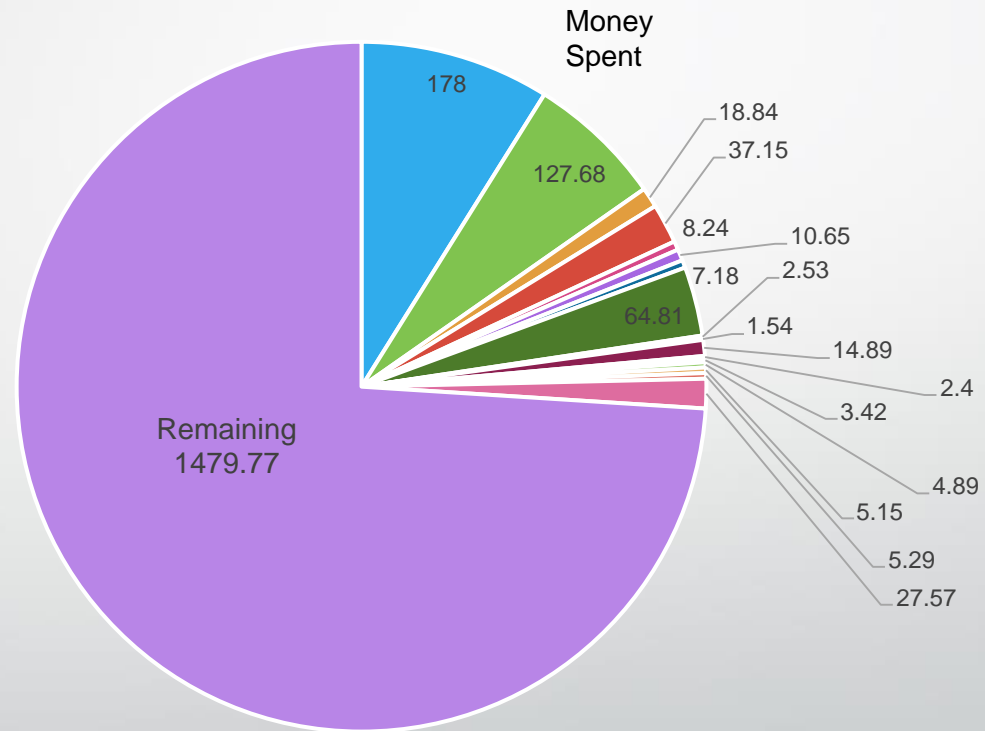


Figure 28

Budget Report

Team 6 Budget Report		
Part Number	Item	Cost
60135K95	Guide Rails	178
60135K94	Track Roller	127.68
9008K12	AL Bars	18.84
45K177	Tape	37.15
8975K11	AL 12"x 24" sheet	8.24
91253A266	Short Screws	10.65
91253A010	Long Screws	7.18
98023A111	Washers	64.81
8975K615	Al Bar	2.53
8974K22	Al Rod	1.54
8974K13	Al Rod	14.89
98750A113	Threaded Stud	2.4
92825A355	Spacers	3.42
91247A489	Hex Head Screw	4.89
87095K82	Stainless Steel Rod	5.15
92240A542	Hex Head Screw	5.29
8982K44	Al 90 angle	27.57
	Total	520.23
	Remaining	1479.77

Budget Pie Chart



Summary

- The overall assembly process was analyzed to find the best steps to improve
- Designs were created for 4 of the steps
 - 2 will become automated and 2 are manual
 - All 4 steps reduced original assembly time
- Many challenges were faced
 - Delayed getting the prints to the shop
 - Finding a shop to make some of the parts

References

- **Kevin Walker, Assembly Steps Handout**



Questions?