ENGINEERING PORTFOLIO & ENGINEERING HANDBOOK

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INTRODUCTION: PORTFOLIO + HANDBOOK

This document is intended to be included **two different components** in the one document.

1. **Engineering Portfolio**
2. **Engineering Handbook**

Even though portfolio and handbook are **sharing high-level objectives**, the first part of this document will do a job for the Engineering Portfolio, and the second part of this document will do a job for the Engineering Handbook due to fulfill different purposes.

Purpose of Engineering Portfolio

1. Demonstrates summarized description of products of design work done by the author, Jaehah Shin, during first year Engineering Science.
2. Demonstrates author's positionality as an engineering student, and his definition of engineering design gained from experiences.

Purpose of Handbook

1. Explain each tool or model about when to use, the benefits of using, and why the author, Jaehah Shin, uses these to strengthen his weakness.
2. Remind what author had used tools, and limitation and strength of tools for the future uses.

What Reader Can Gain from This Document?

This document contains plenty of information about the Author's life story in positionality section, since the author values the most on experiences of his life that has changed his values, thoughts, engineering, and engineering design. Each section will also contain how that positionality has affected author's engineering design processes and engineering design products. Even though positionality section is a bit long, those will provide what engineer the author would like to be in the future, his initial thoughts, and current thoughts on the engineering design during the first year. Reader can also gain engineering design activities that author participated.

Potential Bias

As this is written by the author himself, there can be an argument from personal incredulity through the positionality. However, as those bias are also part of the author that are influenced by experiences that author gained through life, this potential bias will also be great indication for people to understand author's thoughts and insights.

How to Read?

Since positionality has a significant role in this author's document, positionality will be placed before introducing two components: Engineering Portfolio, Engineering Handbook. Even though Engineering Portfolio and Engineering Handbook is separated completely, they will share the positionality.

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POSITIONALITY

[ORIGIN OF MY NAME]

My name is Jaehah Shin. My name has three components in Korean. Shin is from my dad’s last name, and hah is my Mom's last name. Jae is from the common syllable in the names of family members. My parents put their last names to my name because they think family unity is the most significant aspect of life. Furthermore, when I translate my name into Korean, my name has the meaning of the presence of God.

[RELIGION, INITIAL THOUGHT ON ENGINEERING AND ENGINEERING DESIGN]

I am also Christian. My Mom is a pastor. I was growing up as a Christian and as a pastor's son. This provided me with slightly different aspects from others through several remarkable experiences. Not just the perspective of Christianity; I also gained unique experiences and values from that.

For instance, I had several opportunities to be a missionary as an elementary student with my parents. Figure 1 is when I collaborated on the performance with Nepal friends in the Church during the missionary. Since my parents and I couldn't speak those languages, my team used the performance for the missionary. Nepal and Indonesia were countries that I went to as a missionary.

Figure 1. Nepal Missionary

The first feeling I had when I walked on the street of those two countries was sadness. Most people on the street were suffering from starvation, illness, and hotness. Even though people had houses to sleep in, they also suffered from hunger and lack of clean water to drink.

I was shocked; that was the first turning point of my life.

My Dad was a material engineer and always taught me about the appropriate technology.

As figures 2 and 3 demonstrate, I was a person who was passionate about science and making stuff with my hands during childhood.

Figure 2. Making Rubber-Powered Airplane

Figure 3. Participating in Science Camp with Peers

Feeling and thoughts I gained from missionary, that was the first moment I thought about becoming an engineer who could help those people. Since then, I have become more interested in the appropriate technology.

At that point, the definition of an engineer was "a group of people who provides help to people in a tough situation," for me.

And the definition of “engineering design” for me was the process every engineer should encounter inevitably and carefully to succeed in their purpose without wasting time.

[KOREA → TORONTO := NEPAL?]

I was born and lived in South Korea for 15 years. Figure 4 is the life map I drew on Oct 27th, 2020, indicating significant events in my life. As figure 4 demonstrates, I moved to Canada in 2018. This was not planned at all, and my parents told me that in December 2017. There is a behind story in this within my family and my value.

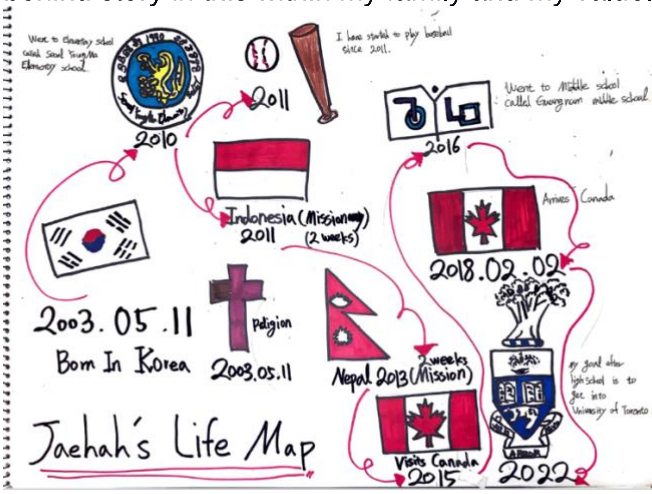


Figure 4. Life Map, which is drawn on Oct 27th, 2020

As I mentioned, my mom is a pastor. In December 2017, my mom was called by the Korean Church in Canada. My parents thought that was a part of God's plan. Therefore, my whole family member moved to Canada since Christianity and family unity is the most important aspects of my family and me.

Living in Canada for five years, I found another similar feeling I faced in Nepal Missionary. In Toronto and Vancouver, there are lots of homeless people on the street. Specifically, during winter, I am always worried about them. The definition of my engineer has mostly stayed the same in the past. Therefore, I would like to help them with what I learned from engineering as a student engineer. My one of the future dreams after graduation is to work for those appropriate technology as an engineer so that more people can have smiles on their faces.

[RUMINATING…]

My habit of ruminating grew from my upbringing as reflecting on our days became a ritual with my family. This value is one of the essential values for differentiating me from other engineers.

My family would often delve into deep conversations about various topics such as scientific, political, relationships, and world issues. These discussions built the foundation for my inquiries about our world. Questions about the why, when, why, where, and how of the world often fill my mind as my burning eagerness to learn grows greater.

Learning through inquiry is of utmost importance, as it is through curiosity one has a reason to know. As Indira Gandhi perfectly puts it, "The power to question is the basis of human progress."

Why is the process of reflection and having inquiries so vital to me? The answer is simple: without the powerful tool of pondering and questioning, no learning can exist, and gaining wisdom through knowledge is where I find joy and happiness. Furthermore, engineers should improve by reflecting on past experiences. This is vital for engineering design.

[TUMOR AND ?]

This event also had affected me significantly when I was considering about my future dream after the graduation.

In grade 11, I discovered I had carried a tumor on my knee for ten years. And the value that I gained from my parents continued with this experience. Finding out that I had a tumor that could end my life was daunting. I was wondering the whole day, "why me?" I questioned this an infinite number of times, but each time my parents would always say, "It is a gift to make you stronger."

I had constant pessimistic thoughts of the endless unanswerable. However, once I accepted it with time, I grew curious about this tumor. Why did it form? Who tends to get this? How can it heal? Never-ending questions the doctors could not give me firm direct answers to, for some strange reason, got me even more curious in a compelling way. Turning my questions into statements I could understand gave me a sense of wisdom and comfort as I became more familiar with the source of my anger.

For English class, I decided to expand my knowledge in this area and did my inquiry project on my rare illness, the Plexiform Fibrohistiocytic Tumor. There was insufficient research since the tumor was still an uncommon, rare illness.

With the limited research available, I tried to connect the dots to understand the human body's mysteries. Learning that the size of my twelve-centimeter tumor was six times larger than the average of one to three centimeters instilled great fear in me. However, the knowledge I gained through in-depth research made me understand that this was a surgery that had to be done. This experience was the pivotal point where I fell in love with putting the puzzle pieces together. My passion for learning and trying to find answers to what seemed like the impossible ignited. This is what engineers should do in real life. I want to practice engineering design on the value I got from previous experiences, which is learning through inquiry. I will always remember the beneficial aspect of learning, as learning is endless.

