

Request for Proposal

Robertson Screws, Am I Right?

ESC102 - Praxis II

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Abstract

GTA WoodWorks is a community woodworking makerspace in North York that manages displaced Robertson screws after fabrication processes. These screws are currently stored in a plastic box mixed with scrap materials and unidentified of their types. Manual effort required to reclaim and sort them for reuse is a burden, resulting in workflow delays and repurchasing of materials. The owner, Mr. Ginsberg, has identified the need for a method for reclaim and reuse of displaced Robertson screws that minimizes manual effort.

This presents an engineering design opportunity requiring analysis, measurable evaluations and intentional designing for usability and integration with the existing workspace. Variety in screw length, head shape and condition (corrosion) introduces a need for classification that must be addressed under spatial and operational constraints.

This RFP presents context about *GTA WoodWorks*, authoring team position, relevant stakeholders, frames the opportunity with Needs-Goals-Objectives (NGO) framework, as well as an analysis on several reference designs. The NGOs define measurable criteria related to classification, minimizing manual effort, usability and safe integration. The scope excludes modifications of workshop infrastructure and operation, and is bounded by the feasibility for a responding team of first-year Engineering Science students.

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1. Introduction

This request for proposal presents *GTA WoodWorks*, a community woodworking makerspace in North York and explores an engaged engineering design opportunity. The goal is to identify and frame an opportunity that can improve the lived experiences of the community members. This community faces woodworking context dependent challenges that are suitable for engineering students to interpret and propose solutions for. *GTA Woodworks* is a woodworking makerspace focusing on 1-on-1 classes providing opportunities for people of all experiences to build hobby projects, fix items and gain woodworking skills with access to tools, machines and guidance from the experienced owner. The people engaged in this community come to gain experiences with woodworking, learn new skills and to build projects in the woodshop. This RFP addresses the authoring team's position, summarizes research on the community, and presents the opportunity surrounding sorting salvaged Robertson type screws.

2. GTA WoodWorks Description

This section presents an overview of the community to provide context for the proposed opportunity. It describes who uses the workshop, how the shop is managed and the activities that take place within the shop. By introducing the community's structure and users, this section supports the background of stakeholder needs and design requirements defined later in this RFP.

GTA WoodWorks is a DIY woodworking makerspace located in North York, run since 2023. The workshop provides 1-on-1 woodworking classes and shares workshop space access for the general public with a diverse community of clients. This structure allows inexperienced members to learn woodworking, while offering more experienced makers access to advanced equipment. The classes guide clients through the design and fabrication of various projects and the workshop space is rented for access to tools and machinery not typically available at home workspaces. To support the business, *GTA WoodWorks* advertises the classes, shop rentals, and personal project development on its website [1].

2.1 Community Engagement and Workshop Operation

GTA WoodWorks operates as a shared workshop space for clients taking classes and renting out the space. Client reviews and the meeting with the owner (Mr. Ginsberg) indicated that many approach *GTA WoodWorks* with a specific project in mind rather than seeking general guidance on the woodworking process [3]. Having a shared workspace is a privilege for woodworkers in the GTA who may not have access to equipment at home. The woodshop is equipped with a large variety of woodworking machinery and tools, which are listed on the *GTA WoodWorks* website and shown in figure 2.1.1 [1]. The equipment available for clients allows for the fabrication of projects with varying sizes and complexity to be created at the workshop (Appendix G).



Figure 2.1.1: Image of the *GTA WoodWorks* workshop. The rear end of the workshop is depicted.

Based on in-person conversations with Mr. Ginsberg and the *GTA WoodWorks* social media, the operation of the workshop can be grouped into three areas: material preparation, inventory, fabrication classes, cleaning and maintenance. Material preparation includes purchasing and ensuring availability of wood at the workshop, transporting wood, stocking fasteners and treating wood surface. The 1-on-1 classes include discussing desired project goals with clients, guidance through the fabrication process and supervision with machine use. Lastly, cleaning and maintenance includes clearing the workspace of woodchips, sawdust and waste, collecting excess fasteners for reclaim in the future and ensuring safe storage of all machines and tools.

2.2 Stakeholder Perspective of GTA WoodWorks Owner

Mr. Ginsberg has operated *GTA WoodWorks* since 2023 and has greatly expanded his business over the years. One of the tasks he does is take old projects and scrap them for spare wood and screws. He barely has time to organize his shop, leaving most of his screws unorganized and thus unusable for other projects. With so many unsorted screws, he throws out a lot of them instead of sorting them so he can focus on organizing tools and preparing for future lessons. During our in person meeting, he mentioned how he considers it “wasteful” but he had “no other option” due to his tight time restraints.

2.3 Robertson Screws in GTA WoodWorks

Robertson screws are a Canadian standard for screw/bit design commonly used in woodworking as they maintain their usability during harsh conditions. Additionally, they can stay firmly attached to a bit, even when held horizontally and not directly supported. Since Mr. Ginsberg uses steel Robertsons, all of his screws and bits are magnetic, ensuring his screws don’t usually fall out of his tool while in use. This allows him to use a magnetic tool to easily pick up screws and slot them into his screwdriver bit. The types of Robertson screw heads most common for woodworking and cabinetry are flatheads, oval heads, and round washers.

3. Facing Biases in Understanding of GTA WoodWorks

This section analyses how the authoring team's biases and assumptions towards *GTA WoodWorks* influenced the choice of opportunity and NGOs. The team's prior experiences in woodworking and its associated biases shaped how the needs and goals within the community were identified and approached. Thus, the team aimed to seek a better understanding of *GTA WoodWorks* to limit the biases present within the goals of the RFP.

3.1 Reducing Biases in Selecting Screw Sorting

Due to the limited prior experience the team has in woodworking, the scope of opportunities identified by the team was smaller and more limited by assumptions (see Appendix A) than the scope of opportunities identified by Mr. Ginsberg. We worked to mitigate these assumptions through meetings with Mr. Ginsberg to such that a chosen opportunity wasn't limited by the scope of our experiences. Additionally, the team combined this primary research with secondary research through various sources to ensure that chosen opportunity wasn't limited by prior assumptions about woodworking. In the end, we converged on sorting Robertson screws as the chosen opportunity.

