



## Semi-automated Improvements to Paper Bag Making Process

Department of Mechanical Engineering

### Greenii Inc.

Greenii Inc manufactures novelty paper bags by recycling newsprint, flyers, and brochures for retail, supermarket and individual consumers. The organization is guided by the motto "A tree saved, is equal to a tree planted."



### Scope

Three independently operating devices are required to semi-automate portions of the current manufacturing process to increase efficiency and throughput as well as mitigate fatigue experienced by production employees.

### Devices and Requirements

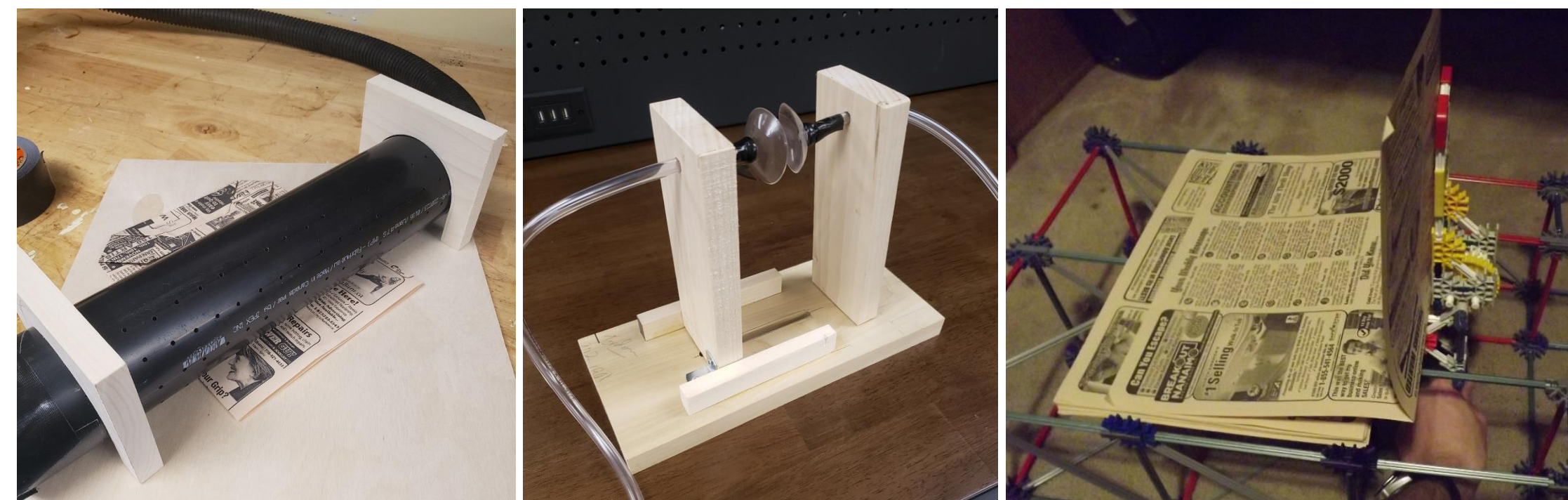
**Handle Placement** – Automatically open the mouth of a complete bag within 1 second to allow employees to place pre-assembled handles within 10mm of the center of the bag.

**Multi-Sheet Joining** – Automatically apply a bead of glue along the edge of a sheet such that multiple sheets can be joined together with no more than 25mm overlap.

**Sheet Unfolding** – Automatically unfold a stack of bi-fold paper sheets. \*This device will be completed if time permits