[FUTURE DREAM + MY DEFINTION OF ENGINEER]

Like I made a difference in my life with research, I want to make a difference in other people's lives, too.

I want to make a positive change in the world so that everyone can live a better life. There was a mentor that I met in the past who told me that engineers are the people who should act as a bridge between technicians and scientists, and this is what I hope to achieve in the future. However, I dream of becoming not just that bridge but also the bridge that can ultimately improve each one's life. More specifically, I want to be an appropriate technology engineer who can do engineering design flawlessly. I want to be an engineer who can provide smiles to suffering people.

Figure 5 is the quote I wrote in Gr.12 for my capstone project, which is also my family motto. "Study hard to help other people." I aim to become an engineer who helps others, which is why I am studying. And that is my definition of an engineer, and that is the engineer I aim for.

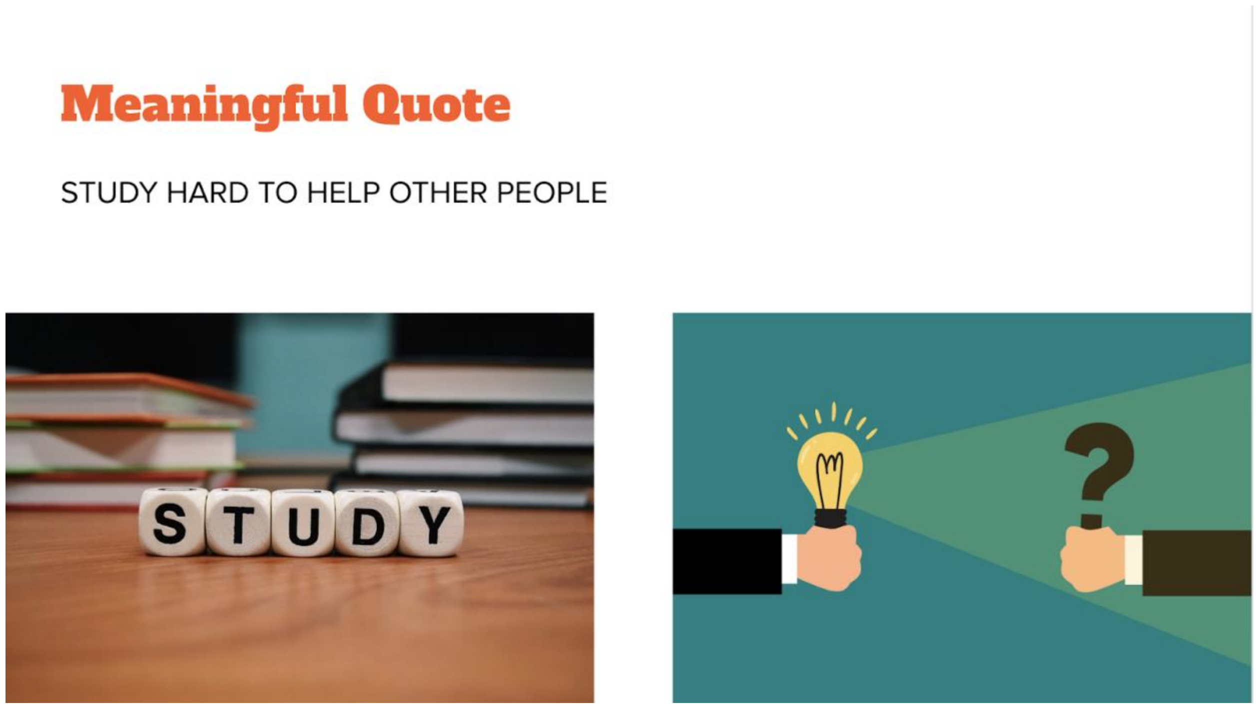


Figure 5. From Grade 12 Capstone Project

[SUMMER PLAN TO GET CLOSER TO IDEAL ENGINEER IN MY DEFINITION]

Currently, I got a research position in the Lab with Professor Franklin, and I am working on the project how to modify the wearable devices for certain purposes.

As I did a project on this tumor in Gr.12, I noticed the limitation of diagnosis about rare tumors since there is not enough data on it. Therefore, I started to have a great passion for how I can help people who have similar experiences to me.

My ultimate future goal is to develop wearable medical devices which can be operated by normal people easily and can diagnose tumors without doing a biopsy. This will lead to faster and more appropriate action that should be done to patients. Also, even after surgery, patients can monitor themselves with a device if the tumor has recurred, and this will reduce the time and cost it takes.

I believe that learning through inquiry is what I find to be of utmost importance, as it is through curiosity one has a reason to learn. Through this research, I think I will be able to establish a great foundation for achieving my goal in the future since I will learn how wearable devices work and how I can modify them for specific purposes.

Website of Lab: https://franklinresearch.ca/
My research Proposal:
https://drive.google.com/file/d/13dwXxZvcNCTNIgtXNyfM49xmeF6wzfKb/view?usp=sharing

Currently, that definition of engineering for me has not changed a lot. I still dream of becoming not just the bridge between people but also the bridge that can ultimately improve each one's life. Also, I still think the engineering design process is the indication that if the design is going to the right path or going to the wrong path to whoever is doing the design in engineering.

There are two future dreams that I would like to accomplish as a engineer after the graduation.

First, I want to be an appropriate technology engineer so that I can improve one's life who are going through suffers in their life because of lack of "basisbehoeften."(Basic Needs)

Second, I would love to become an engineer who can resolve the conflicts that I had encountered during and after getting a surgery of the tumor.

This positionality, portfolio, and handbook will be updated as participating to more engineering design activities in the future.

ENGINEERING PORTFOLIO

In Engineering Portfolio, author will introduce the summary of engineering products that author had worked on during first year engineering science, and how the author's position has affected on those design process throughout the document. Introduction and positionality section can be referred if needed, since they also describe the author's value and biases towards the engineering and engineering design. Following values and biases are applied to the teamwork project.

1. Author's value:
   - In the teamwork, author values the exertion and the distribution from the team.
     - ➔ As every single person has the weakness, it doesn't matter if individual is not good at something. As a team, that can be resolved. Therefore, exertion from every single teammate is the necessary for teamwork.
     - ➔ In author's case, the author's weakness is the personality which is introvert. Therefore, the author tries to have more conversation with teammates during free time so that author can overcome it.
   - In the teamwork, author values the communication between team.
     - ➔ Lack of communication will result in disbelief each other, since people can't expect the other person to understand what they think without telling them what they think.

2. Author's Biases:
   - As the author is also individual that possibly not be in someone's shoes, the author might have different perspective from other teammates.
   - As the author is still learning and improving in engineering design process, therefore, some of aspect or engineering products that author has done might be off from what real engineering design is. However, this is also the process of improving as a student engineer to the ideal engineer that I had introduced in previous section. Therefore, as more engineering design that author will involve in the future and depends on how much author participates into those process, author will become the ideal engineer in the future.

PERSONAL ENGINEERING DESIGN PRODUCTS + ROLE OF POSITIONALITY

CIV 102 BRIDGE DESIGN AND CONSTRUCTION

I have experience doing engineering design in CIV 102. I worked with Seoyun Yang, and Ria Borger. My teammates and I made a bridge that includes engineering design's fundamental and indispensable factors that can survive from the train that is going on the bridge which is 400N.

First step of the designing the bridge was doing the hand calculation for design 0 which is given by instructor. By doing the hand calculation of this, first we were able to learn at which part the bridge is going to fail, second, therefore, we were able to learn what part we should concentrate to make bridge is not failing. Following figure represents the hand calculation for design 0. [Appendix A]

After calculating for design 0, I used Python and MATLAB to plot some graph, and calculate if the design is going to fail or not iteratively until the calculation indicates that the design is going to survive. Total five components were considered during the iteration decision: heigh of bridge, number of layers and bottom flanges, addition of diaphragms, the weakest part of bridge from design 0, and the placement of diaphragms. Those five components are also from another value which is ruminating. To find out the ultimate and better solution I kept researching during those iteratios. All the following calculation and diagrams are performed by Python and MATLAB. Cross sectional area of design 0 and our final design is modified by those five components. [Appendix B]

However, unfortunately, the bridge failed before the expected range.
After failing the bridge, I have reviewed why the bridge had failed.