3.2 Utilizing Mr. Ginsberg's Considerations in forming Goals and Objectives

To ensure the goals and objectives suited the given opportunity, the team discussed various opportunities with Mr. Ginsberg, preventing a single perspective from negatively affecting the RFP. By learning the limitations to other proposed opportunities, the team was able to form a more comprehensive list of requirements and constraints (e.g. space, size) to frame the goals around. Additionally, the goals were molded such that they relied less on the team's preconceptions on what aspects of the design are most important by learning more about Mr. Ginsberg's business model and day-to-day experience. This creates the strict emphasis on dimensions within the goals, as infrastructure limitations is a major problem for Mr. Ginsberg.

However, Mr. Ginsberg did have clear bias towards himself and his clients when explaining his bias. We didn't attempt to mitigate this bias, as it allows us to focus more on the systemic problems which affect his business rather than how the behaviors of clients negatively impact *GTA WoodWorks*. This allowed the goals to better focus on the functionality of the design and its integration into the garage.

Despite recognizing the clients of *GTA WoodWorks* as stakeholders, the team was unable to contact them to shape the goals. As such, the team consulted Mr. Ginsberg to discuss common behaviors of clients to gain an understanding of his clientele, later shaping the goals accordingly around how simple and intuitive the design is to use.

In summary, the goals were shaped through discussions with Mr. Ginsberg, analysis of his workspace, and the interpretation of his opportunity by the team to prevent significant bias from impacting the goals and objectives.

4. Opportunity: Robertson Screw Reclaim and Sorting

This section frames the engineering design opportunity proposed in the RFP. It establishes the current operation, identifies relevant stakeholders and defines the scope of the opportunity by clarifying what is included and excluded from the design space and constraints.

4.1 Current Use of Reclaimed Screws

GTA WoodWorks reclaims screws from old client projects. These screws may be reused if identified and stored properly. However, the manual effort required is currently too high, and the owner has established interest in a more efficient solution.



Figure 4.1.1: Image of unsorted screws at *GTA WoodWorks*

Primary observation from the workshop revealed that *GTA WoodWorks* currently does not use a structured reclaim process for displaced Robertson screws. After fabrication, Robertson screws left in the workspace are stored in a plastic box in a drawer containing mixed fasteners and scrap parts. As the screws are unsorted, when reuse is needed Mr. Ginsberg must manually retrieve and inspect individual screws to identify reusable screws by length, head shape and condition. This manual process requires additional time and effort during clean up and inventory preparation. As a consequence, reuse is discouraged and screws are discarded and repurchased more frequently, contributing to workflow delays and repeated purchasing of materials.

4.2 Importance of Robertson Screws



Figure 4.2.1: Image of a standard flat head Robertson screw. [14]

Robertson screws are the standard fasteners used in woodworking. Robertson screw head features a tapered square socket to enable easier single-hand driving and slip-resistance. For a wide range of applications, they vary by length and head shape. Within the workshop, they are stocked in multiple lengths and head shapes for a variety of projects. Different head shapes are for benefits like flush finishes, stronger holds, and better load distribution [16]. Screws are typically manufactured from steel and may corrode due to oxidation after use or exposure to adverse conditions. Accurate classification between variants is necessary for effective and reliable use.

4.3 Stakeholder Identification

Stakeholders in the design process are individuals or groups directly or indirectly affected by the opportunity. Each stakeholder is identified and described by their need and influence on the design space.

Table 4.2.1: Stakeholder Analysis with their Relationship to the Opportunity

Level	Stakeholder	Relationship to Opportunity
Primary	Mr. Ginsberg	Mr. Ginsberg requires a system for reclaiming and reusing Robertson screws displaced after fabrication. As the owner and the primary operator of <i>GTA WoodWorks</i> , he will be directly affected by the change in workflow, material preparation time and cost for purchasing new screws.
	Responding Praxis II Team	The responding Praxis II team interprets this RFP and develops a feasible design that addresses the identified need of the opportunity. Their design decisions will determine whether the proposed solution is effective and meaningful.
Secondary	<i>GTA WoodWorks</i> Clients	Clients taking classes or renting the workshop are indirectly affected by the change in screw availability and workspace organization and preparation time before or during classes or rentals. With improved screw availability, they will be able to produce projects in reduced time.
	<i>GTA WoodWorks</i> Workshop	<i>GTA WoodWorks</i> workshop makes up the environment in which the system will operate. Its spatial constraints, dust exposure and existing equipment shape the design space and requirements for the design solution.
Tertiary	Hardware Stores	May experience a change in Robertson screw purchasing amount and frequency as improved screw reclaim system will decrease the need to source more from hardware stores.
	Screw Donors	May be indirectly affected by the decreased demand for donation.

4.4 Engineering Relevance

The reclaim and reuse of displaced Robertson screws present an engineering design opportunity rather than just an organizational challenge. The limitation in current workflow stems from the absence of a repeatable method capable of consistently performing in the workspace condition. Addressing this opportunity involves engineering analysis, defining measurable performance evaluations, intentional design iterations and testing to accommodate human interactions and integrate the given community

conditions. As such, the opportunity is a relevant engineering design opportunity for Praxis II teams extending beyond an organizational challenge and into the development of a functional design solution.

4.5 Opportunity Scoping

This opportunity is bounded by physical, operational and stakeholder constraints of *GTA WoodWorks*. The scope includes the development of a method to enable reclaim and reuse of displaced Robertson screws within the existing *GTA WoodWorks* workshop environment. The scope excludes modifications to workshop infrastructure, overall shop operation and fabrication process. Some of the conditions that the opportunity is related to but does not directly include are de-rusting of screws, classification of non-Robertson screws and storage systems for other materials. The opportunity is further constrained by feasibility appropriate for a team of first-year Engineering Science students to develop within a timeline.

5. Need, Goals and Objectives

This section identifies the stakeholder's need for the opportunity and structures a set of design goals and measurable objectives to frame the engineering design space.

5.1 Need

The stakeholder requirements establish the following need:

The owner of *GTA WoodWorks* needs a usable system for reclaiming and reusing Robertson screws displaced after fabrication to minimize manual effort.

5.2 Design Goals

Following the need and stakeholder analysis, the key design goals are derived. Goals outline the primary expectations of the design and define the necessary outcomes.

