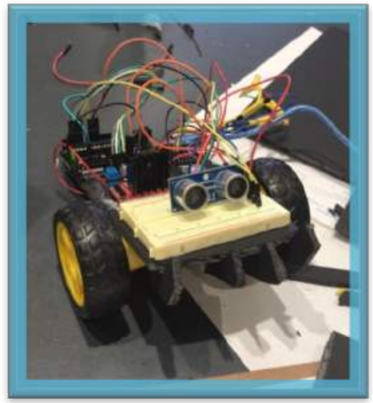
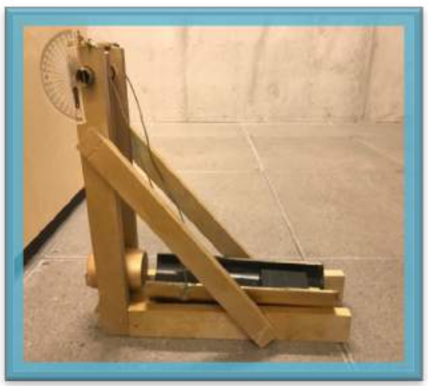
ESC102; PRAXIS II

Student Engineer Handbook





by Elif Celik

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Introduction

Fig 1: A photo of me

As an Engineering Science student at the University of Toronto, I have had experience working on engineering designs both in class and competitions. Most of these projects were done in a team environment whereas some of them were done individually. With this handbook, I aim to document and represent my personal design concepts and processes, as well as demonstrate and reflect on the engineering tools, frameworks and models I have used along the way.

I value ambition, discipline and hard work, all of which help me withstand challenges. I believe in self-improvement, personal growth and empathy when working with others. Both in daily and professional lives, I strive for minimalism, simplicity and precision. During the entire design process, whether I work individually or with a team, I try to live by these values and foci.

As a novice engineer, satisfying the needs of the community I work with is crucial, and I believe that is possible through a focus on designing for usability, accessibility, assembly and simplicity. Following these aspects will ensure that a design is easily obtainable, practical, and also appear to be more modern. As a result, these are integrated into my designs and are illustrated in this handbook.

Being skilled in computer languages such as Python and C has helped me during the process of creating some designs. Although not all designs required computing experience, the skills I have gained through programming, such as finding efficient and smart solutions, allowed me to tackle some of the bigger challenges more easily. In addition, having critical thinking, team work and conflict resolution skills allowed me to engage comfortably in a team(s) which at the end resulted in us achieving our goals and objectives.

Lastly, I believe that my personal biases can affect my designs, which is why being aware of them enables me to be more objective. For instance, my self-interest in aesthetics might prevent me from fully focusing on satisfying the needs of the stakeholders, especially given a limited time. Also, wanting to perfect a design by including unnecessary design features might result in me not focusing on the main objective of the design, and instead creating a more complex design.

Personal Engineering Design Products

This section focuses on representing my designs and their features, and is categorized into three parts:

1) Designs created in Praxis II
2) Designs created in Praxis I
3) Designs created in competitions/activities.

In each of these three subsections, I decided to represent my work in reversed chronological order, as my most recent designs are more advanced than the first ones. The purpose of this section is to show the details of my designs as well as my design preferences and how I use my values, foci and strengths to enhance the quality of my work.

1) Designs Created in Praxis II:

1) <u>Piston Dispenser (Showcase Prototype):</u> The piston dispenser was designed for ESC102 Showcase by my team, whose members were Esther Ho, Shawn Zhang and Kevin Hu and myself. This system was created for the Sanctuary, a Christian church that primarily serves homeless people and university students. The opportunity was to automate the distribution and data collection of the harm reduction kits at the Sanctuary, enabling safer drug use, taking down social anxiety when requesting a kit, as well as more accurate data collection. For governmental purposes, the genders of the kit users and number of kits given out are required to be recorded.