1. The bridge construction was done rapidly than should be since author and one of other teammate had covid-19 during the construction. Therefore, the time management was the key problem here. Author and teammates should've done time managing more rigorously.
2. This is related to values that author thinks important which are communication and exertion from the teammates. As my team couldn't establish a great communication from each other, it results into the not equally distribution of working hours. If everyone in the team could contribute equally, the bridge would be better current design.

There are things that author also learned from this experience that author think it would be better if author did it during the design process. Making a prototype and doing a small experiment with calculations. This would give my team some perspective we couldn't point out from just calculations. engineering design, all people should remember that rushing doesn't help anything. Having the stage of inquiring and more time to deep into the problem profoundly during engineering design will result in better products in terms of functionality and aesthetic. Practicing engineering design and the process of iteration will guide me through the development as a student engineer, and limitless practicing will guide me to become an engineer who can provide proper needed base products for people.

I will specifically focus on doing iteration during the engineering design since that will result in more failure, which I can learn from.

ESC 101: IMPROVING WINTER-TIME SAFETY AND CLEANLINESS WITH B-RUSH

This is the first engineering design course which is praxis 1 which was about resolving the splartz that is related with University of Toronto. The definition of splartz is “a minor annoyance something not quite right, something that could be better, something most people just live with, and focused on UofT community.” [1] Tanvi Manku, Anna Chen, Quinn Skoretz was my teammate.

The splartz that my team focused was a “Improving Winter – Time safety and cleanliness of University of Buildings”. The purpose of design was to reduce the wetness and dirtiness of the floors of the University of Toronto. Therefore, my team came with several designs on it, and the final design that my team came up with was B Rush.

During the engineering design, my team did the survey to people who work, or attends University of Toronto, about their experiences during the winter to get useful data. [Appendix C]

As the following slide indicates, the notable features is there are multi-material brush and water spray, therefore, the people can just walk through this design which is placed at the entrance. This design will help people who cleans the building, the instructor, and students who goes to UofT during the winter time whenever they enter the building.

Figure 12. B Rush [Drawing Credit to Tanvi Manku]

Figure 13. Physical Prototype of B Rush [Prototype Credit to all of my teammates(including author)]

During this design activity, this is my first time learning how to overcome the introvert within the team. Before this project, every environment was new for me, and Toronto was new for me as well, therefore, I had suffering to communicate in the team at the first time. Therefore, I tried to keep talking more to my teammate during the meeting, and I finished all of jobs that I had. At the end of the semester, I felt comfortable sharing my ideas with my teammates, and I learned how the communication affects my team. This was the design activity that I learned the importance of the communication and distribution and as well as how I can overcome my internal conflict which is hesitance to share my ideas to my teammates due to nervousness.

ESC 102: IMPROVING WATER SAMPLING FROM ONTARIO LAKE

This is the second engineering design course which is praxis 2. My teammate were Nasrudeen Oladimeji, Ian Wu, and Haoyan Zheng. In this design course, my team and I contacted to community, and have a conversation with them to improve their life experiences.

Our design opportunity was to help improving water sampling from Ontario Lake, and more specifically, it was Design a tool for collecting a sample from water outside of arm's reach for Swim Drink Fish (a community water testing organization). The community we worked with was "swim drink fish", and as the logo also indicates [Appendix D], their primary focus is to make people be more familiar with the water while collecting the water sample.

The framing of this designing activity was difficult since this was needed to be re-framed few times due to difficult of understanding community's needs. However, after having few times meeting with community, and going into the community place to experience what is community doing, my team and I finally can decide what the opportunity is.

Their current problem was when they couldn't go into the water to collect sample since that is too dangerous, they use the pole which is long. As they are transporting with the bike, or transit system, this pole is impossible to carry around. Also, the head of the pole is not more produced, therefore, they need a new pole in case they lost it.

Figure 15. Author holding the current pole

Therefore, my team divided the functional interfaces [Appendix E] of design so that we can diverge and converge on each stage then connect each of design idea at the end.
The functional interface was divided into Extend Reach, 30cm depth below surface of the water, and the holding the sampling bag.

After connecting all the ideas, then we got the final design which contains rope and rope console for extend reach, and rope and the marker to indicate the 30cm for 30cm, and the twist cup for the water sampling.

During this design process, I once again noticed the importance of the communication and exertion from the teammates. As the final stage of this design activity was a showcase which represent our design to the other people, this is significant to attend all the meetings, or at least know what is going on with our design. However, as two of my teammates didn't show up while preparing for the showcase, therefore, they couldn't prepare for the showcase well. From this I learned that I need to learn the better way to communicate with my teammates since when they just don't reply to the message or don't show up to the meeting, then there is no way to contact them and no way to let them know what is happening during the team meeting.

This would be better to upload a summary of meeting for them could help them catch up when they don't show up without any notice. I will try that one so that I can keep communicating with them.

ENGINEERING HANDBOOK

BEFORE START

All the design process are done in Praxis 2 is done by me and my teammates: Nasrudeen Oladimeji, Ian Wu, and Haoyan Zheng

All the design process are done in Praixs 1 is done by me and my teammates: Tanvi Manku, Anna Chen, Quinn Skoretz

PERSONAL ENGINEERING DESIGN PROCESS

Before starting with the specific step of engineering design process, there is the most significant aspect during the engineering design process.

1. There are no “more important steps” during the engineering design process.
   - Why?

     Since if one of the steps is weighted less than the other steps, then this will affect the final design of the product. This will be described more profoundly in each section of the engineering design process.

2. Even though one of the steps already finished, if needed, then that step should be done again.
   - Why?

     Before having a final design, this is significant that design need to improve and develop regarding to the purpose. As this is common during the design process that some aspect is misunderstood, therefore, this is important to keep in mind that some of steps should be repeated.

Therefore, the process of the engineering design is all about moving back and forth while approaching to the final products of the design.

Essentially, there are four stages during the engineering design.

1. Frame
2. Diverge
3. Converge
4. Represent

Each of the step will be discussed profoundly in the following sections. The highlighted terms will be explained in a detailed manner throughout the document.

Then the specific tools and models used in the engineering design process will be introduced in the order of Framing, Diverging, Converging, and Representing, respectively.

FRAMING

- Stage to **define the direction** through the **opportunity** with **stakeholders,** and **requirements.**

DIVERGING

- **Generating as many as ideas** that are fit into **requirements** for the solution, using **tools**.

CONVERGING

- Deciding on **one recommendation**, using **tools.** Might **re-frame, re-fine, re-scope** or **re-diverge** sometimes if needed.

REPRESENT

- **Demonstrate the recommendation** who may have never heard of this project at all.

TOOLS, MODELS, AND FRAMEWORK

In this section, the author is going to describe the tools, models and frameworks that author used during the first-year engineering science. This will be introduced in the order of FDCR model which is Framing, Diverging, Converging and Representing.

The purpose of this is for author himself for the future references when author needs to use these tools, models, and framework later.

Therefore, this section will contain the brief explanations of each tools, the examples author has used before, and the limitation or helpful aspect that author found out during the design process.