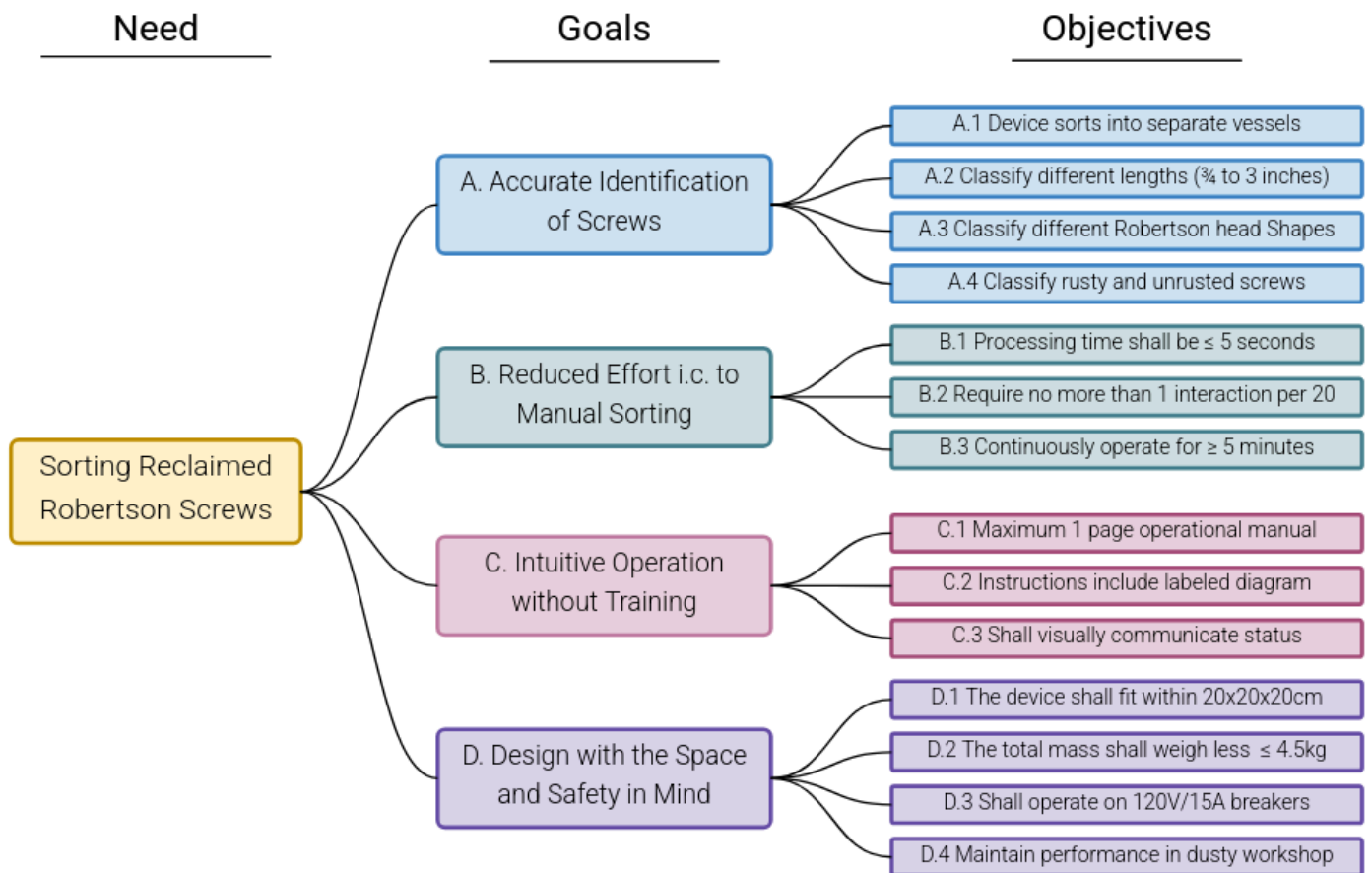
Table 5.2.1: Identified Goals of the Need and Supporting Justification

	Description	Justification
Goal A	The design enables accurate identification and preparation of reusable Robertson screws for reclaim	The primary stakeholder (Mr. Ginsberg) requires that Robertson screws displaced during fabrication be reliably distinguished by different properties (length, head shape, corrosion state) and only the reusable ones be stored for future reclaim. Inaccurate identification risks resource waste and improper use in projects.
Goal B	The design reduces time and manual effort required to prepare Robertson screws for reuse relative to the current workflow	The current manual process of identification involves visual inspection and individual placement of screws, which discourages

		reclaim due to the excessive effort and time required. Improving workflow directly supports efficiency and sustainability.
Goal C	The design enables intuitive operation requiring minimal technical training and knowledge	The design will be operated in the workshop by individuals without electronics or software expertise. Intuitive operation and reliable performance are necessary to ensure adoption and practical integration into the workflow.
Goal D	The design operates safely within the environmental and spatial constraints of the workshop	The workshop operates within a confined garage environment with large machinery occupying most of the space. Maximizing available table workspace is necessary, thus the design may need to be put into storage or relocated frequently.

5.3 Graphical Breakdown of NGO Framework

Figure 5.3.1: This figure shows a graphical breakdown of the NGOs involved with this RFP.



5.4 Objectives and Evaluation Metrics

Following the goals, measurable objectives are established. Objectives translate each goal into a quantifiable benchmark and allow evaluations of proposed designs.

Table 5.4.1: Objectives for Goal A

Goal A: The design enables accurate identification and preparation of reusable Robertson screws for reclaim			
Description		Metric	Justification
Objective A.1	The design must be able to sort screws into different vessels for each variant.	Boolean	Sorting functionalities (A.1-4) are directly from stakeholder requirements (Appendix C).
Objective A.2	Classify Robertson screw lengths within the range of $\frac{3}{4}$ to 3 inches at $\frac{1}{4}$ inch intervals with $\geq 97.5\%$ accuracy.	Classification accuracy (%) (as calculated in Appendix E)	A.2: From <i>GTA WoodWorks</i> ' inventory, the most commonly used lengths are between $\frac{3}{4}$ and 3 inches. (Appendix H). Wood screws of lengths between 1 and $2\frac{3}{4}$ inches are manufactured in $\frac{1}{4}$ inch intervals [17].
Objective A.3	Classify Robertson screws by different head shapes as defined in Appendix B with $\geq 97.5\%$ accuracy.		A.3: The most commonly used head shapes in woodworking and the distinction affects usability and project outcome (Appendix B).
Objective A.4	Classify Robertson screws below and above the 25d corrosion semblance with $\geq 97.5\%$ accuracy.		A.4: Laboratory corrosion studies show that bolts exposed to 25 days of corrosion have considerably altered threading relative to uncorroded specimens [13]. Therefore the threshold distinguishes screws reliable for reuse. For A.2-4, classification accuracy shall be evaluated using ISO 2859-1 [18] attribute sampling with an Acceptance Quality Level (AQL) of 2.5%. With a sample size of 50, about a double of the amount used in usual projects at <i>GTA WoodWorks</i> , this level allows 1 misclassified in the set before rejecting the ability, aligning with the reliability goal.

