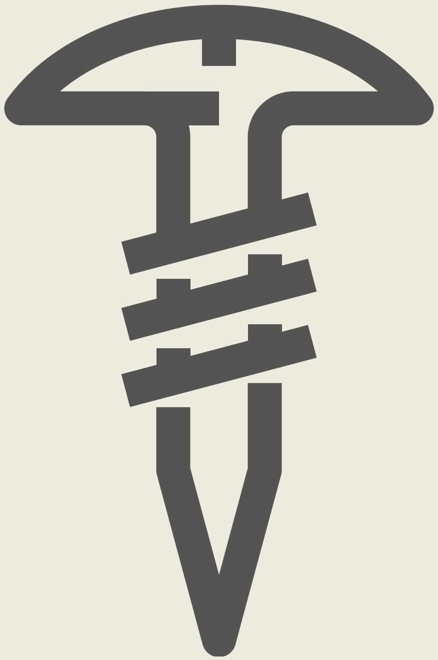
SCREWED.

Automated Robertson Screw Sorting System



ESC 102
PRAXIS II SHOWCASE
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TH12_T12_480
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THE OPPORTUNITY

In GTA small-scale wood workshops, manual sorting of Robertson screws is a bottleneck that reduces productivity. This project aimed to develop an automated system that classifies screws by head shape and length with high precision.

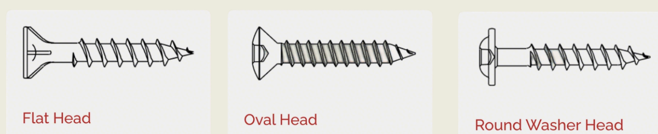
THE STAKEHOLDER

Mr. Ginsberg, the owner of the GTA wood workshop, is the primary stakeholder of this design.

- Goal: Improve workflow and reduce manual sorting effort
- Key requirement: High speed and accuracy in screw sorting, clear and easily visible operational feedback
- Constraint: Must fit within a 30 × 30 × 30 cm space, in order to suit limited workshop space

ROBERTSON SCREWS

Robertson screws can be divided into categories of three head types and ten lengths, ranging from ¾ to 3 inches at ¼ inch intervals

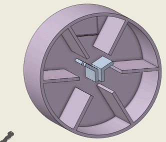


DESIGN CONCEPTS

The design can be split into 4 main parts:

- A feeder
- Head shape sorting
- Length sorting
- Transportation between parts

THE FINAL DESIGN

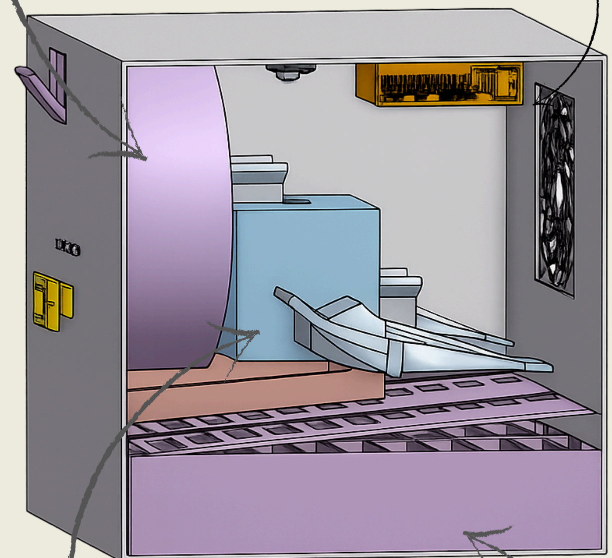


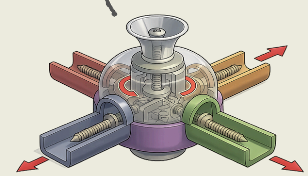
Drum Feeder

Takes in a bulk of screws and outputs vertically aligned screws

Raspberry Pi Camera

Placed right above the screw to identify different head shapes



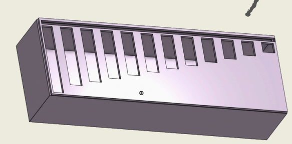


Routing Hub

The device rotates to match and align with the corresponding head shape rail.