### Design Process

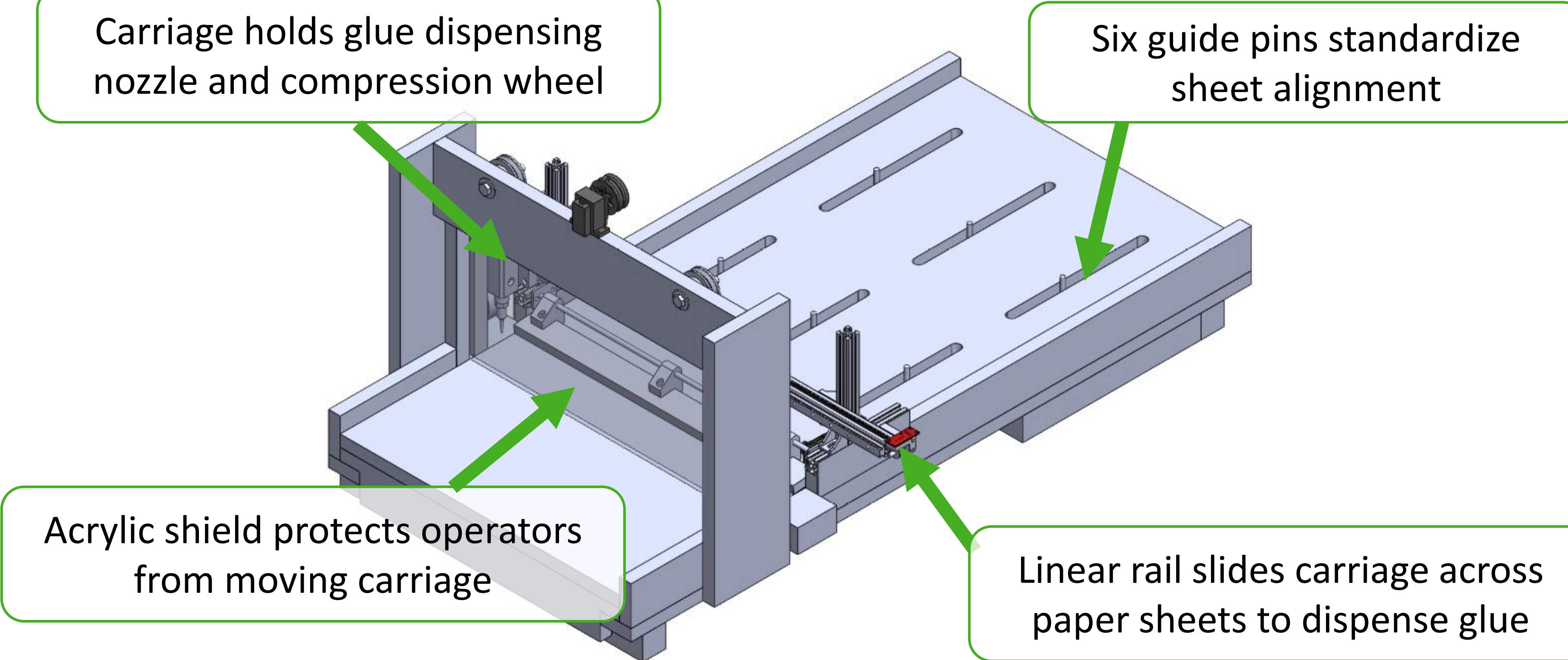
Initial sketches were used to determine guiding designs for the three different devices. A rating process designated the top ideas which were then turned into rough prototypes.