Table 5.4.2: Objectives for Goal B

Goal B: The design reduces time and manual effort required to prepare Robertson screws for reuse relative to the current workflow			
Description		Metric	Justification
Objective B.1	Processing time per screw ≤ 5 seconds	Processing time (s)	Manual screw classification involves pickup, visual inspection and individual placement. An estimate for the processing time per screw based on preliminary testing is $1+3+2 = 6$ seconds. Under conservative assumptions, the lower bound of manual processing time is 5 seconds.
Objective B.2	Require no more than one user interaction per a set of 20 screws during processing	Number of user interactions per 20 screws (count)	ISO 9241-210 [19] states that designing human-machine interaction requires allocation of tasks between user and the system. In the context of screw reclaim, limiting manual handling and allocating the classification process to the system improves efficiency of the workflow by reducing cognitive burden and unnecessary travels. The usual project uses approximately 20 screws and this will allow an effective reclaim process per class [24].
Objective B.3	Continuous operation without user interference for ≥ 5 minutes	Continuous operation duration (min)	If one screw requires 5 seconds to process and a typical start-stop cycle processes 20 screws, one cycle takes about 2 minutes. Therefore, the 5 minutes benchmark works as a conservative buffer covering at least 2 consecutive batches. Continuous functional operation is required for practical integration into the workflow.

Table 5.4.3: Objectives for Goal C

Goal C: The design enables intuitive operation requiring minimal technical training and knowledge			
Description		Metric	Justification
Objective C.1	Operational instruction shall not exceed one single-sided letter-sized page	Number of pages (count)	ISO 9241-110 [19] defines learnability as supporting discovery of system capabilities while minimizing the need for learning.

			Limiting operational instructions to a single page ensures conciseness and simplicity, strictly involving necessary information about relevant system operation and minimizing cognitive burden for users without particular technical training.
Objective C.2	Instructions include at least one labeled diagram illustrating parts of the system	Number of diagrams (count)	ISO 9241-112 states that information must be perceived first before it can be understood [20]. Visual representations enhance perceptibility and understandability of system elements for users without special technical knowledge.
Objective C.3	Communicate operational status (on, off, processing and error) with the user in a way perceptible within 75 cm distance	Status perceptible distance (cm)	Interactive systems should indicate task progress and inform users about changes in the system as ISO 9241-110 states [21]. Clear communication of operational status enables users to respond appropriately. The average human arm's reach distance is approximately 75 cm and considering the space constraints in <i>GTA WoodWorks</i> , within 75 cm ensures perceptibility when user has access to respond to the system update [22].

Table 5.4.4: Objectives for Goal D

Goal D: The design operates safely within the environmental and spatial constraints of the workshop			
	Description	Metric	Justification
Objective D.1	Fit within a 30x30x30 cm bounding volume during operation	Length, width and height of the design (cm)	D.1-2 are directly from stakeholder requirements (Appendix C), and are based on the spatial and operational constraints in <i>GTA WoodWorks</i> workshop. D.1: A compact bounding volume ensures integration into the current shop layout and workflow. D2: The design may require relocation or temporary storage between fabrication and the limit in
Objective D.2	Total mass $\leq$ 4.5kg	Mass of the design (kg)	

			mass enables single-person handling without physical burden.
Objective D.3	If electrically powered, must operate using standard 120V, and a maximum current draw of 15A.	Operating voltage (v) and maximum current draw (A)	<i>GTA WoodWorks</i> operates within a residential garage. Typical breakers in Toronto allow a maximum current draw of 15 A and Canadian outlet power is 120V [23]. The design must be compatible with existing infrastructure to ensure integration without safety risks.
Objective D.4	Maintain operational performance while exposed to airborne sawdust in the workshop without misclassification or jamming for ≥ 5 start-stop operational cycles	Number of start-stop operational cycle (count)	Screw reclaim is expected to occur in the workshop after every fabrication class rather than all accumulatively at the end of the day. Repeated start-stop operations with break periods allow airborne sawdust to settle within the design. Therefore it is required in order to operate under realistic workshop conditions.

6. Reference Designs

This section describes four reference designs (additional designs may be found in Appendix D) and compares them with the NGO framework in Section 5. The detailed information is presented in the table below.

Table 6.1.1: SensoVision Sorter Evaluation

6.1: SensoVision Sorter	
Design Description	Pros/Cons / Reference Image
The sorter lines up screws and feeds them into a high-speed rotating glass disc. Multiple industrial cameras capture high-resolution images from different angles. Subsequently, image algorithms calculate the screws' geometry, head shape, thread integrity, and even surface defects. Screws are blown into their corresponding	Pros: Meets all Objectives in Goal A Meets all Objectives in Goal B Meets Objective C.2
	Cons: Does not meet Objective C.1 as the sorter is a sophisticated instrument with complex operation, requiring detailed explanation; Objective C.3 as the sorter device is large, has many parts, and the information is scattered, making it difficult for users to obtain all the information within a 75-centimeter range.

recycling bins by pneumatic nozzles. [7]

Does not meet Objective D.1 as the sorter has dimensions of $89 \times 89 \times 188 \text{ cm}$; Objective D.2 as the sorter's weight is typically in the hundreds of kilograms; Objective D.3 as the sorter has a power requirement of 230V; Objective D.4 as the sorter utilizes precision optics, even a small amount of dust can affect its operation.

The screenshot displays the SensoVision software interface. On the left, a 3D model of a screw sorter is shown with a green bounding box. To the right, there is a table of statistics and a 'Pass' button.