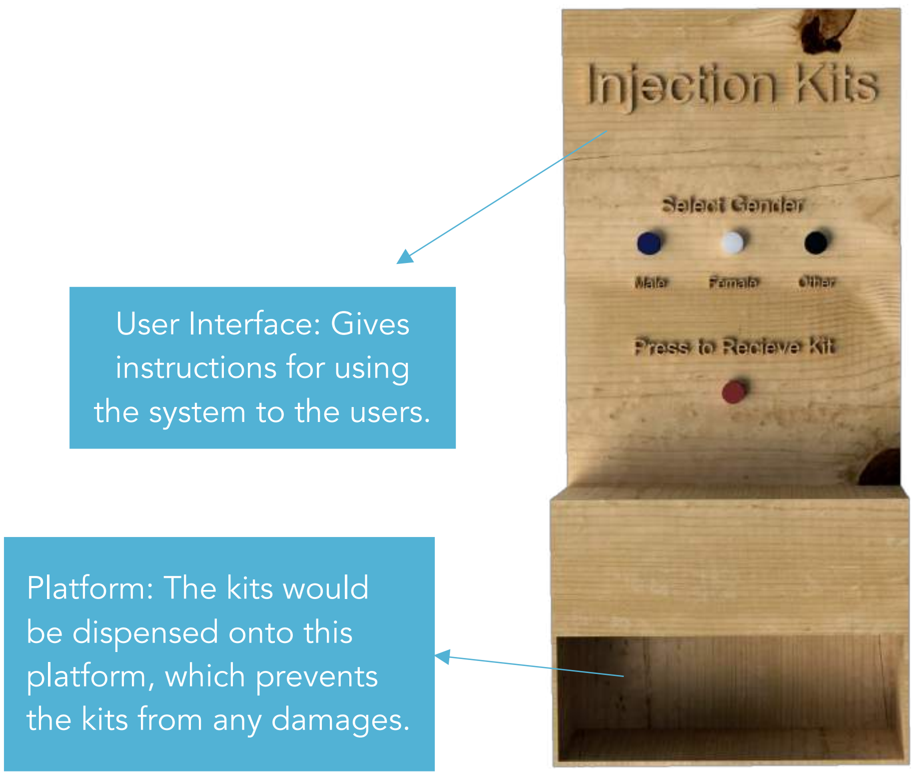


Fig 2*: The Piston Dispenser User Interface

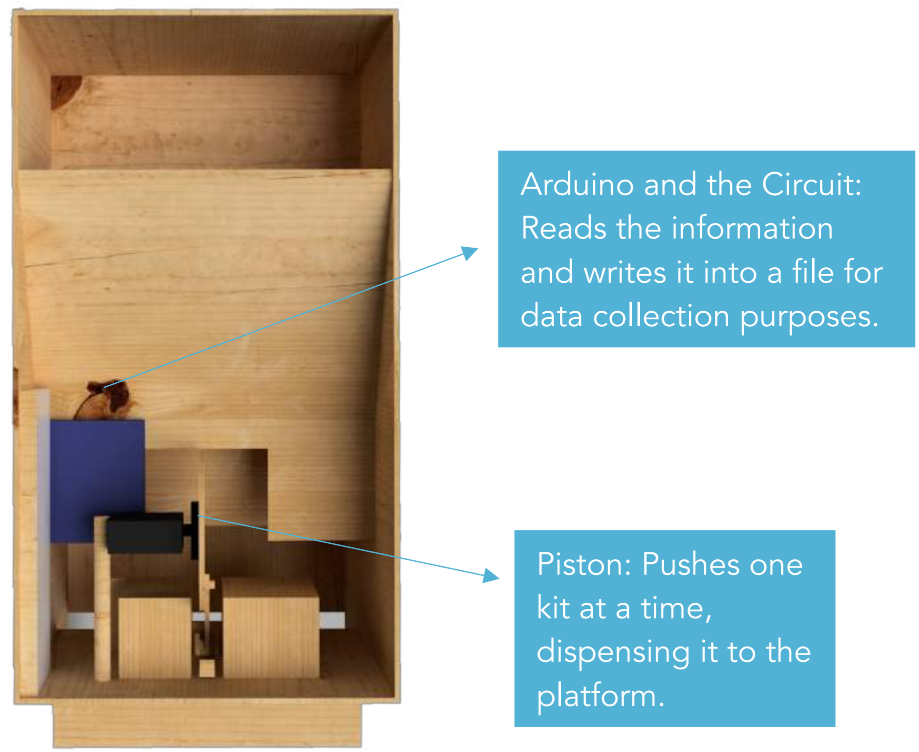


Fig 3*: Piston Dispenser Inside

*This 3-D representation of the piston dispenser was built by my teammate Kevin Hu.

To achieve the final design, quite a few steps were taken, and many engineering tools were used, including various brainstorming tools, pairwise comparison, ratings matrix and more.

The three main designs for excellence that this product accomplishes are:
1) Design for accessibility: Height is adjustable
2) Design for speed: Dispenses a kit in seconds
3) Design for accuracy: As data is collected electronically, it is more accurate than the current data collection system

This product was validated with the nurses at the Health Clinic who are one of our primary stakeholders, as they engage with the kit users on a daily basis. Additionally, this design and the community's values align with my personal values and goals, as well as and my team's values such as empathy, accessibility and usability.

This is how the fully functional prototype looks like in real life:

Fig 4: Set of Photos of the Piston Dispenser Prototype
This prototype was built by all of the team members (W23), including myself.

2) Vending Machine Dispenser: During the process of diverging and generating ideas for our stakeholders (the Sanctuary), we used brainstorming tools, one of which was classical brainstorming. The objective was to improve the kit distribution and data collection process at the Sanctuary. To achieve the high-level objective, I generated this design concept as I was inspired by vending machines. This product would have many slots to hold the components of the harm reduction kits. The interface allows the user to select the type of kit they need, which the machine then dispenses with the components of the kit as well as a plastic bag.

Fig 5: The Vending Machine Dispenser Design

The three main designs for excellence that this product accomplishes are:

1) Design for accessibility: Easy to transport and access
2) Design for speed: Dispenses a kit in seconds

The idea of the vending machine dispenser is viable because most people are familiar with how they work and as my main goal is to satisfy the needs of the stakeholders, this design seemed to be a good candidate for the sought-after solution.

The original drawing of the design, before I created a 3-D prototype:

Fig 6: Quick (Original) Drawing of the Vending Machine Dispenser

3) <u>Assembling and Dispensing Machine:</u> Our original RFP was about improving the assembly process of the harm reduction kits at the Sanctuary. This design was created before we changed our RFP to improving the data collection and distribution of the harm reduction kits at the Sanctuary. During one of the team meetings, I created this product by using classical brainstorming.

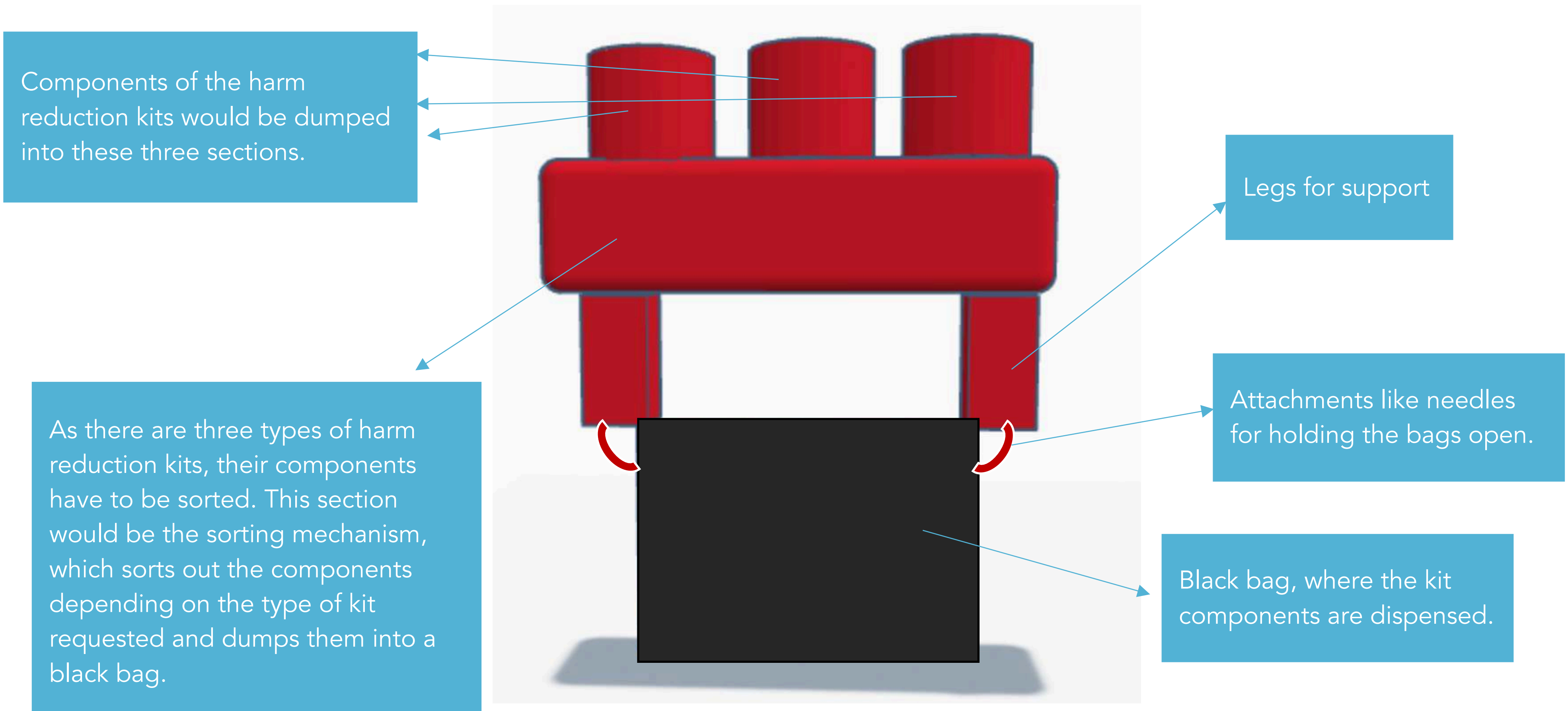


Fig 7: Set of Assembling and Dispensing Machine Design

This design was approved and highly liked by my teammates, as it accomplishes a couple of tasks at once. However, after engaging with our stakeholders more, we completely changed our RFP, which resulted us in finding new design concepts and not proceeding with this one.