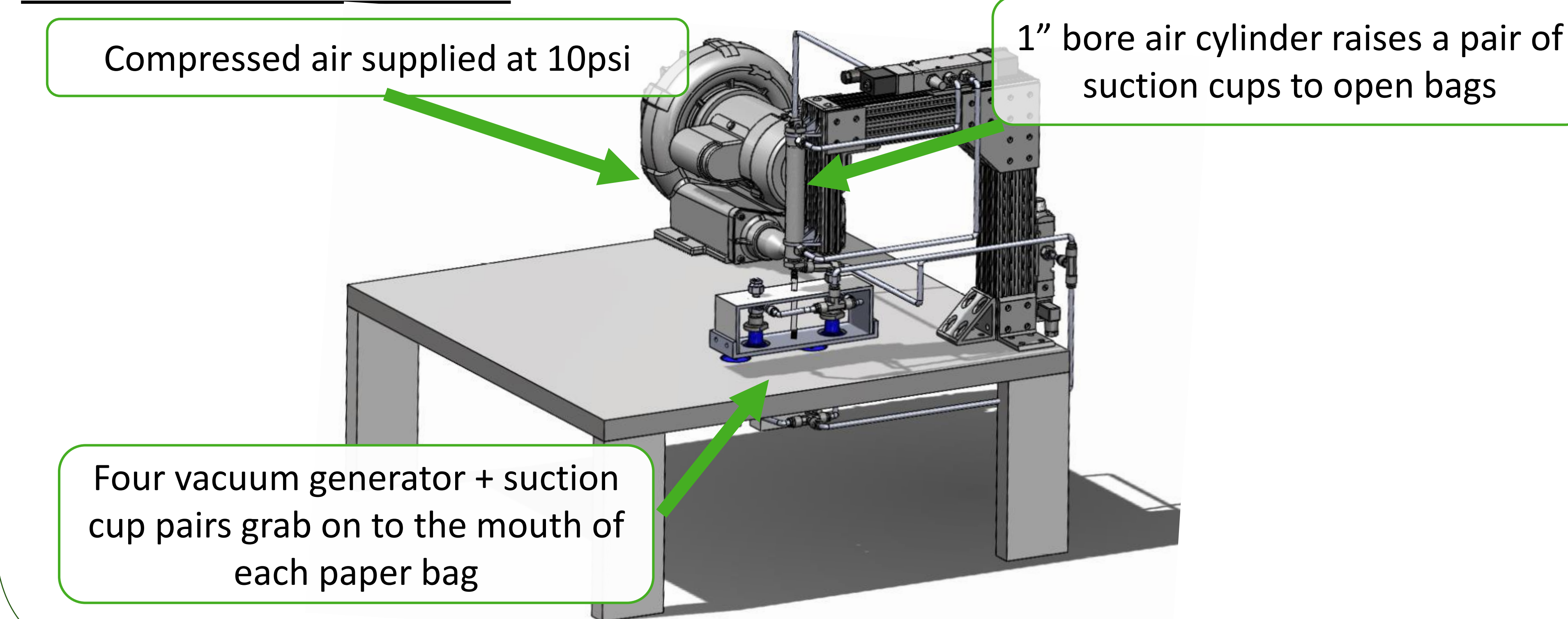
### Lessons Learned

- 1) Paper is porous which leads to 1 – 5 sheets of paper being picked up at a time depending on suction power.
- 2) Guides are required to hold paper sheets in place due to the flexibility and tendency to curl of individual sheets.
- 3) Dispensing glue in a controlled manner requires precise control of flow rate and glue properties.

### Multi-Sheet Joiner

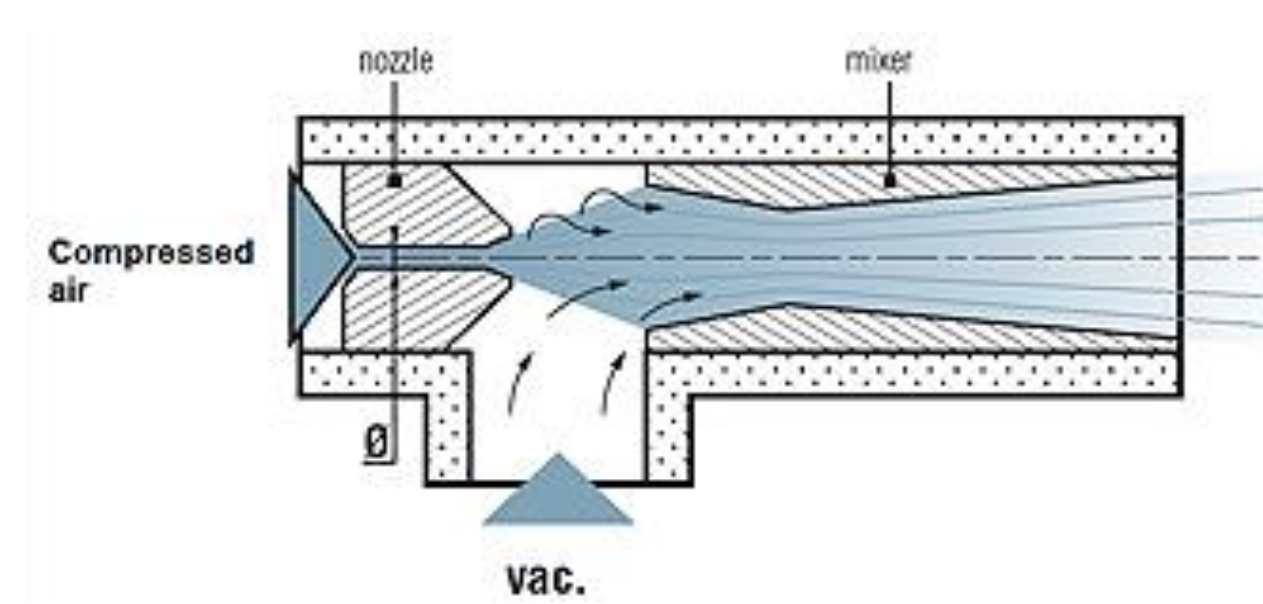


### Handle Placement Assist



### Key Technologies

**Arduino** based hardware controls all automated equipment. Driving code is developed using Arduino IDE.



**Vacuum generators** convert compressed air into vacuum to give precise control over suction power.



**Ultrasonic Sensors** adds additional layer of safety by preventing devices from operating if any operator joints or limbs are detected.