	Min	Max	Defect	In Pix	Value	Pass/Fail
Segmentation	0	255	0	7.9	7.9	PASS
Blp	0	120	0	1	7.9	PASS
Ring	0	120	14	1	7.9	PASS
Blp Not	0	120	0	1	7.9	PASS
Slot Presence	120	10000	765	17704	7.9	PASS

SensoVision
Taking Research into Product

Cam 2 Stats

Total No. 3194

NG No. 1038 Fail % 32

Cam 2 Failures 779 Cam 2 Failure % 24.3

Screw Rate 225

Pass

Table 6.2.1: 3D Printed Screw Sorter Evaluation

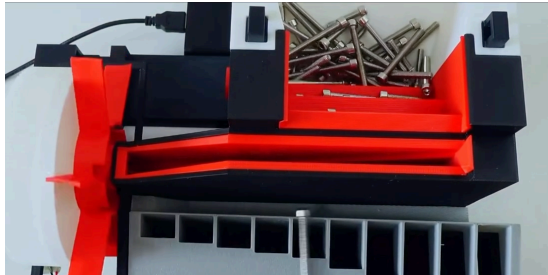
6.2: 3D Printed Screw Sorter	
Design Description	Pros/Cons / Reference Image
The screws are conveyed upwards from the hopper through a stepped lifting plate. The mechanical height difference allows the screws to be arranged individually. The screws then slide onto a ramp, and using their gravity, screws of different lengths fall into the corresponding sized notches as they roll over specific positions. [11]	Pros: Meets Objective A.1, A.2 Meets all Objectives in Goal B Meets all Objectives in Goal C Meets Objective D.1, D.2, D.3
	Cons: Does not meet Objective A.3 as the sorter has no limit for different head shape screws; Objective A.4 as the sorter can not distinguish if the screws are rusted. Does not meet Objective D.4 as wood chips can easily get into the gaps between the stepped lifting panels, and if they accumulate, they can cause the lifting panels to jam.
	 The photograph shows the physical 3D printed screw sorter. It features a hopper at the top, a stepped lifting plate in the middle, and a sorting mechanism at the bottom. The device is primarily red and black, with a hopper filled with screws.

Table 6.3.1: DIY Tiny Sorter Evaluation

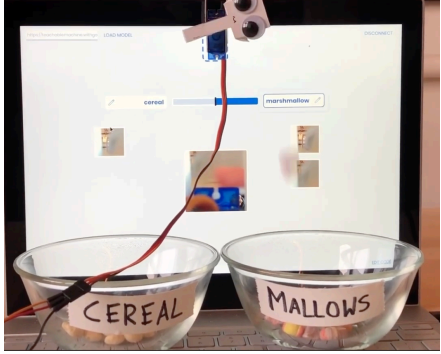
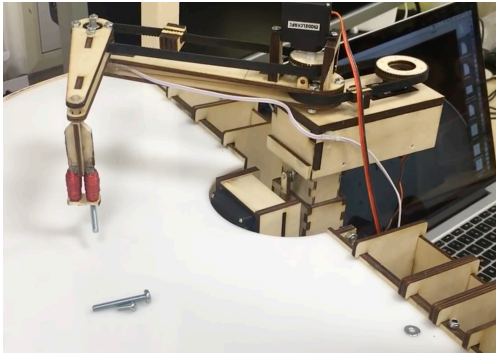
6.3: DIY Tiny Sorter	
Design Description	Pros/Cons / Reference Image
This is a small experimental sorter combining Arduino and Google Teachable Machine. Users train an AI model to distinguish features such as color and shape of objects. When an object falls onto a sorting tray, AI uses the computer's built-in camera to identify its category, and the Arduino controls servos to guide the object to different collection bins. [8]	Pros: - Meets Objective A.1 - Meets Objective B.2, B.3 - Meets all Objectives in Goal C - Meets all Objectives in Goal D
	Cons: - Does not meet Objective A.2, A.3, A.4 as screws' features are not significant enough for the AI to distinguish accurately. - Does not meet Objective B.1 as the sorter takes about 8 seconds to distinguish obvious differences, for similar screws may take longer time.
	

Table 6.4.1: FabLab Moscow Sorter Evaluation

6.4: FabLab Moscow Sorter	
Design Description	Pros/Cons / Reference Image
The sorter combines robotic arm vision with electromagnets. A camera images a screw on the workbench, and an algorithm identifies its coordinates and other features such as shape. Then, a robotic	Pros: - Meets all Objectives in Goal A - Meets Objective B.1, B.3 - Meets all Objectives in Goal C - Meets Objective D.2, D.3
	Cons:

head equipped with an electromagnet moves over the target screw, energizes the electromagnet, picks the screw up, and moves it into the corresponding sorting box. The sorter uses an Arduino / Raspberry Pi + servo system. [10]	For Objective B.2 and D.1, if the sorter needs to meet less than 20 cm on all edges then can not sort 20 screws at once; otherwise the sorter exceeds the size limit. Does not meet Objective D.4 as dust may affect the operation of the motors which are not enclosed properly. 
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7. Conclusion

In conclusion, this RFP proposes and frames an opportunity for enabling reclaim and reuse of displaced Robertson Screws within *GTA WoodWorks*. The opportunity stems from the absence of a repeatable method for identifying reusable screws under workshop condition with minimized manual effort. The classification must be based on length, head shape and level of rust.

The RFP also provided context of the *GTA WoodWorks* community using both primary engagement (in-person visits and interview) and secondary sources (comments and website). The authoring team position acknowledged the biases for transparency of understanding and framing of the opportunity. Relevant stakeholders were identified in relation to the opportunity in order to analyze the requirements and constraints they impose on the scope of this opportunity. The NGO framework established a structured measurable performance expectations related to the aspects needed to be satisfied for the need. Reference designs were analyzed to introduce existing designs and highlight requirements and constraints for this opportunity.

The scoped opportunity presents an engineering design challenge for first-year Engineering Science student teams. The opportunity and following information in this RFP is intended to be considered as starting points for further analysis and interpretation by responding Praxis teams rather than finalized statements.

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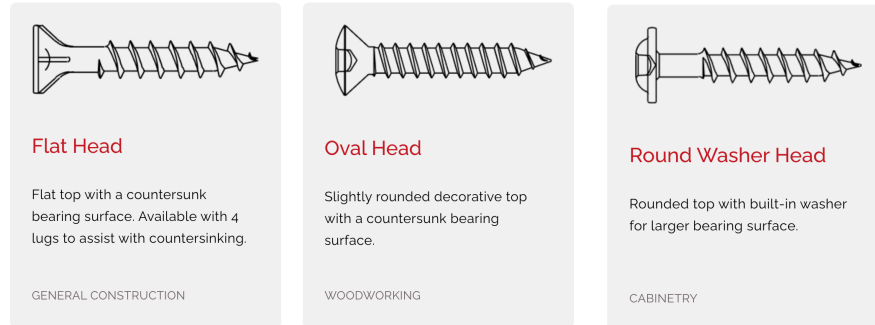
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Appendix