The two main designs for excellence that this product accomplishes are:

1) Design for Usability:
2) Design for Speed:

This design was not verified or validated as the physical prototype was never made. However, it included all the features we wanted to have in our system to meet the requirements, and it was considered to be very efficient. Although most of the products shown in this section are more simplistic, I believe that this design still represents my interests and values as it focuses on design for usability, which to me is the most important DfX. That is because designing for usability allows the user to effectively achieve goals in an efficient and satisfying way [1].

The original drawing of the design, before I created a 3-D prototype:

Fig 8: Quick (Original) Drawing of the Assembling and Dispensing

4) Launcher: This design was also done by my team with the same members. The goal of the project was to shoot a projectile to a predefined target from the launcher; more specifically, to the center of the target zone, and then aim the launcher at one of the six alternate targets as outlined in Build + Test Assignment Specifications for ESC102 [2]. We wanted to build a system that is stable and reliable in use, which is why we used a mallet as part of the design due its wide surface area and its strength. As for the projectile, my teammate Shawn 3-D printed a half cylinder, which we thought had the least friction out of all the other projectile candidates, such as foam balls. The projectile would be placed on the ramp while the mallet would be pulled back, its angle being adjusted by the protractor, and finally released to hit the projectile. For each zone, we tracked which launching angles resulted in the projectiles landing there, as illustrated in Fig. 9.

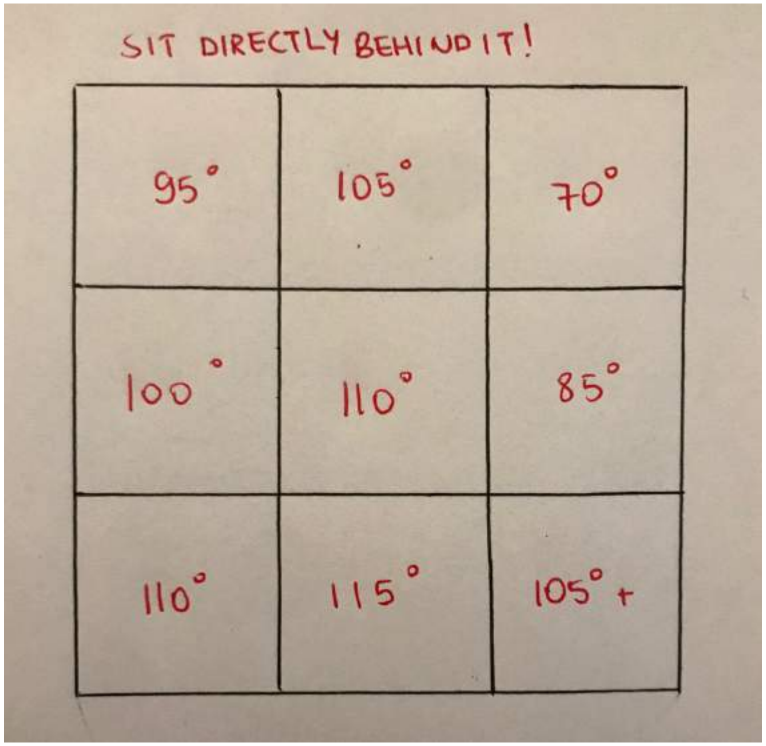


Fig 9: Angles for Each Target Zone for the Launcher

The launcher and the projectile look like this:

Fig 10: The Mallet Launcher (built by team W23)

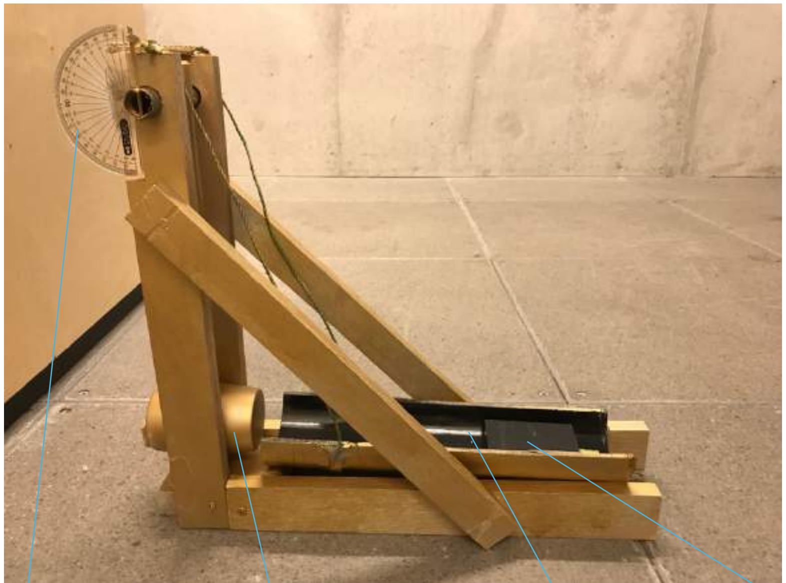


Fig 11: The Projectile (Built by Shawn Zhang)

The three main designs for excellence that this product accomplishes are:

1) Design for Accuracy: Use of protractor enables high precision and accuracy
2) Design for Reliability: Chose reliable material that would last long
3) Design for Simplicity: Few components used to create a simple system

This design was tested with a critical test where the accuracy had to be approximately 90% or higher. The angles were adjusted until desirable accuracy was achieved.

2) Designs Created in Praxis I:

5) Backpack Insertion: This was the final design that my team and I (Morgaine Saskia van Beers, Elif Celik, Kerryn van Rooyen, Yuqing Feng) decided to proceed with for our Design Review for ESC101. The objective was to improve the learning experience of the Engineering Science students by creating a backpack aid to facilitate better organizational capacity. I generated the design of this product during one of our meetings by using classical brainstorming. This product would go inside of a backpack and has 6 pockets since an Engineering Science student takes on average 6 courses. The front pocket is slightly larger than the rest as it is specifically designed for the CIV102 textbook. Also, there are 2 elastic fasteners at the front designed for CIV102 set square. Additionally, it has padding at the back which protects users from feeling sharp and irregularly shaped objects. The padding could also work as a pillow, which students could sleep on during their break

Fig 11: Backpack Insertion Outside

Fig 12: Backpack Insertion Inside

The three main designs for excellence that this product accomplishes are:

1) Design for Usability: Product must fit in most backpacks with no problem
2) Design for Aesthetics: Aesthetically pleasing product is desired as students do not want to look different from their peers
3) Design for Cost: As students are on a budget, it is important to keep this product affordable

Since I am empathetic to others' issues and am part of the primary stakeholders (engineering science students), generation of this design was relatively easy as I know what would satisfy my peers' needs.