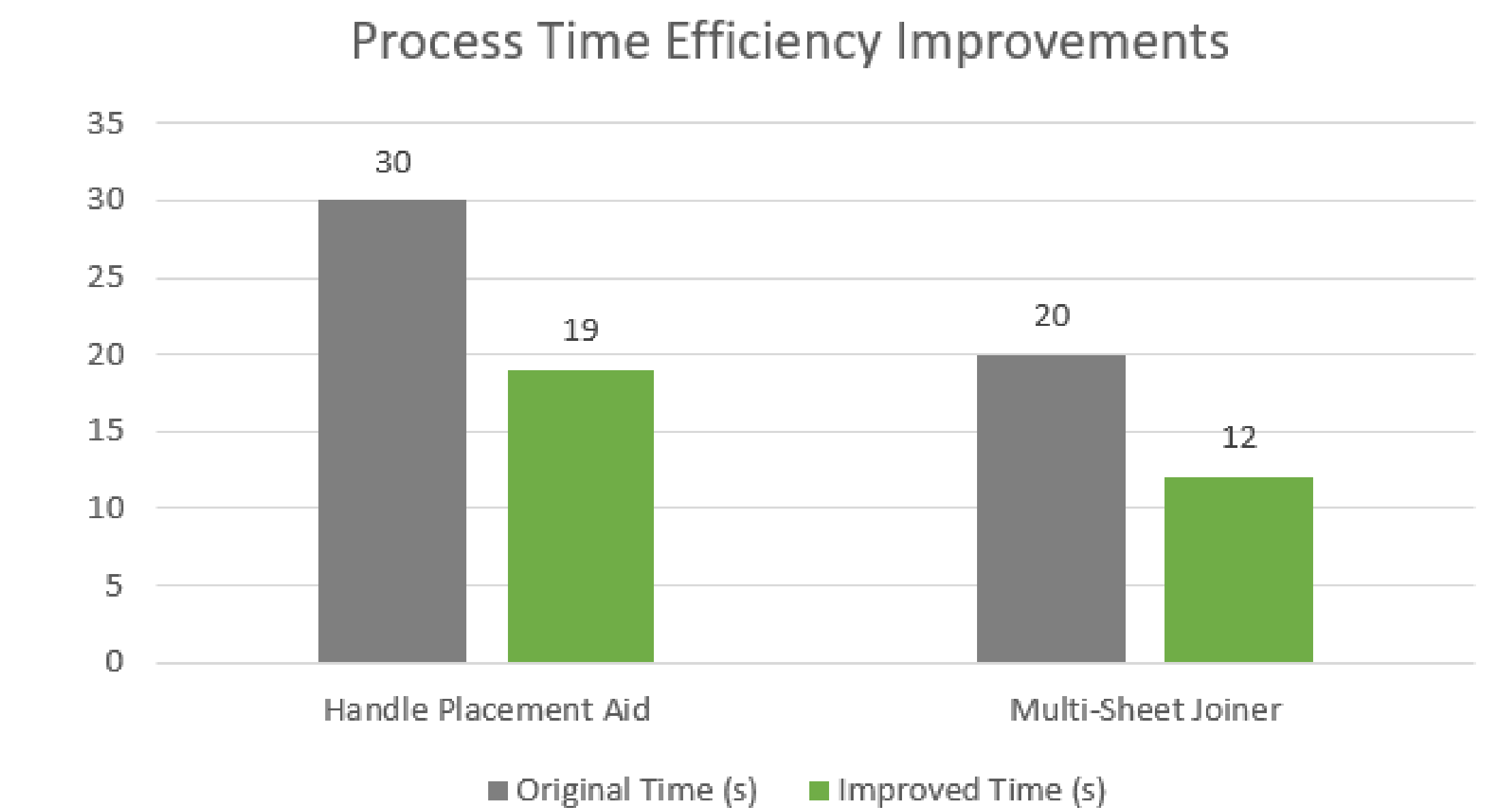
**Pneumatic Glue Dispenser** provides a continuous stream of cold glue to desired locations.



**Piab F33 FCM Suction Cups** specifically designed to handle paper without causing any creases or tears in individual sheets.