FRAMEWORK

REQUIRMENTS MODEL

Requirements model contains following objectives:

- Stakeholders' values and needs.
- Objectives that explain what the role of design.
- Metric: Units of how this is used to measure for how well the design meets the objective.
- Criteria: Requirement that design should or must meet
- Constraint: Minimum Requirement that design should or must meet

Requirements Table for Praxis 1
Foundation for Objectives

Stakeholders	**DfX**	**Objective(s)**
UofT Students, Staff, Faculty, Visitors	***Safety*** Slippery floors pose injury hazards to stakeholders	Reduce the amount of water present on the floor
	Efficiency As seen in Section 2.2, no students polled were willing to spend more than 60 seconds cleaning and drying footwear.	Clean and dry shoes quickly
	Aesthetics Students remarked disliking dirty floors, as mentioned in Section 2.2.	Reduce dirt and debris on the floor
Maintenance Staff	***Maintenance and Effectiveness*** Reducing the amount of debris and water on the floor will consequently reduce the workload of maintenance staff in cleaning UofT facilities	Reduce the amount of water present on the floor Reduce dirt and debris on the floor
UofT	***Aesthetics***	Reduce dirt and debris on the floor

	Dirty floors can give an unkempt impression of the school and	
	Affordability Ensuring the solution falls within UofT's maintenance budget	Is cost-efficient to implement
Design Team	**Sustainability** The team must be intentional about designing to minimize negative environmental impact	Must not significantly impact the environment negatively

Requirements Table for Praxis 1
Engineering Requirements for the Solution

Objectives	Metrics	Gradient	Constraints
1. Reduce the amount of water present on the floor	The volume of water on the floors in m^2. (cm^3/m^2)	Less is preferred	Should be less than 40cm^3/m^2. Based on observation of water quantity that poses a large slipping hazard.
2. Is cost-efficient to implement	The money used in the design, manufacturing, and implementation of the solution ($ in CAD)	Less is preferred	Should be equal to or less than $20,000 CAD Based on 0.01% of UofT's maintenance budget for all three campuses [13].
3. Must not significantly impact the environment negatively	(1) *If* the solution *uses* water *and* electricity: • Energy consumed in kilowatt-hours per year (kWh/year) • Water used in gallons per use (2) *If* the solution *does not use* water *or* electricity: • Tonnes of carbon dioxide equivalents (tonnes CO_{2e}) emitted during the manufacturing,	Less is preferred	(1) Should meet the Energy Star standards for a compact dishwasher [14]: • Consumes 203 or less kWh per year • Uses 3.10 gallons or less of water per cycle and must pass the DOE test method defined in 10 CFR 430, Subpart B, Appendix C [14]

	implementation, and use of the solution [1]		Based on similarities of mechanisms between a dishwasher and an electrically-powered water-using machine (2) If solution is a one-time use: • Total should be less than 1 tonne per year Otherwise: • Total should be less than 0.5 tonnes to manufacture and implement, and less than 1.5 tonnes to use per year Based on a comparison of other sources of greenhouse gases [2].
4. Clean and dry shoes quickly	The total time to clean and dry shoes in seconds (s)	Less is preferred	Should be less than 19 seconds. Based on the survey [Appendix A].
5. Reduce dirt and debris on the floor	Debris on the floor (g/m^2)	Less is preferred	Should be less than 5 g/m^2. Based on personal experience regarding cleanliness concerning visible debris on the floor.

Requirements Table for Praxis 2

Objective	Metric	Criteria	Constraint
Reach			
Should be able to collect a sample from a distance	Maximum vertical sampling distance (ft)	More is better	Must be able to reach 12ft below
	Maximum horizontal sampling distance (ft)	More is better	N/A
Should require minimal force when lowering and lifting the device	Maximum force exerted in lifting or lowering (N)	Less is better	N/A
	Maximum bending moment in lifting or lowering (Nm)	Less is better	N/A
Must fit within a backpack	Maximum dimension does not exceed 30x25x42cm (average team member backpack size) (Yes/No)	Yes	Must be Yes
30cm			
Should be able to collect the water sample at the desired depth.	Divergence of sampling cup rim from 30 cm below surface (cm)	Less is better	Less than ± 15 cm
Sample			
Should be able to attach Whirl-Pak quickly	Time in seconds(s).	Quicker is better.	Should be less than 60 seconds.
Each component should be attached securely	Number of separate parts	Less is better	N/A
	Force to forcefully remove whirl-pak in pulling motion (N)	Less is better	At least 3N (300g*9.8N/kg)
Should be able to collect water sample without being contaminated	Number of sample parts that are reused across locations that contact the water sample	Less is better.	N/A
	Contact surface area of inside of Whirl-Pak and sampling device (cm^2)	Less is better.	N/A

OPPORTUNITY

Opportunity

Design a tool for collecting a sample from water outside of arm's reach for Swim Drink Fish (a community water testing organization).

Figure: Opportunity for Praxis 2

Right opportunity will help design team goes to the right path. However, if the opportunity doesn’t meet what the stakeholders’ needs, then the opportunity should be changed.

During the praxis 2, author and author’s teammate had a suffer to find out the right opportunity for the community which is Swim Drink Fish due to RFP authoring team had different ideas from the community. Therefore, my group was able to find the right opportunity by visiting the community, asking questions and participating into the volunteer.

EXISTING SOLUTIONS

Figure 18. Author holding the pole.

This is the existing pole and head that currently used by the Swim Drink Fish community. By visiting the community, we had chance to use the pole in the office. And then we found out that the head part is no longer produced.

4-3-5 BRAINWRITING

This is used as diverging tool during the praxis 1 and praxis 2.
Generally, this is great tool of diverging for the following reasons.

Benefit of Brainwriting:

➔ Helps think more creatively

As people don't interfere with each other while doing this activity, it eliminates the possibility of limiting their valuable ideas by listening to others. Often, whenever I listen to people's ideas during a discussion, I instantly focus on that idea and limit myself to that idea. I always have difficulty coming up with anything other than that idea. Therefore, that is the one thing I always would like to avoid. However, with this method, it benefits me to avoid being affected my idea by other people.

➔ **Great for people who are introvert**

I always hesitate before sharing my opinions in front of people, this activity helps me to share my ideas more without being stressed. With this method, since I don't have to talk out loud, this helps me to provide my ideas to my teammates especially during praxis 1 when I wasn't familiar with talking in front of people. This helps me to acknowledge why the providing the feedback to teammates is significant during praxis 1. Therefore, after using this method, now I always talk about my ideas to teammates without hesitating.

These are examples of brainwriting in praxis 1 and praxis 2.

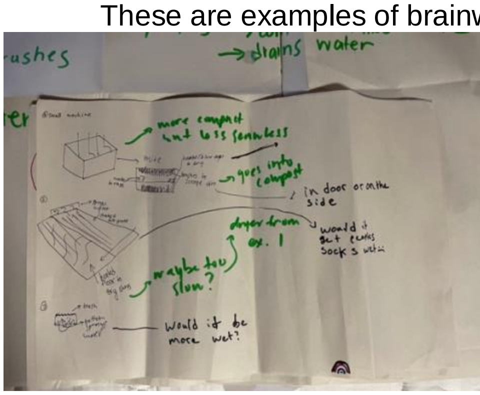


Figure 19. Brain Writing Praxis 1

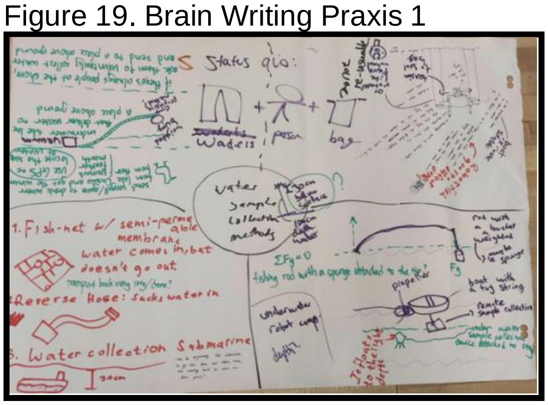


Figure 20. Brain Writing Praxis 2

MORPHOLOGICAL CHART

This is another diverging tool used in Praxis 2.
This morph chart was essentially helpful for the design process in Praxis 2. As my team divided the design in to three functional interfaces for the design, this chart help us to mix and match options for each. Also, in Praxis 2, the ultimate design was collected with three functional designs from interfaces, therefore, this chart gave us benefit of doing that process.