Appendix A: Preconceived Assumptions regarding GTA Woodworks

Assumptions
<i>GTA WoodWorks</i> is a small business run out of the house of someone who has a lot of woodworking skill
It gets a decent amount of clients and is very busy due to the 1-on-1 classes offered
There could be safety concerns as woodworking can be dangerous
Being a small-business space, there is not much specific secondary research available for reference
As it is a hobby shop, machinery may be less industrial quality
As the space is limited, there may be some larger machinery lacking, making certain woodworking steps harder.
The owner is likely someone who loves his job working there

Appendix B: Flat vs. Pan vs. Round Washer Head Shape Types Robertson Screws



[25]

Appendix C: Questions and Notes from Meeting with Mr. Ginsberg

Questions	Notes
- What are some misconceptions about your job - What are some of the challenges you face with your job - What are some of the aspects of the job you find the easiest	- Opportunity: Organizing Robertson Screws - Organizing Robertson Screws of different length, head shape, and color - Has to be smaller than a certain size (for him anything larger than a cubic foot would be way too large)

- What is your most important value/favourite aspect of your job? - Is injury prevalent, how do you deal with it when it happens? - How do you promote machine safety to newcomers and prevent accidents for them? - How do you balance the woodworking and entrepreneurship side of your life? - When moving heavy timber or operating large machinery alone, what are the most strenuous or risky processes for you? - How do you prevent damage to the machine or equipment when you rent out the space - How does renting out the space work, actually? - How do you balance running a full woodshop out of your house (e.g., sound considerations, woodchips everywhere etc) - Are there any challenges and/or benefits associated with 1-on-1 woodworking sessions as opposed to teaching larger classes? - How is the space used by the customers/members - What are some safety rules people are expected to follow in the workspace - What is the biggest risk/common mistakes that lead to dangerous outcomes in the environment - What are some projects your customers work on - What do you do when they misbehave - What are some challenges with using ppe - Cleaning up or managing materials? - How do you sell products, how does that work? - Your demographic seems to go as low as 12ish, how do you ensure they are safe? - How do you design moving parts? (hinges and stuff) - A lacking tool/process that could help woodworking?	- Has to be something he can carry (under 20 pounds) - - He Tried to make us do other things like making a wood dust collection system for his table saw, and also tried to make us make a screw sorting system He doesn't care about much else except dust collection or screw sorting - He isn't too interested in something to make lifting things easier, he can buy one - He isn't really interested in much besides the dust collector which is just designing a funnel with a comically small design space and the screw sorter which has ... some potential with how you'd mechanically sort screws? - Screw sorter would most likely have a sensor component for color and a mechanical component for length and head shape but I'm sure there's a bunch of things to do Requirements focus on - max weight and size as he dictates, - its primary function, - power usage (as needed) - number of uses before failure (cite an ISO for this one) - resistance to wood dust (cite ISO, I'd guess an IP61 rating should be good enough for this then all we gotta do is say yea minimal moisture + lots of dust = IP61) - ECs focus on - the specific weight and size being minimal - the power usage being minimal - Ergonomics - Screw capacity and processing speed - Repairability (cite an ISO?) - Sustainability (tie back into our values and interests yippee we have a coherent belief system) Need: - Sort the screws as I already typed out (sorting robertson screws between $\frac{3}{4}$ inch to 3 inch long based on color, length, and head shape)
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- Show our interest and willingness to learn more about them rather than just approaching for the assignment - This list only entails pre-prepared questions, many other questions were asked on-site.	Goals: - Intake screws - Process and sort - Spit out into sorting system - Inventory management, Time management of projects, Making sure expectations stay in check - People expect it's gonna go wonderful and it might not - All one-on-one to make sure people are safe, smart solution, eyes on at all times to make sure they're always safe - Dust collection, biggest issue is dust - More about dust collection at the source of every machine, tools only as good as his implement of them, makes sure it's turned on - Opened garage door and opened it up but always dust - Shelves, chair, cutting board, their own projects - Manages time: juggling act - Problem based on ability to expand or let things go, doesn't want to expand - Might want to do this
---	---

Appendix D: Additional Reference Designs

Appendix D.1 3D Experience Smart 3D-Printed Sorter	
Explanation	Pros/Cons / Reference Image
This is a purely manual sorter. The board is designed with round holes of different diameters (for measuring head diameter/shape) and grooves with scales (for measuring length). Users can manually categorize screws by inserting them into the holes or placing them in the grooves to test their size. [9]	Pros: - Meets Objective A.1, A.2, A.3 - Meets Objective B.1 - Meets all Objectives in Goal C - Meets all Objectives in Goal D
	Cons: - Does not meet Objective A.4 as the sorter can not distinguish if the screws are rusty. - Does not meet Objective B.2, B.3 as the sorting machine is an auxiliary tool, sorting still needs to be done manually.
	

Appendix D.2: STOGER Step feeder	
Explanation	Pros/Cons / Reference Image
This is a feeding sorter. A stepped plate lifts haphazardly arranged screws upwards. At the highest point, geometric constraints allow only screws of specific size to pass through and enter the guide rails. Screws that do not meet length requirements or have heads that are too small slide directly back into the hopper. [12]	Pros: Meets Objective A.1, A.2 Meets all Objectives in Goal B Meets Objective C.2
	Cons: Does not meet Objective A.3 as the sorter does not limit the screws' head shapes (although the size does); Objective A.4 as the sorter can not distinguish if the screws are rust. This does not meet Objective C.1 as a sorting machine is a precision instrument with complex operation that requires detailed explanation; it also does not meet objective C.3 because a sorting machine is large, has many parts, and disperses information, making it difficult for users to obtain all the information within a 75-centimeter range. Does not meet Objective D.1 as the sorter has dimension with $45 \times 42 \times 38 \text{ cm}$; and Objective D.2 as the sorter has the weight 35kg; Objective D.3 as the sorter has a power requirement of 230V; Objective D.4 as if sawdust accumulates in the guide rails, it will inevitably affect the screws from entering the guide rails.
	

Appendix E: Calculation of Sorting Accuracy

The characterization of the sorting accuracy of the system may be calculated as such:

$$\frac{C.S.}{N} \times 100\% = A$$

Where N is the size of the sample (number of screws that are of the desired subtype), C.S. is the number of the subtype that are correctly sorted, and A is the accuracy.

This calculation makes the assumption that the other parameters are correctly controlled (e.g. no rusted screws of length 2 in when testing for length 2 in).