3) Designs Created in Competitions/Activities:

6) <u>Obstacle Avoiding Robot (Robotics for Space Exploration – Space Engineering & Exploration Kompetition SEEK 2019):</u> I participated in the SEEK 2019 competition with a team (Lucy Xinyu Ma, Amelia Zhang, Gerry Chen, Elif Celik) where we were asked to build a robot within 8 hours. This robot was to move through a path full of obstacles and compete with other teams' robots. We were given components such as cardboard, DC motors, an Arduino, jumper wires, breadboard, a sensor, battery and wheels. I mainly worked on connecting the circuit to the base of the robot. Despite being given 4 wheels, we decided to use only 2 to minimize the weight of the robot and to conserve the life of the battery. As for the front part, we attached pointy objects to help move the obstacles out of the way and make sure those do not hit vulnerable spots such as the circuit or the sensors.

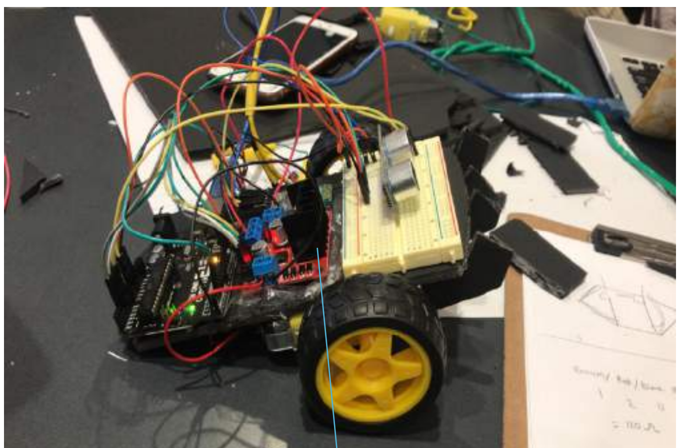


Fig 13: Obstacle Avoiding Robot From the Side

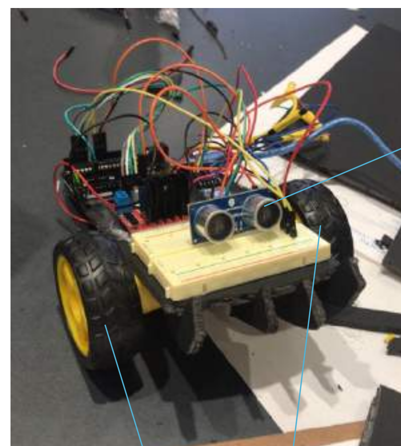


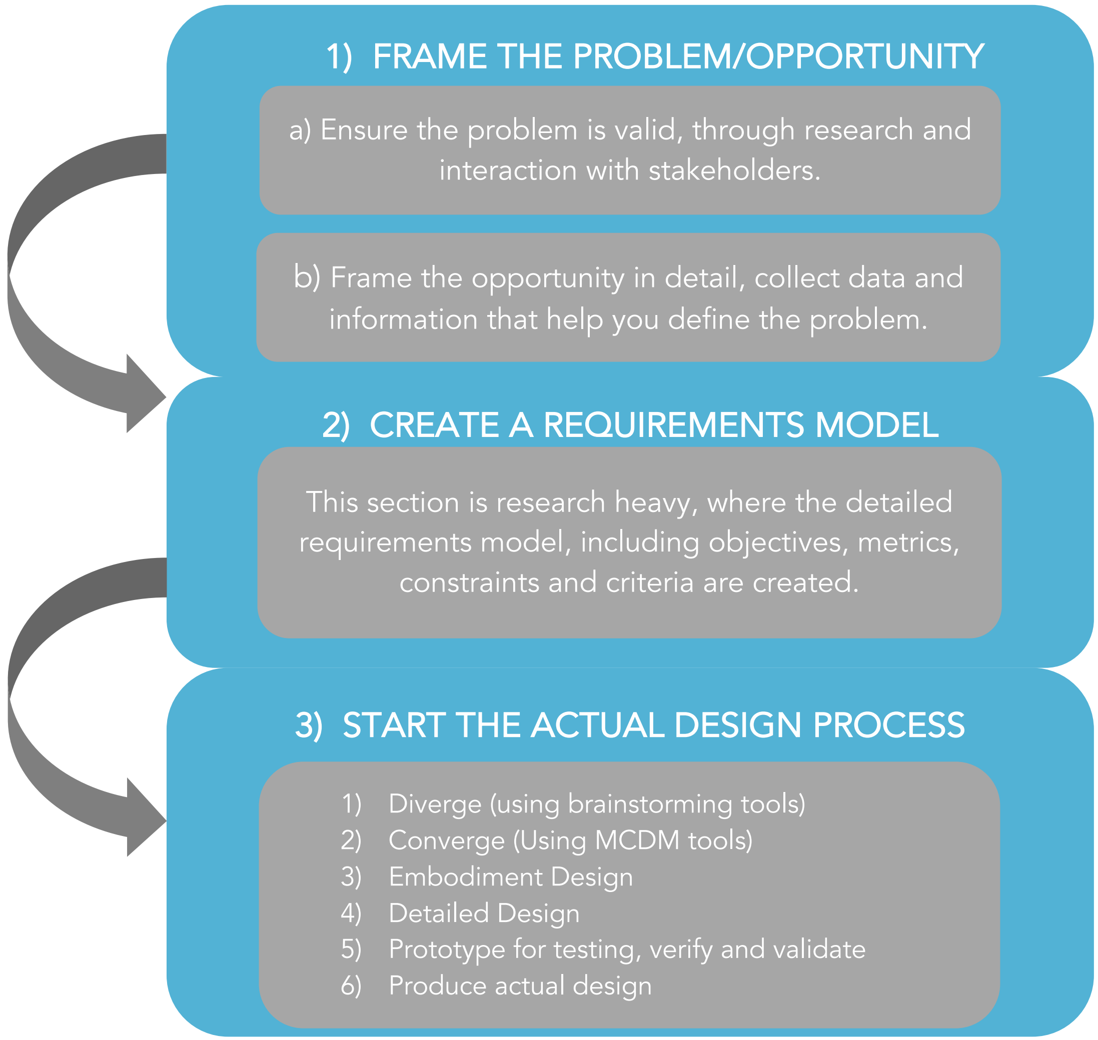
Fig 14: Obstacle Avoiding Robot Front

The two main designs for excellence that this product accomplishes are:

1) Design for Speed: To increase the speed of the robot, pointy objects were placed at the front that moved the obstacles away
2) Design for Assembly: By reducing the number of components, we were able to test various builds to find the best design. This was done by disassembling and constantly reassembling the robot to tweak or improve on certain features.