Following chart is the morph chart that is made during the Praxis 2.

Morph Chart

Functional Requirement	Examples
Horizontal Reach	fishing rod, pole,
Vertical Reach	fishing rod, pole, string
30cm submersion	same for all so far, 30cm longer vertical reach, weights on lightweight parts
Hold Water Sample	slip on and clip, magnetic clasp (now velcro lol)

Figure Morph Chart from Praxis 2

CHALLENGE ASSUMPTIONS

This is also diverging tool used during Praxis 2.

This is an "'assumptions' technique aims at overcoming your thinking habits" for thinking differently. There was a benefit during praxis 2 for my team.

Benefit of Challenging Assumptions:

➔ Avoid people thinking that they are right.

During Praxis 2, as my team and I wasn't understanding how RFP's opportunity well due to lack of information in the RFP. Therefore, my team did this to think about some questions that "what if.. this is wrong..?" technique so that we can ask to community during the meeting. As we prepared our questions through this, we found out that some of information from RFP is completely wrong, therefore, we could focus on the right opportunity that what the community really wants from us.

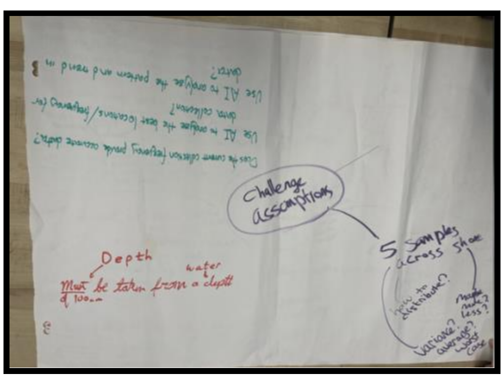


Figure 21. Challenge Assumption Praxis 2

LOTUS BLOSSOM

This is used as diverging tool in praxis 1.

Personally, I think the benefit of this is this can let us think outside of the box.
Concepts of this that we never considered before as "unfolding themes trigger new ideas and new themes." [3]

However, during Praxis 1, I also found out that there is a limitation of this tool.

Limitation of Lotus Blossom:

- ➔ Terms are repeated at the end.

During Praxis1, my team didn't use this tool in the early stage, but we used this tool later. Therefore, this ends up just repeating or some of random words that was not helpful for the team.

However, I think if we used this tool in the early stage, then it would definitely be helpful.
Next time, I will try earlier this tool during diverging.

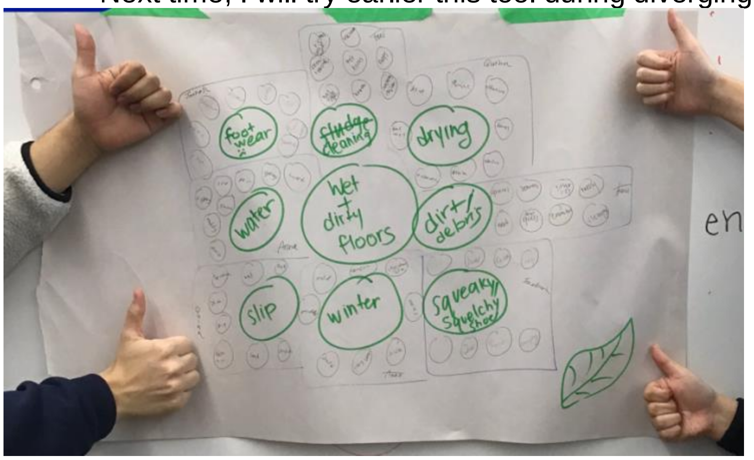


Figure 22. Lotus Blossom in Praxis 1

PAIRWISE COMPARISON

This is used as converging tool during the praxis 2.

This is where comparing two candidates(requirements) at the same time.[4] Comparing two candidates and then when one thing is more important then write down 1. Higher the total mark is more important.

As this is used in the Praxis 2 during ranking the importance of the requirements, I found out the benefit of this method.

Benefit of Pairwise Comparison:

- ➔ Focus on the importance requirement throughout designing.

This is one of things that I regret during praxis 2 since my team and I used this method later in the converging stage. If we used this one, this would be a great indication for us to tell where we are heading to during the design process.
Fortunately, our design also follows this rank of importance.
This will be better if we can use this design earlier stage rather than later.

Pairwise Comparison between Requirements for parxis 2

--	Vertical Distance	Horizontal Distance	Force to collect	Backpack	30cm	Whirl-Pak Time	Number of Part	Force Remove	Contamination	**Total**
Vertical Distance	--	1	1	1	1	1	1	1	0	**7**
Horizontal Distance	0	--	0	0	0	0	0	0	0	**0**
Force to collect	0	1	--	0	0	0	1	1	0	**3**
Backpack	0	1	1	--	0	1	1	1	0	**5**
30cm	0	1	1	1	--	1	1	1	0	**6**
Whirl-Pak Time	0	1	1	0	0	--	1	1	0	**4**

Number of Part	0	1	0	0	0	0	--	1	0	**2**
Force to remove	0	1	0	0	0	0	0	--	0	**1**
Contamination	1	1	1	1	1	1	1	1	--	**8**

Ranking:

1. Contamination
2. Vertical Distance
3. 30cm
4. Backpack
5. Whirl-Pak Time
6. Force
7. Number of Part
8. Force to remove
9. Horizontal Distance

MEASUREMENT MATRIX

This is used as converging tool during the praxis 2.

By using this chart, I found out that this is good when comparing the requirements with the measurement. [5] In our case, since we separated into three functional interfaces, this was beneficial to separate the measurement matrix into three parts, and compare right away, then choose the best one from each interface. Then those three best functional interfaces can be connected for the final design.

Measurement Matrix: Reach for praxis 2

Objective	**Metric**	**Foldable Pole**	**Rope**	**Fishing Rod**	**Current Solution**
Collect a sample from a distance	Maximum Vertical Sampling Distance (ft)	12	0	16 (Length of Rope)	10.5
	Maximum Horizontal Sampling Distance (ft)	12	16	12 (Length of Pole)	10.5
Minimal force when lowering and lifting the device	Maximum Force Exerted In Lifting or Lowering(N)	17.5	6	8	17.5

	Maximum moment In Lifting or Lowering (Nm)	16	0	?*	32
Fit within a backpack	Maximum Dimension < (30 x 25 x 42)cm^3	Yes	Yes	No	No

*fishing rod calculations neglected as this design was abandoned

Measurement Matrix: Sample for praxis 2

Objective	**Metric**	**Twist**	**Velcro Clasp**	**Elastic Band**	**Current Design**
Attaching Time	Time to attach Whirl-Pak to sampling cup (s)	9	23	11	40
Attachment Security	Number of Separate Parts	1	3	2	2
	Force to remove Whirl-Pak (N)	99	101	31	?
Avoid being Contaminated	Contact surface area of inside of Whirl-Pak (cm^2)	45	48	45	22
	Number of parts that will be reused	0	2	0	1

Measurement Matrix: 30cm for praxis 2

Objective	**Metric**	**Marker**	**Buoyancy**	**Current Solution**
Collect at 30cm	Divergence from 30cm (±)	7.5	?	15**

*Buoyancy is theoretically possible but was not experimentally tested

**Current solution is as good as the human operator, according to Stakeholder

REPRESENT

FINAL PROTOYPE

In Praxis 2, my team and I did the showcase to represent the final prototype of our designs.

First, we brought physical prototype of recommendation, and drawing, CAD models to show the candidate, and theoretical prototype which is a fluorocarbon rope to help people visualize what we made.

1. Physical Prototypes

Following figure is the final physical prototype of our design. As we tested at the Ontario Lake, this demonstrates our physical protype functions really well.
However, there is small space to be improved which is designing the rope console so that it is compatible with the fluorocarbon rope which will be described in number 3. Also, counterweight that this design has can be made more rigorously. (calculate for the counterweigh)

Figure 23. Final Physical prototype of the design

2. Drawing / CAD Models

During Praxis 2 showcase, the drawing of fishing rode was used since this can't be made as a physical prototype and we need show people to help them visualize easily.