Appendix G: Various Projects completed at GTA WoodWorks

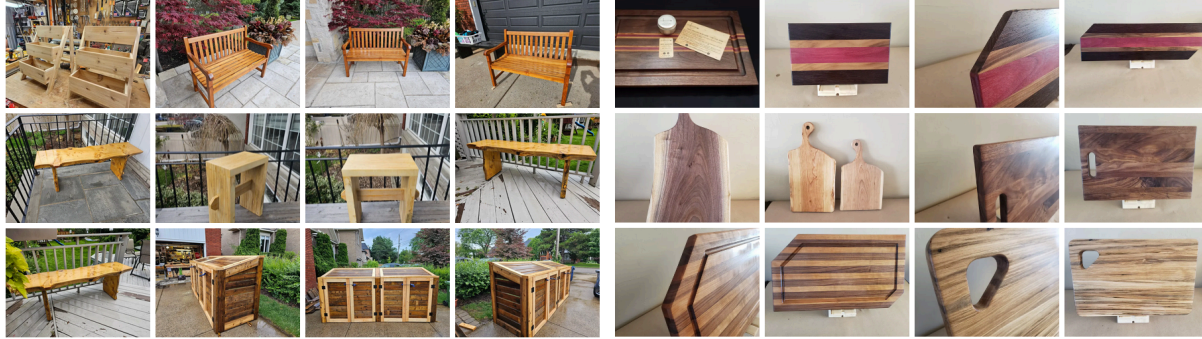


Figure G.1: Various projects completed at *GTA Woodworks* [1]. A large range of project sizes are visible, demonstrating the flexibility of the workspace.

Appendix H: Commonly used and stocked screws at GTA WoodWorks



Figure H.1: A picture of the screw stock at *GTA WoodWorks* from the visit.

Source Extracts

[1]

Book a Class

Take a woodworking class or a few and build the project of your dreams.



Rent the Shop

Unleash your creativity! My woodshop has all the tools you need plus ME to help guide you.



Start Your Project

Full-service woodshop for all your woodworking and DIY projects.



[2]

- Make sure that all machines have start and stop buttons within easy and convenient reach of an operator. Start buttons should be protected so that accidental contact will not start the machine. A collar around the button 3 to 6 mm (1/8 to 1/4 inch) above the button is recommended.
- Ensure that all cutting tools and blades are clean, sharp, and in good working order so that they will cut freely, not forced.
- Turn the power off and unplug the power cord (or [lock out](#) the power source) before inspecting, changing, cleaning, adjusting or repairing a blade or a machine. Also, turn the power off when discussing the work or when your attention is distracted.
- Use a "push stick" to push material into the cutting area. Jigs are also useful in keeping hands safe during cutting procedures. Keep hands out of the line of the cutting blade.
- Do not stand directly behind stock that is being cut, planed, or jointed to avoid injury from kick-back.

[3]

**Matthew L**

Local Guide · 24 reviews · 7 photos



★★★★★ a month ago

Jeff was fantastic to work with. I came in with a rough idea but not a fully formed plan, and he took the time to walk me through different options—where to cut the beams, how to approach the finish, and what would actually look best in the ... [More](#)

**Oshynne L.**

Toronto, ON

@ 7 📷 184 🗨️ 386



Mar 19, 2024

🚩 First to Review

Jeff is a fantastic teacher for woodworking. I went to him for a specific project, and it is evident that he is passionate about his craft. He took the time to go through the important safety features of the tools, and even provided guidance on how best to complete the project and fix any errors that happened along the way. He was incredibly helpful with problem solving and explaining the processes and thinking behind each step. When I came with a number of questions, he was always happy to answer and was very patient. I would definitely return to GTA Woodworks if I have another project in mind in the future!



Helpful 1



Thanks 1



Love this 1



Oh no 1

**Jeff G.**

Business Owner

Jun 2, 2024

Happy Birthday Oshynne and thank you for your amazing review!!!!

I really enjoyed working on this woodworking project with you and was super impressed with the skills you brought to the table. You've inspired me to build one for myself. Please send a pic of the finished piece once you have found a space for it in your home. Looking forward to helping with any other woodworking projects you have. Thanks again!!!

[Read less](#)



[5]

Irritation, coughing or sneezing are caused by the dust itself. Exposure to excessive amounts of wood dust may irritate the eyes, nose, and throat. Workers may also experience shortness of breath, dryness and sore throat, conjunctivitis (inflammation of the mucous membranes of the eye), and rhinitis (runny nose).

[Dermatitis](#) is common and may be caused by the chemicals in the wood. For dermatitis, the skin may become red, itchy, dry, or blister. [Allergic contact dermatitis](#) may also develop.

[6]

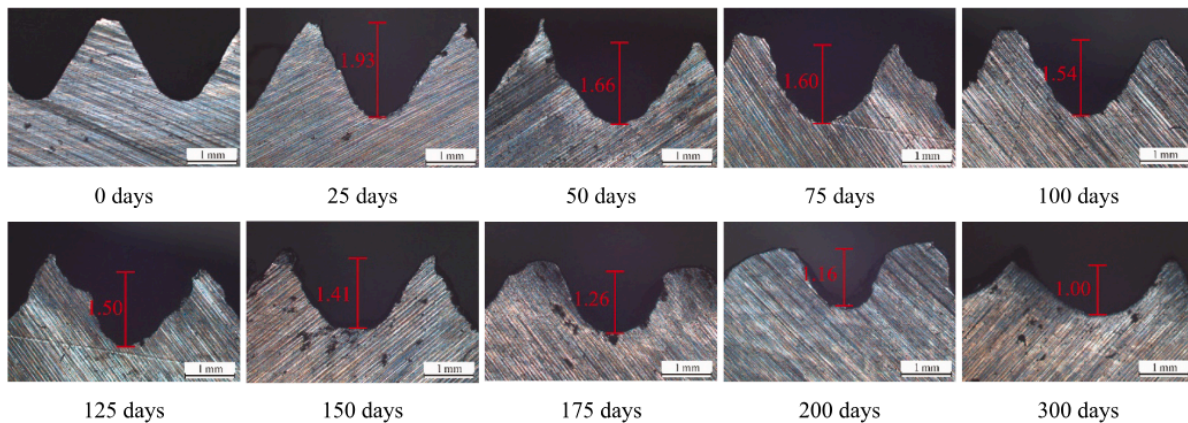
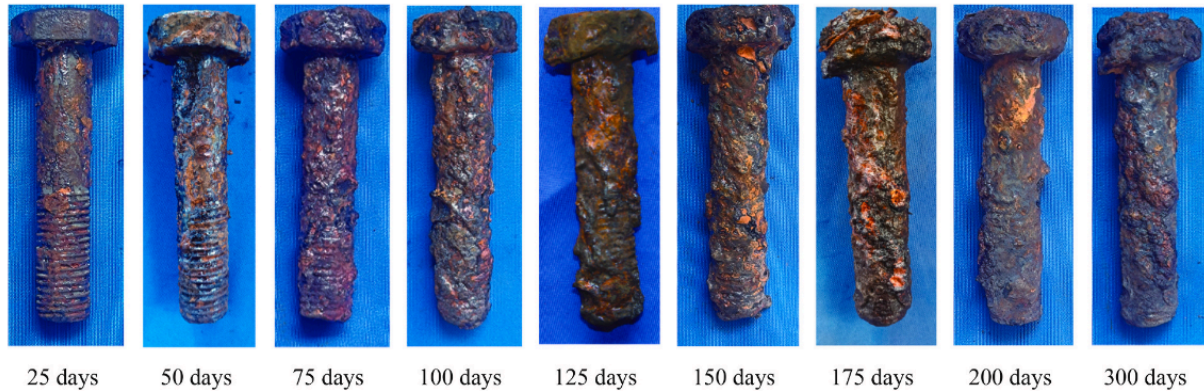
What conditions are needed for a dust explosion to happen?