Personal Engineering Design Process

My personal design process consists of three main sections with subsections. The three main sections with brief descriptions are shown below:



Section 1 Detailed: Framing the Problem/Opportunity

1) FRAMING THE PROBLEM/OPPORTUNITY

- I believe that correctly describing the opportunity is very important when it comes to design. That is because, when the problem is not properly defined, the solutions might not be highly accurate. To achieve desirable results, I follow these two steps:

a) Ensure the problem is a valid opportunity through interaction with stakeholders and research if needed. Questions to ask at this stage:
   - Will solving this problem make an impact on the community?
   - Am I qualified to solve this problem? Can I make it work?

It is important to correctly interpret what is observed. To ensure right interpretation, check your understanding with the stakeholders. If research is needed at this step, consult the use of the CRAAP test.

b) Once the validity of the opportunity is confirmed, start the actual framing process of the opportunity. To give a background to the problem, engage with the primary stakeholders, collect as much data and information as possible. Then, support these data with research, and finish framing the problem.

Section 2 Detailed: Create a Requirements Model

2) CREATE A REQUIREMENTS MODEL

- Creating a requirements model enables me to see the big picture of what I desire to achieve by the end of a design concept. Therefore, it is crucial to do intense research to support the requirements model, by using a CRAAP test for each step. This allows me to also keep track of all the intricacies of the project.

a) High Level Objective: State the high-level objective of the opportunity, keeping in mind to satisfy the needs of the stakeholders and focusing on various DfXs.

b) Detailed Objectives: I find it best to do one detailed objective at a time with all of its metrics, criteria and constraints before moving on to the next detailed objective. This allows me to fully focus on each objective separately, and it also increases the quality of my research. Typically, I would start by carefully stating the detailed objective, and then finding both qualitative and quantitative metrics. Next, I would simultaneously describe the criteria and constraints for the objective.

Having a detailed and accurate requirements model is important, as it will be used during the actual design process, and later on to verify the features of the final design.

Section 3 Detailed: Start the Actual Design Process

3) START THE ACTUAL DESIGN PROCESS

a) Diverge: Generate concepts with the help of various brainstorming tools such as classical brainstorming and reverse brainstorming (Conceptual design also takes place in this stage through simple sketches).

b) Converge: Converge on an idea by using MCDM tools. Pairwise Comparison or Borda Count Tools (system-1 thinking) are efficient as they rely on intuition which can often be the simplest solution.

c) Embodiment Design: Define the needs and technical functions of the final product. Also, determine the arrangement of the elements and the design of the main components. Create a risk-minimizing solution layout for the product.

d) Detailed Design: Finalize all decisions including material choice and dimensions. When determining the details such as dimensions of the components, go back to the requirements model to ensure they meet all constraints. Ensure that the final design is manufacturable.

e) Prototype & Test: Create a relatively low-fidelity prototype for the design and test it against the metrics, ensure that it does not violate constraints. Create two ratings matrices: for comparing current design to reference design and for comparing current design to candidate designs. After ensuring that the current design is optimal, validate it with the primary stakeholders.

f) Produce Actual Design: Once the design is verified and validated, produce the actual high-fidelity design.

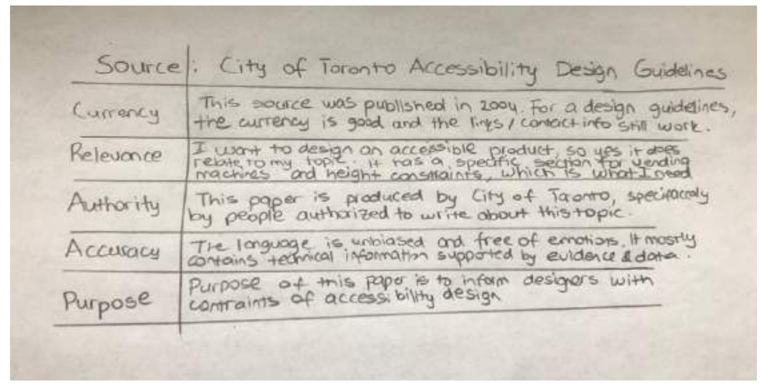
Tools, Models and Frameworks

1) CRAAP Test:

The CRAAP Test is a test for evaluating the quality and relevance of information [3]. It consists of 5 parts, which are:

- Currency: the timeliness of the information
- Relevance: how the information fits my needs
- Authority: information about the author or the source
- Accuracy: describes how reliable, truthful, and correct the source is
- Purpose: explains the reason why the information exists

Example: During the design process of the piston dispenser, both my team and I used this tool many times before to come up with our metrics and constraints. I used the CRAAP test to evaluate a source for one of our detailed objectives: accessibility, as illustrated in Fig. 15.



Source	: City of Toronto Accessibility Design Guidelines
Currency	This source was published in 2004. For a design guidelines, the currency is good and the links / contact info still work.
Relevance	I want to design an accessible product, so yes it does relate to my topic. It has a specific section for vending machines and height constraints, which is what I need
Authority	This paper is produced by City of Toronto, specifically by people authorized to write about this topic.
Accuracy	The language is unbiased and free of emotions. It mostly contains technical information supported by evidence & data.
Purpose	Purpose of this paper is to inform designers with contraints of accessibility design

Fig 15: Evidence of using the CRAAP Test

- Assessment of Utility: This tool is very important when doing research as it ensures that the information that the source provides is trustworthy and relevant. This tool has high utility as it prevents students from using unreliable sources that might not contain correct information. It should be used any time one needs to do research, specifically when doing the requirements model as it creates a base for the features and functions of the design.
- Assessment of Fit: This tool is one of the tools that I have tried to use at every step of my design process, because I value precision and accuracy. Also, it helps me overcome my biases through fact-checking.

2) **Verification & Validation:**

Verification asks the question "Does the design meet the requirements?" whereas Validation asks, "Do the stakeholders accept the implementation as meeting their needs?" [3]. Although these two procedures are independent, they go hand-in-hand which is why I included them in the same section. The objective of Verification is to ensure that the design meets the requirements and other specifications. The objective of Validation is to ensure that the design satisfies the users' needs.

Example: My team and I (W23) completed the verification and validation steps together for our piston dispenser. For verification, we tested for metrics such as the total time elapsed for the request and dispenser of one kit, since it was one of our most testable metrics. We also did tests against cost, accuracy, and ensured the dimensions of the prototype fit the dimension constraints. For validation, we met with the nurses who work at the Sanctuary, as they were one of our primary stakeholders. We showed them the functioning prototype and they validated our design as being useful for them and other stakeholders.