There is a limitation of the drawing, since drawing can't be tested in real life, therefore, this can't be compared with the other solutions. However, as we already abandoned this idea due other reasons;(can't fit into the backpack), it was not necessary to be compared with the other solutions.

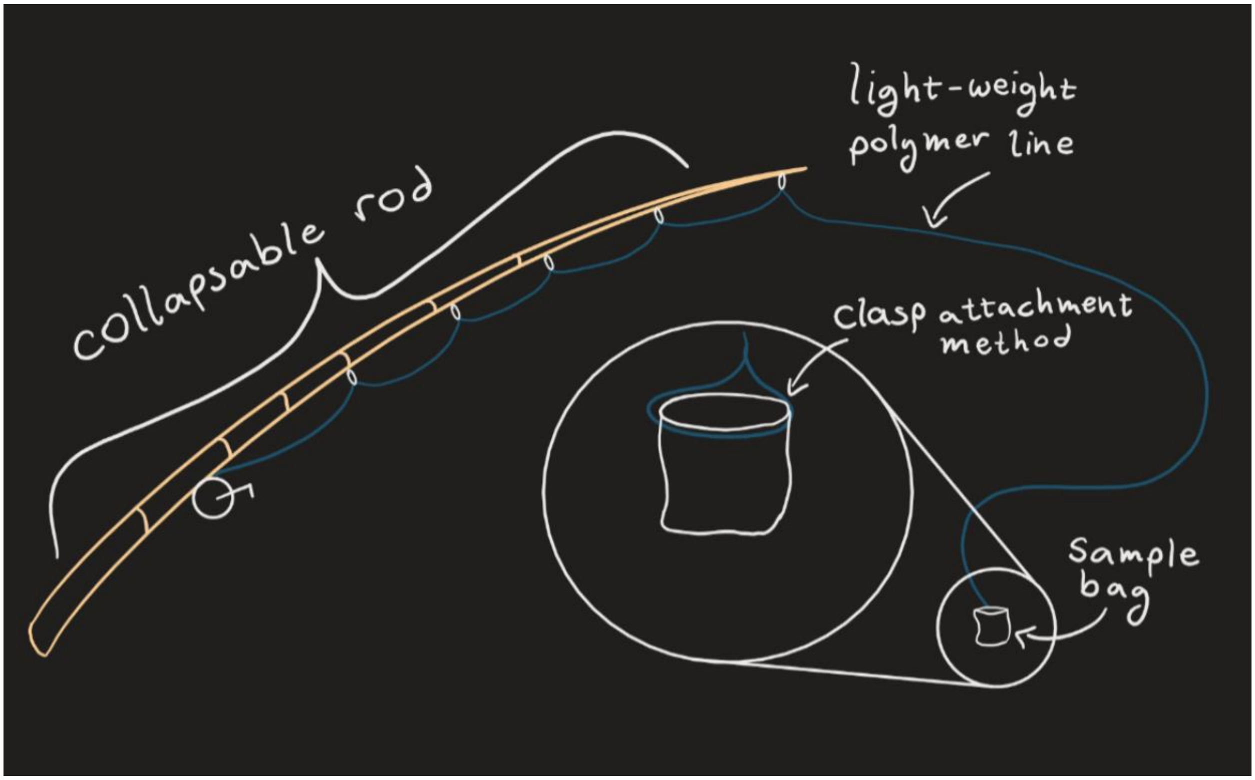


Figure 24. Fishing Rod

These are the CAD models that we made for 3-D printing, and this was really helpful for us for following reasons.

1. We could bring the 3-D printed candidate solutions to the showcase, so that people can see and feel how those candidates working.
2. For us, during the comparing and converging stage, 3-D printed cups are realistic, therefore, this was great for us to test these functions which are mentioned in the converge stage.

Figure 25. Twist Cup

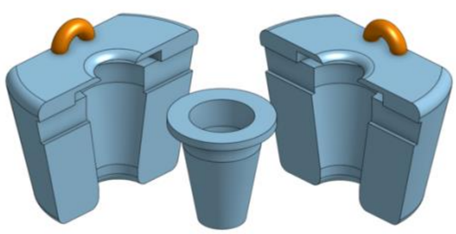


Figure 26. Velcro Clasp.

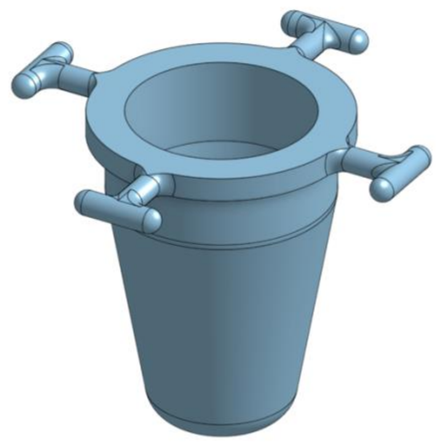


Figure 27. Elastic Cup

3. Theoretical Prototype

During the praxis 2 showcase, we also brought the fluorocarbon string that are our solution for the rope

By bringing this we could explain and why we need this specific spring for several reasons:

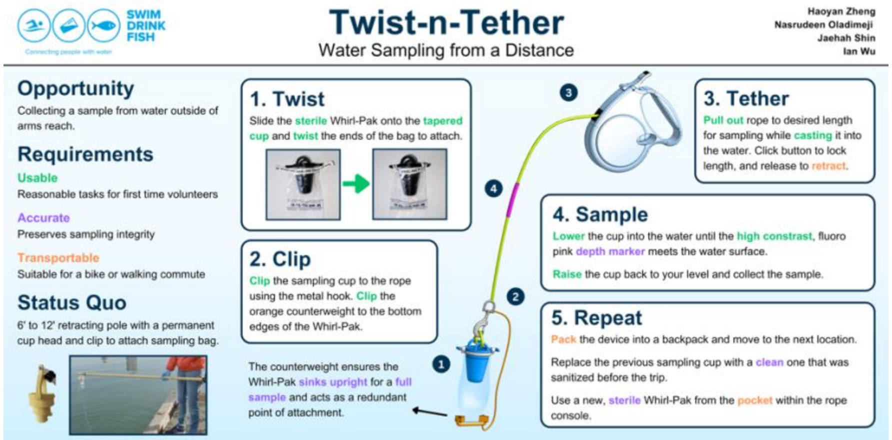
- ➔ Great at abrasion resistance
- ➔ Don't absorb the water

Figure 28. Fluorocarbon String

This part is connected to the prototyping part since I mentioned about what jobs prototype had during the praxis 2 showcases. There are two additional sources that we used during the showcase which are poster and one-pagers.

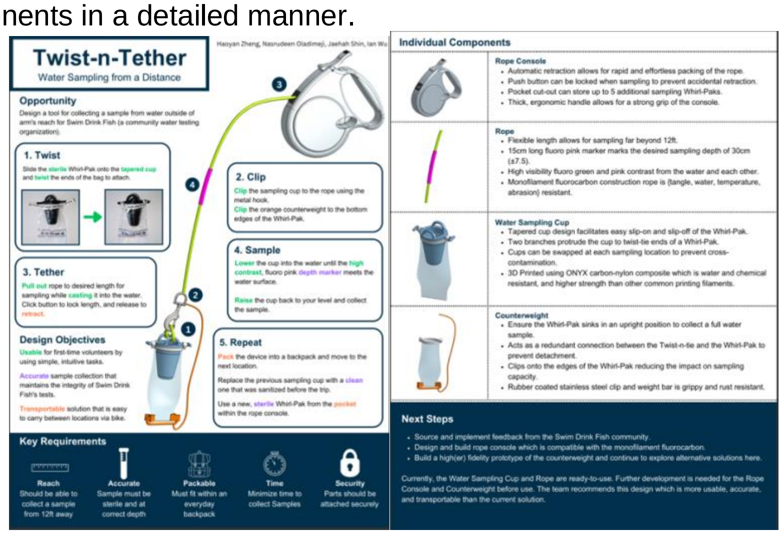
1. Poster

Poster that our team made is intended to grab the attention and easy to navigate without any additional explanations. Also, we use the three different colours to represent how requirements match with each step of operating our design so that audience can visualize more easily.