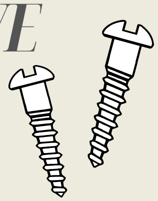
Piano Box

Passive sorting – As screws roll along the channel, increasing slot width allows them to fall into their corresponding slots.

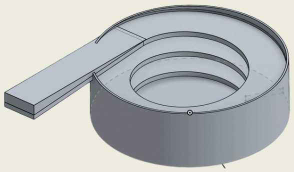


Our design prioritizes Operational Sustainability. The device requires low energy consumption, use disposable material, and allow easy part replacement, extending the machine's lifecycle.

ALTERNATIVE DESIGNS



1. The Feeder

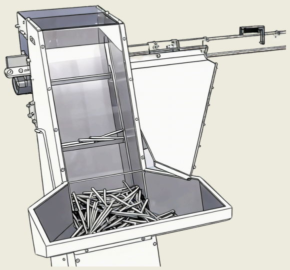


Vibratory Bowl

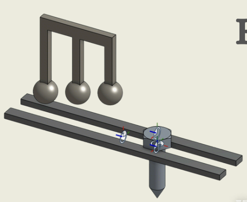
The vibration causes the screws to move to the conveyor belt on side along a track, which gradually aligns them horizontally so they exit the feeder one at a time.

Step feeder

The machine lift the screws one out of time upward in steps and pushes them onto a track where they are aligned into a single row



2. Head Sorter



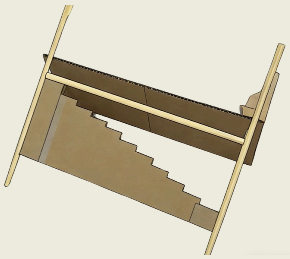
Head Thickness Detection

Since different head shapes have different head thickness, the screw's head will trigger the sensor as it pass through, so it could be categorize into 3 different categories

3. Length Sorter

Leaning Block

Screws slide down an incline via gravity. As the block height decreases, screws drop into specific drawers based on their length.



EVALUATION CRITERIA

We evaluated design concepts using 6 criteria:

EC1. Higher accuracy in classifying screw length and head shape

EC2. Faster processing time per screw

EC3. Greater portability and efficient use of space and mass

EC4.Higher autonomous capacity (more screws processed per cycle without user input)

EC 5.Ease of repair and maintenance

EC6.Optimize production cost

CONVERGENT TESTING

FEEDERS

Drum Feeder

- 20 - 50 pieces per minute - EC2
- Flat horizontal cylindrical with 20cm diameter × 8 cm depth - EC3

vs. Vibratory Bowl

- 40 -200 pieces / min
- Vertical cylinder of 30cm diameter × 10 cm height
- Vibration interferes with the camera

vs. Step Feeder

- 30 - 65 pieces / min
- Cuboid of 10 × 10 × 30 cm

HEAD SHAPE SORTING

Raspberry Pi Camera

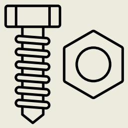
- Achieved ~80% accuracy - EC1
- Size of 8.8 × 5.6 × 1.7 cm - EC3

vs. Head Thickness Detection

- low accuracy (struggles in the "Grey Zone")
- Cuboid of 10 × 5 × 5 cm

vs. Shape Fit Matching

- Easy to jam
- Need to have 30 different pairs



LENGTH SORTING

Piano Box

- Simple modular design - EC5
- Fully mechanical system - EC6

vs. Leaning Block

- One single piece
- Unstable to hold the screw

vs. Raspeberry Pi Camera

- Increased complexity
- Increased risk of malfunction or incorrect sorting.

VALIDATION

- Space Constraint Met - the final volume is 28.5x28.5x29.2
- Operational Simplicity - the user only needs to pour bulk screws into the Drum Feeder.
- Performance Reliability - the system satisfies speed and accuracy priority with Mr.Ginsber's screw
- Cost Effectiveness - a system with low power consumption and maintainance costs

NEXT STEPS

- **Improve accuracy** by doing heavier machine learning with Raspberry Pi
- **Minimize operational noise** through vibration damping
- **User testing & feedback** from woodworkers