- Assessment of Utility: These tools are high in utility as they help confirm that the objectives are achieved. They are critical since failing to fully satisfy these tools would result in not creating the desired product that would meet the needs of the stakeholders.
- Assessment of Fit: Personally, I use both of these tools more than once throughout the whole design process. I use Verification at each step in Part 3 of my Personal Design Process, since if not done right, various problems might accumulate over the process. Also, I make sure to validate before producing the actual design. This tool fits my needs perfectly as it improves the quality of my design, however I tend to spend too much time on it due to my desire to make every feature flawless.

3) Classical Brainstorming:

This is a tool that could be used individually or in a group setting to generate ideas. Ideally, the topic would be written on a board for everyone to see and understand. When brainstorming, everyone starts generating ideas and sharing them with the rest of the group. They key is to avoid criticizing ideas and judgement, and to come up with as many ideas as possible. At the end, similar ideas can be grouped together while others could be recorded separately [3].

Example: As for most of Praxis II, my team and I had a lot of sessions where we used classical brainstorming. Figure 16 shows a part of such brainstorming when generating ideas for the assembly process of the harm reduction kits at the Sanctuary. As a side note, my designs "Vending Machine Dispenser" and "Assembly and Dispensing Machine" were generated as a result of classical brainstorming, in which we wrote down all ideas on a large piece of paper.

Fig 16: Evidence of Classical Brainstorming

- Assessment of Utility: This is an effective tool for group brainstorming as there are no strict rules and everyone is free to generate as many ideas as they like. Also, it allows people to be creative and see things from another perspective. Classical Brainstorming can be used during the Diverging Process to generate many ideas and concepts.
- Assessment of Fit: Even though I believe that this is a suitable tool for brainstorming, I prefer to do such brainstorming individually. Having no strict rules limits my idea-generation process as I like to outline and follow certain rules when working on a project.

4) Pairwise Comparison:

Pairwise Comparison is a tool where each entry (such as Design Concept, Objectives, etc.) is compared and ranked against all other entries. All team members vote for their preferred candidate and the one with the highest votes receives the rank of 1. At the end, all the ranks are summed up, and the one with the highest will be the chosen candidate [3].

Example: My team and I (W23) utilized a Pairwise Comparison on the elements of the harm reduction kits process, which can be seen in the Figure 17. We tried to use a System-1 Thinking Pairwise Comparison to finalize our decision on what the most important step in the process is. It turned out that the kit distribution was highly important, contrary to what we had expected before (the assembly step).

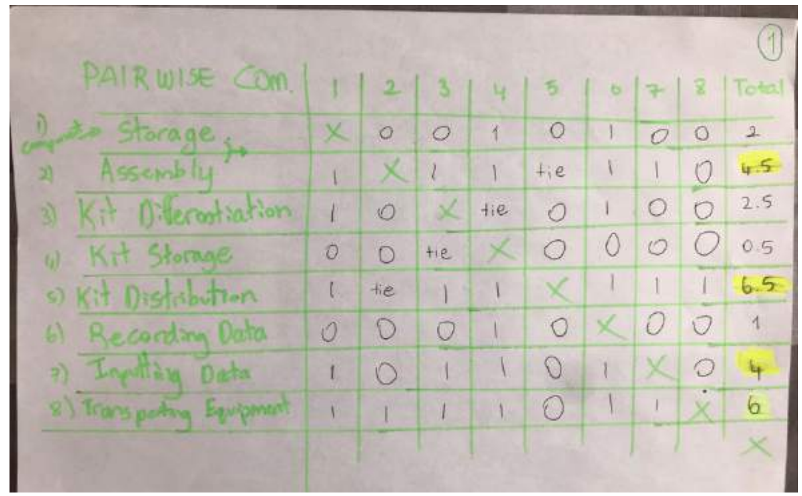


Fig 17: Evidence of Pairwise Comparison

- Assessment of Utility: This tool is of higher utility in a team environment rather than in personal use. It allows all the team members to agree on important elements that might have been overlooked by some of the team members. However, in order to achieve high utility when the tool is used, it is necessary to do proper research to confirm that the chosen element fits the requirements model.
- Assessment of Fit: Pairwise Comparison is effective and efficient as it helps eliminate unwanted ideas and elements and focus on more important steps. However, I would not depend on this tool when working individually as I believe that it would limit my understanding and perception, as well as hinder my evaluation abilities. That is because I know I would likely be biased in thinking that a certain step is more important than it really is.

5) Ratings Matrix:

Ratings Matrices can be used for comparing the ratings of each design concept according to the detailed objectives and their metrics [3].

Example: Upon heavy research, my team and I (W23) found reference designs which we compared to our own to ensure that ours achieved the objectives better than those found. I created a ratings matrix with my teammate Kevin Hu, as seen in Fig. 18. In order to fill out this matrix, we conducted a lot of tests as well as research.

- Assessment of Utility: The matrix has high utility since it clearly outlines the ratings of each of the designs, which can then be easily compared to each other. It is useful because it allows one to see whether the design is unique and effective. However, in order to create a good Ratings Matrix, it is important to do intensive research.
- Assessment of Fit: I would always use this tool during both individual and team projects as it aligns with my values of accuracy and my beliefs of organizational perfection.

Objectives	Metrics	Vending Machines (Seaga Brand-INF5S)	General Dispensers (Tampon Vendor)	Our Design
Accessibility	Button Height in centimeters/ adjustable	1.2 m	Adjustable	Adjustable
Time	Time for Single Dispense	3 seconds	3 seconds	2.49 seconds
Accuracy	Ratio Between Successful and Total Dispenses	NA	50%	100% (conditions apply)
	Ratio Between Recorded and Distributed Kits	0%	0%	100%
User Friendliness	Error Prevention Rating (out of 5)	3	3.5	5
	Ease of Instruction Rating (out of 5)	5	4	5
Damage Prevention	Drop Test	Pass	Pass	Pass
Space Efficiency	Dimensions in Centimeters	W:99 H: 183 D:94	W:37.78 H: 64.45 D: 14.61	W:66 H:41 D:27
Affordability	Cost in CAD$	$9,248	$299.95	$226.62 CAD
Digitalization of Data Collection	Number of Steps Digitized	0	0	4

Fig 18: Evidence of Ratings Matrix with my teammate Kevin Hu

6) Posters:

Posters are great for a visual representation of textual and graphical elements. They convey ideas and objectives clearly in a concise and understandable format. They could also be used in the representation stage of the FDCR.

Example: for the showcase, my team and I (W23) created a large poster as well as a comparatively smaller one. I was responsible for the creation of the smaller poster, and I tried to include the details such as metrics and criteria, which were not included in the large poster.

- Assessment of Utility: A trifold poster has medium utility when standing next to a bigger one during the presentation as it might be distracting the audience from the more important information. However, it is still useful for highlighting valuable information which was not outlined in the larger poster.
- Assessment of Fit: I prefer trifold posters over large sized posters when presenting as it includes more of the important information that I have to mention to the audience whereas the large one fails to include it.