2. One pager

One pager is more specific than the poster. One pager is similar to the poster, but it shows the individual components of design with the key features, and it also has the next steps that will be conducted later. This helps people who are more interested in our design to read the spec of components in a detailed manner.



3. Showcase photos.

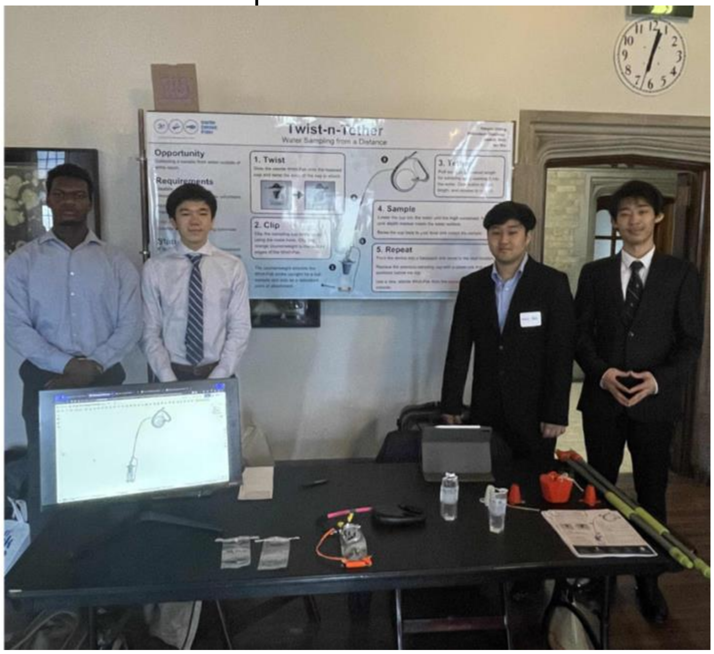


Figure 29: Nasrudeen Oladimeji, Ian Wu, Jaehah Shin, and Haoyan Zheng

Figure 30. Ian Wu is demonstrating water sampling with recommend design.

Appendix A:

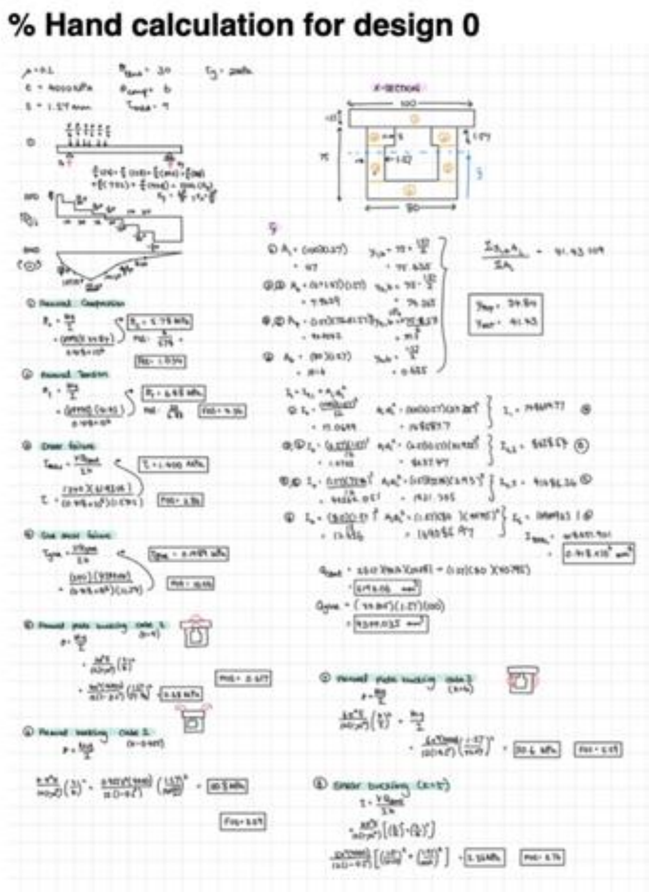


Figure 6. Hand Calculation for Design 0.
[Credit to Ria Borger]

Appendix B:

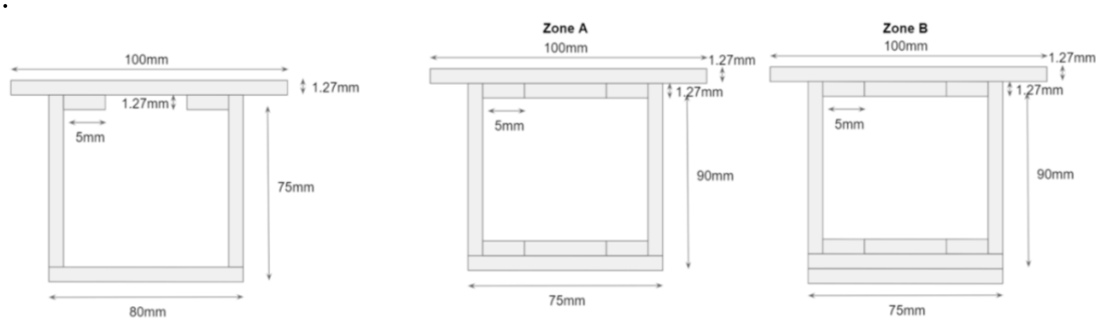


Figure 7. Design zero Cross Section vs Final Design Cross Section

Appendix C:

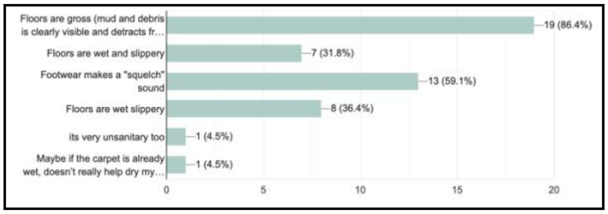


Figure 9. Distribution of complaints about campus during winter

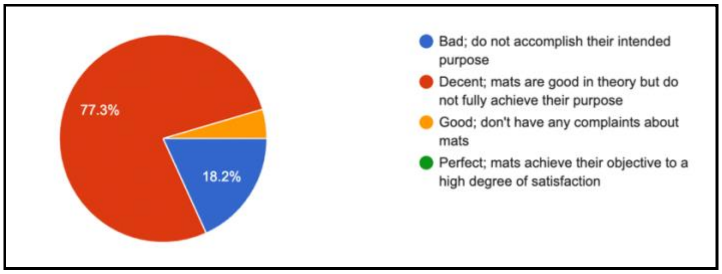


Figure 10. Distribution of opinions regarding current boot-drying methods

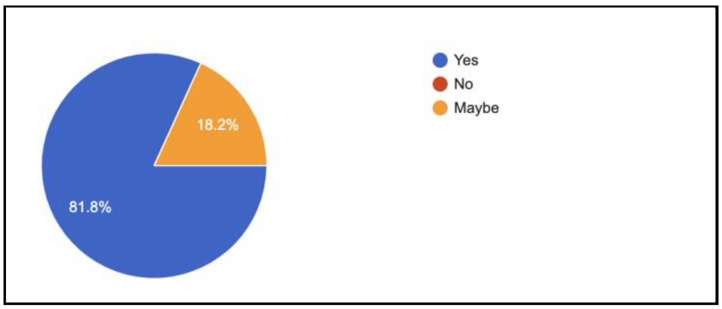


Figure 11. Distribution of responses to whether properly dried and cleaned footwear would improve campus experience in winter.