[Back to top](#)

The basic requirements for a dust explosion to occur are that combustible dusts are suspended in air and are ignited. In practice, for a dust explosion to occur, a number of conditions must be met including:

- The dust must be combustible and release enough heat when it burns to sustain the fire.
- The dust must be capable of being suspended in air.
- The dust must have a particle size capable of spreading the flame.
- The concentration of the dust suspension must be within the explosible range.
- An ignition source must be in contact with the dust suspension.
- The atmosphere must contain sufficient oxygen to support and sustain combustion.
- There is a form of confinement or enclosure that allows pressure to build.

[13]



[16]

Screw heads and drives come in a wide range of styles, most of which can be combined with each other to offer unique benefits like flush finishes, stronger holds, tamper resistance, and better load distribution. Here, we will focus on the varying styles of these two crucial elements. But first, we'll review the basic screw anatomy.

[17]

Screws are usually specified by gauge number, length, head style, material and finish. Screw lengths between 1 inch and 2 ¾ inch lengths are manufactured in ¼ inch intervals, whereas screws 3 inches and longer, are manufactured in ½ inch intervals. Designers should check with suppliers to determine availability.

[18]

16 Tables of single sampling plans

Table 2 — Single sampling plans for normal inspection (master table)

		Acceptance quality limit in percent nonconforming and nonconformities per hundred items (normal inspection)																																							
Code letter	Sample size	0,01	0,015	0,025	0,04	0,065	0,1	0,15	0,25	0,4	0,65	1	1,5	2,5	4	6,5	10	15	25	40	65	100	150	250	400	650	1000														
		Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re		
A	2																0	1																							
B	3																0	1																							
C	5																0	1																							
D	8																0	1																							
E	13																0	1																							
F	20																0	1																							
G	32																0	1																							
H	50																0	1																							
I	80																0	1																							
J	125																0	1																							
K	200																0	1																							
L	315																0	1																							
M	500																0	1																							
N	800																0	1																							
P	1250																0	1																							
Q	2000																0	1																							
Key		There is no suitable plan in this area; use the first sampling plan, including its sample size, Ac and Re numbers, in the appropriate column.																																							
		If this new sample size equals or exceeds the lot size, carry out 100 % inspection.																																							
		There is no suitable plan in this area; use the last sampling plan, including its sample size, Ac and Re numbers, in the appropriate column.																																							
	Ac	Acceptance number																				Re/Rejection number																			

[19]

4.5 Usability

Usability is a criterion against which a work system can be evaluated. In applying the concept of usability within the work system, all relevant system components should be identified.

To evaluate usability, it is normally necessary to use at least one measure for each of effectiveness, efficiency and satisfaction.

NOTE For a detailed description of usability measures and definitions of effectiveness, efficiency and satisfaction, see ISO 9241-11.

[20]

5.2.2.1 The interactive system should provide information that guides the user and minimizes the need for consulting online help, user manuals or other external information.

[21]

modality

mode of interaction referring to one of the human senses

Note 1 to entry: The three modalities most commonly used in ICT are: **visual**, auditory, tactile or haptic.

Note 2 to entry: Modalities are used in interactions between users (3.1) and systems.

[22]

Average Dimensions of Woman

Standing

- Upward reach dimension of average woman: 1970mm
- Top of head height of average woman (average female height): 1650mm
- Eye level of average woman: 1545mm
- Shoulder height average woman: 1355mm
- Shoulder width of average woman: 405mm
- Side reach of average woman: 820mm
- Full reach finger to finger of average woman: 1650mm
- Forward reach of average woman: 705mm
- Knuckle height of average woman: 740mm
- Hip width of average woman: 400mm

Average Dimensions of Man Standing

- Upward reach dimension of average man: 2120mm
- Top of head height of average man (average male height): 1740mm
- Eye level of average man: 1635mm
- Shoulder height average man: 1430mm
- Shoulder width of average man: 460mm
- Side reach of average man: 885mm
- Full reach finger to finger of average man: 1790mm
- Forward reach of average man: 780mm
- Knuckle height of average man: 770mm
- Hip width of average man: 370mm

[23]



Single Pole Breaker

Also known as a 1-pole breaker, the single pole breaker is designed for general use and the most common breaker in Canadian electrical panels.

- Occupies one slot
- Protects one energized wire
- Supplies 120V to a circuit and handles 15-30 amps

TIP: A circuit breaker is rated for the type of wire and load required by its circuit. For safety, the breaker must be sized correctly, according to the current of the circuit.

[Shop Now](#)

[24]

Building A Bookshelf

Let's say you're building a simple bookshelf with three shelves. The sides of the bookshelf are 6 feet tall and the shelves are 3 feet long.

- **Corner joints:** There are 4 corner joints at the sides of the bookshelf. Each corner joint will need 3 screws. So, that's $4 \times 3 = 12$ screws for the corners.
- **Shelf joints:** Each shelf has 2 joints where it connects to the sides. There are 3 shelves, so that's $3 \times 2 = 6$ joints. Each joint will need 2 screws, so that's $6 \times 2 = 12$ screws for the shelf joints.

In total, you'll need $12 + 12 = 24$ screws. Adding 15% for waste and spares, $24 \times 1.15 = 27.6$. So, you should get 28 screws.

~20 screws for a small project