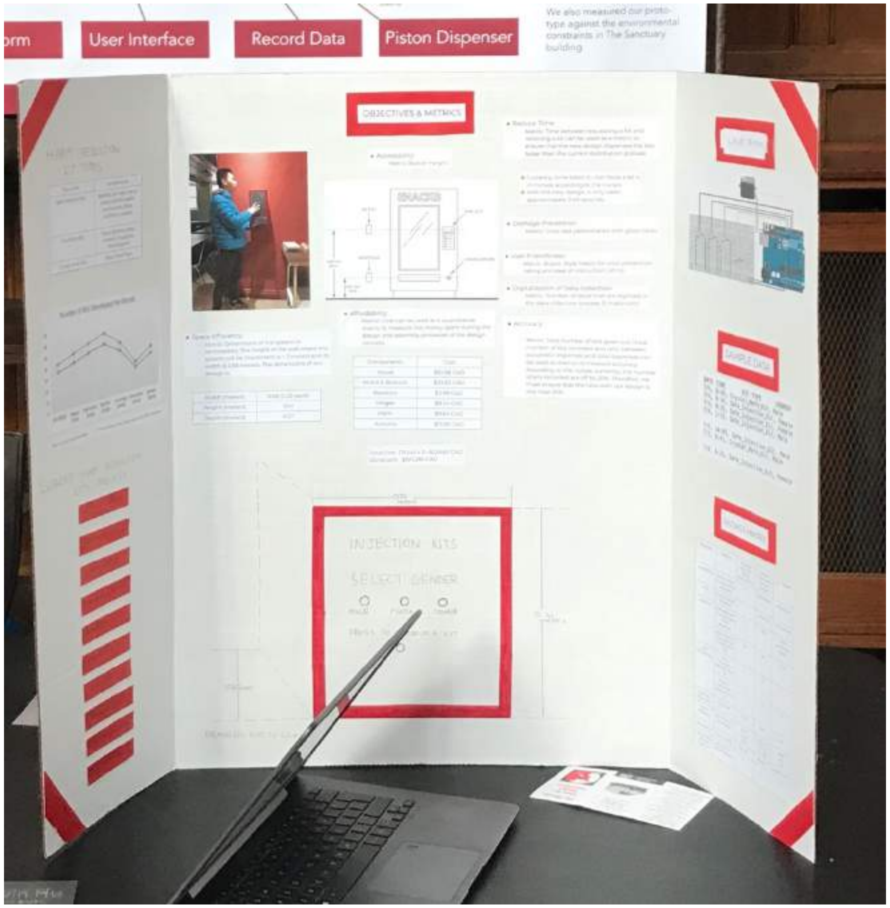


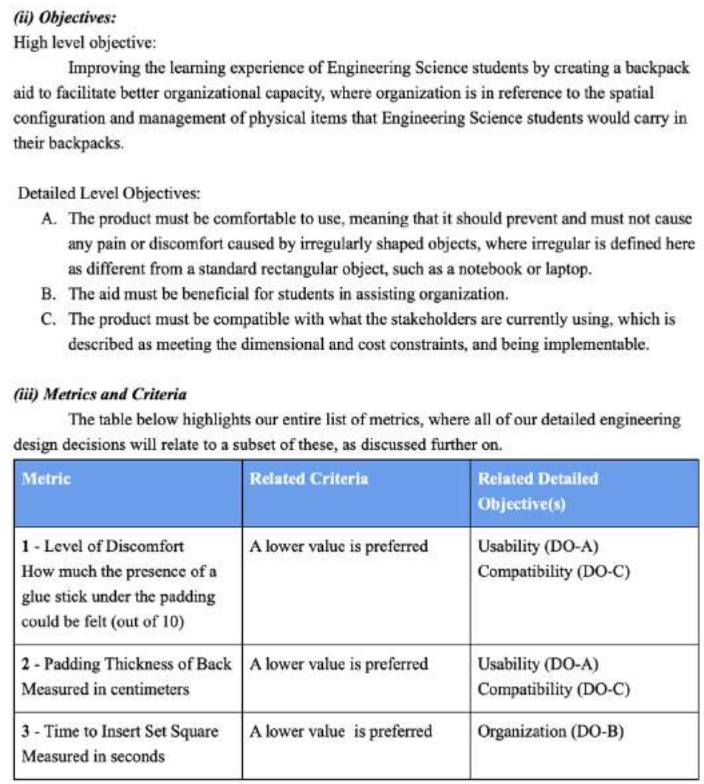
Fig 19: Evidence of Using a Poster

7) Requirements Model

A Requirements Model outlines the process that every engineering design should include. The model includes stakeholders, high-level objectives, detailed objectives, alternatives, metrics, constraints, and criteria [3].

Example: Both in Praxis I and Praxis II, I created lots of Requirements Models when working with my teams. Figure 20 shows a section of the model that I created with my team in Praxis I (Morgaine Saskia van Beers, Elif Celik, Kerryn van Rooyen, Yuqing Feng). This model was created for the backpack insertion product that I displayed earlier in this handbook.

- Assessment of Utility: The Requirements Model is necessary for an Engineering Design and without it a design would not be verified. Hence, due to its importance it has very high utility.
- Assessment of Fit: I would always include this crucial process in my design, and it can also be seen in my Personal Design Process. Therefore, it aligns with my interests, goals, and values.



(ii) Objectives:

High level objective:

Improving the learning experience of Engineering Science students by creating a backpack aid to facilitate better organizational capacity, where organization is in reference to the spatial configuration and management of physical items that Engineering Science students would carry in their backpacks.

Detailed Level Objectives:

A. The product must be comfortable to use, meaning that it should prevent and must not cause any pain or discomfort caused by irregularly shaped objects, where irregular is defined here as different from a standard rectangular object, such as a notebook or laptop.
B. The aid must be beneficial for students in assisting organization.
C. The product must be compatible with what the stakeholders are currently using, which is described as meeting the dimensional and cost constraints, and being implementable.

(iii) Metrics and Criteria

The table below highlights our entire list of metrics, where all of our detailed engineering design decisions will relate to a subset of these, as discussed further on.