Appendix D:

SWIM DRINK FISH

Connecting people with water

Figure 14. Logo of Swim Drink Fish

Appendix E:

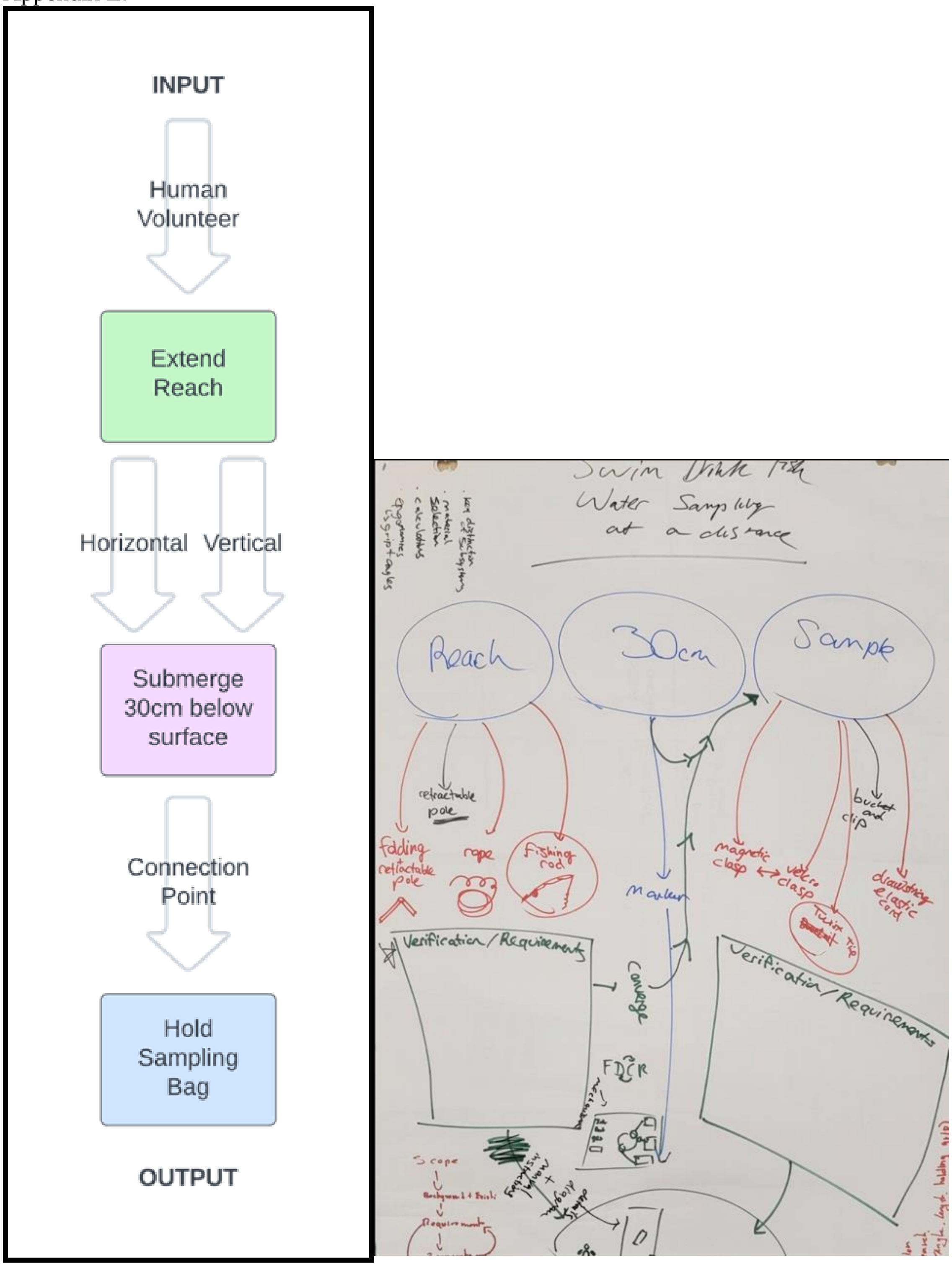
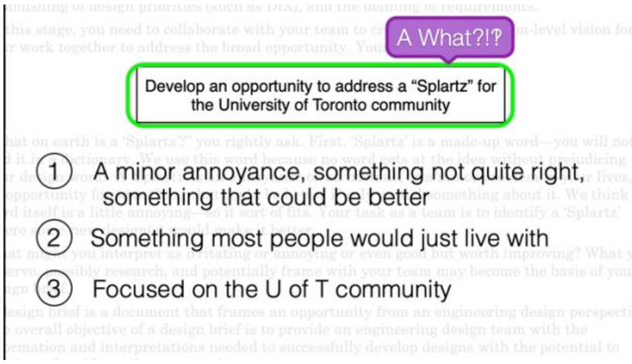


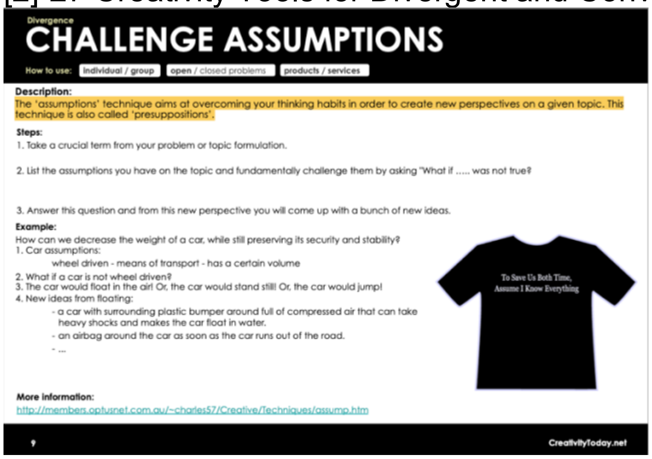
Figure 16. Functional Interface of Design

WORK CITED

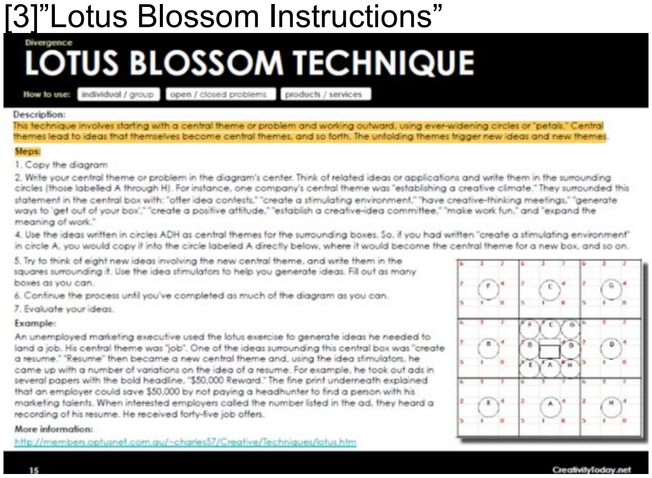
[1] “ESC 101 Lecture 11[slides]”. ESC 101H F LEC0101 20229: Praxis I (October 3, 2022)



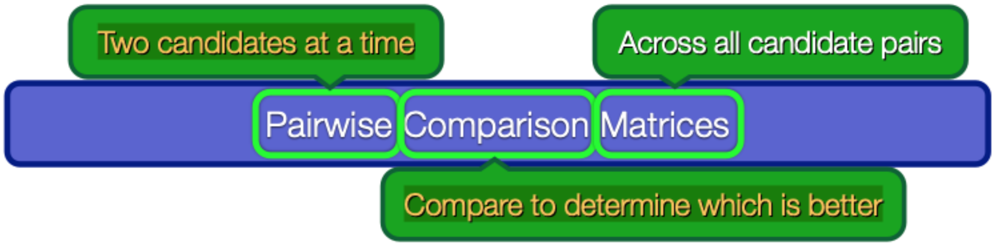
[2]”27 Creativity Tools for Divergent and Convergent Thinking”



[3]”Lotus Blossom Instructions”



[4] “ESC 101 Lecture 27[slides]”. ESC 101H F LEC0101 20229: Praxis I (week 9)



Elicit your biases towards your set of design concepts.
Codify them to better understand requirements.

[5] "ESC 101 Lecture 17[slides]". ESC 101H F LEC0101 20229: Praxis I (week 6)