### Process Efficiency Improvements

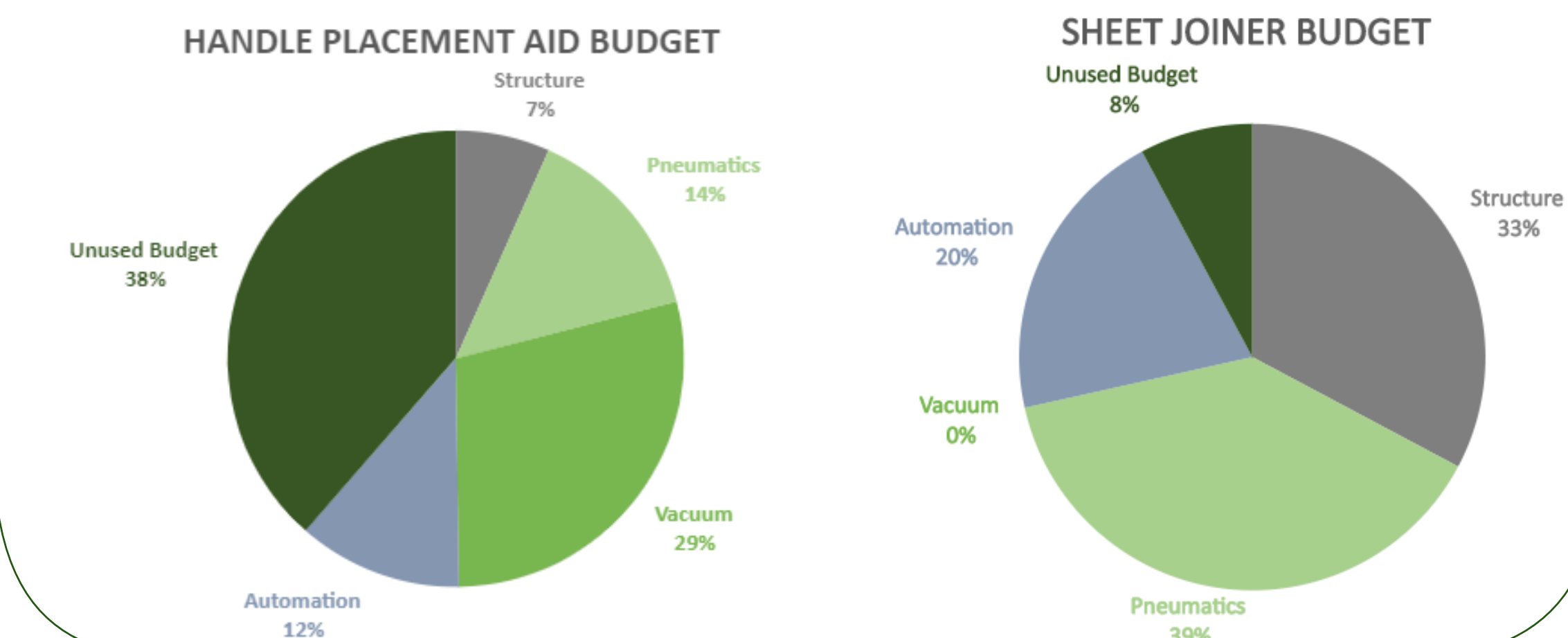
Mitigating employee fatigue and decreasing process cycle time were key project requirements. The delivered designs reduced the cycle time required to produce a single bag by 19 seconds or roughly 31%.



\* Presented values are based on a small number of initial trials

### Budget Review

The budget for each device is broken into 5 key areas: structural, pneumatic, vacuum, and automation components, as well as remaining budget available.



### Future Considerations

- 1) Additional flow and pressure control should be incorporated to individually control pairs of suction cups.
- 2) Guide rails should be installed along the sides of the handle placement device to standardize handle alignment.
- 3) A brush or wet pad should be installed at the "home" location of the sheet joining device to prevent glue from hardening on the tip of the dispensing nozzle.
- 4) Belts or rollers should be incorporated to pull sheet through the devices and add additional automation.

### References

Greenii Inc. (2022) Retrieved from <https://greenii.ca/>  
 Piab (2022) Suction cups and vacuum cartridges. Retrieved from <https://www.piab.com/en-us/>  
 Sparkfun Electronics (2022) Arduino and Ultrasonic Sensor. Retrieved from <https://www.sparkfun.com/>