Metric	Related Criteria	Related Detailed Objective(s)
1 - Level of Discomfort How much the presence of a glue stick under the padding could be felt (out of 10)	A lower value is preferred	Usability (DO-A) Compatibility (DO-C)
2 - Padding Thickness of Back Measured in centimeters	A lower value is preferred	Usability (DO-A) Compatibility (DO-C)
3 - Time to Insert Set Square Measured in seconds	A lower value is preferred	Organization (DO-B)

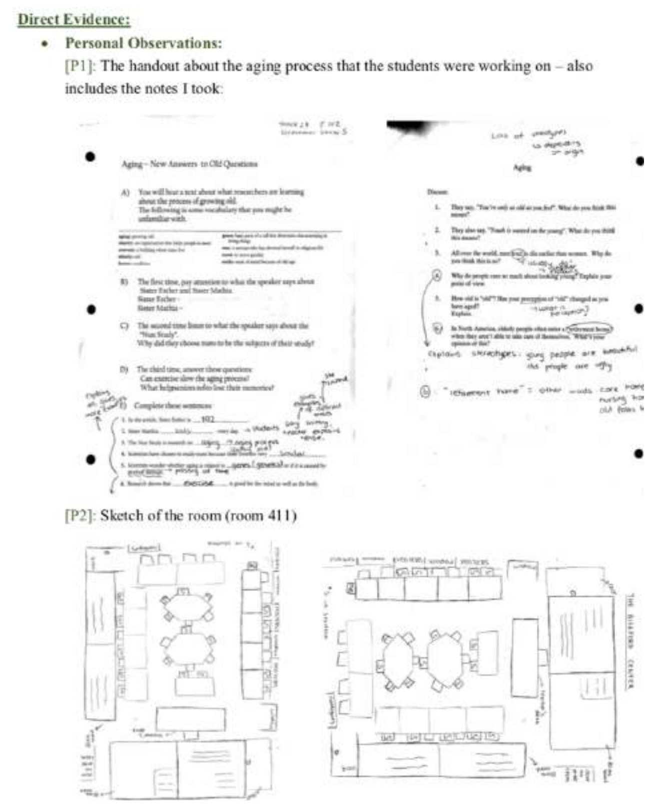
Fig 20: Evidence of Requirements Model

8) Field Notes

Field Notes are used for describing and documenting the engagement process with the community and include many records as well as evidence [3]. In order to make successful field notes, it is important to gain proper background understanding before visiting a community. Also, one should spend considerable time on location while capturing important elements and writing observations down.

Example: for the Field Notes assignment in Praxis II, I visited the Bickford Centre to engage with the community. Some of the direct observations that I wrote down can be seen in Figure 21.

- Assessment of Utility: This tool is high in utility as it allows the researchers to make valid claims regarding the community based on on-the-spot observations.
- Assessment of Fit: After the Field Notes assignment, my team and I shared individual notes with each other. Reading their notes helped me get a better understanding of the communities that they worked with, and I was able to see whether my own values aligned well with those of the communities. This was an important tool for me which helped me write our team's RFP.


Direct Evidence:

- Personal Observations:

[P1]: The handout about the aging process that the students were working on – also includes the notes I took:

[P2]: Sketch of the room (room 411)

Fig 21: Evidence of Field Notes

9) Risk Management

Risk Management is important as uncertainties will always be present in all projects and designs, therefore, it is vital to minimize risks. To treat potential risks, one could: modify the likelihood of the risk, avoid the risk by not pursuing the activity, completely remove the source of the risk, transfer the risk, or retain the risk [3].

Example: While my team and I were creating an obstacle-avoiding robot, we tried to manage the risk by modifying the likelihood of it appearing. To do that, we attached pointy objects at the front part of the robot, as seen in Figure 14.

- Assessment of Utility: Risk Management is a crucial component of any project because, as previously mentioned, they are all exposed to a certain degree of it. Therefore, it should be every team's or individual's concern to treat risk at an early stage of design. Thus, Risk Management is of high utility.
- Assessment of Fit: The values of this tool align well with my personal beliefs. I am convinced that treating risk at an early stage is a big factor of whether or not the project ends up being successful. That is why, I approach Risk Management seriously in any task or project.

10) Random Input

Random Input is a divergence tool for generating ideas. To use it, a random noun is selected from a dictionary or a random word generator. Then, the noun is used as a starting point for brainstorming.

Example: When my team and I (W23) were trying to generate ideas for Beta (Praxis II), we conducted the use of Random Input. The generated words had absolutely nothing to do with how we wanted to approach the problem. We tried to find nouns that could help us come up with design concepts for the assembly, but instead we received words such as Barometer, Chauvinist, Steward.

- Assessment of Utility: This tool ranks low in utility due to its high dependence on random variables, which more often than not tend to offer no help or guideline in the project.
- Assessment of Fit: I would not use this method as it only made my team and I lose time on unrelated concepts. I believe there has to be a lot of luck involved to generate any successful ideas using this method, which is not the way I prefer to solve things.

Summary: Design Tools, Frameworks, Models and When to Use Them

Tools	When, Where, Why to Use It
CRAAP Test	Use when researching to evaluate the quality of a source.
Verification & Validation	Verify when creating a design (part 3 of my personal design process) to make sure the features of the design do not violate constraints and meet all metrics. Validate with stakeholders after building a simple prototype to ensure it meets their needs.
Classical Brainstorming	Use classical brainstorming individually to generate as many ideas as possible during the diverging step of a design process.
Pairwise Comparison	Use pairwise comparison with a team as it is more effective than using it individually, to converge on one idea.
Ratings Matrix	Use this tool after designing a concept, but before prototyping and validating with the stakeholders. Ratings matrix could be a good tool for verifying a design against metrics and comparing the concept to other designs.
Field Notes	Use when you want to engage with a community, to better understand their values and determine if they align with your goals and values.
Posters	Posters are good for representing an idea or design but try not to use more than one poster per presentation, as it might distract the audience.
Requirements Model	This is a big part of my personal design process and must be used whenever when creating a design after framing the opportunity.
Risk Management	Risk management is important for spotting potential risks that might turn into bigger ones later on. To prevent this from happening, try to reduce or modify the risk at early stages of the design process.
Random Input for Diverging	Never use this tool, unless you want to generate completely irrelevant ideas or have extra time to play with your designs.

Conclusion

In this handbook, I aimed to document the best representatives of my design concepts, as well as my personal design process, the tools, frameworks and models I prefer to use. I also illustrated the connection between sections with my values and goals, which are outlined in the introduction section. This handbook is a good representative of my work and I plan to look back at it throughout my whole university and professional life.

Source Extracts

[1] Definition of Usability
"What is Usability?," The Interaction Design Foundation. [Online]. Available: https://www.interaction-design.org/literature/topics/usability.

What is Usability?

Usability is part of the broader term "user experience" and refers to the ease of access and/or use o a product or website. A design is not usable or unusable *per se*; its features, together with the context of the user (what the user wants to do with it and the user's environment), determine its level of usability.

The official ISO 9241-11 definition of usability is: "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use."

A usable interface has three main outcomes:

1. It should be **easy for the user to become familiar with and competent in** using the user interface during the *first* contact with the website. For example, if a travel agent's website is a well-designed one, the user should be able to move through the sequence of actions to book a ticket *quickly*.
2. It should be **easy for users to achieve their objective** through using the website. If a user has the goal of booking a flight, a good design will guide him/her through the *easiest* process to purchase that ticket.
3. It should be **easy to recall the user interface and how to use it on subsequent visits**. So, a good design on the travel agent's site means the user should *learn* from the first time and book a second ticket *just as easily*.

[2] J. Foster, R. Irish, “Build + Test Assignment, Praxis 2”, Toronto, 2018-2019
[3 J. Foster, R. Irish, “Praxis 1 & Praxis 2”, Toronto, 2018-2019