2022 - 2023

ENGINEERING PORTFOLIO

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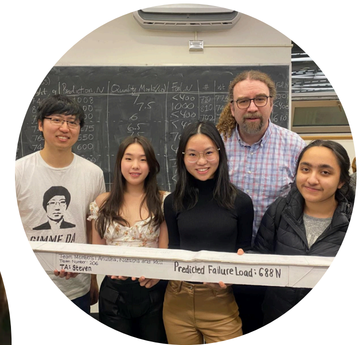
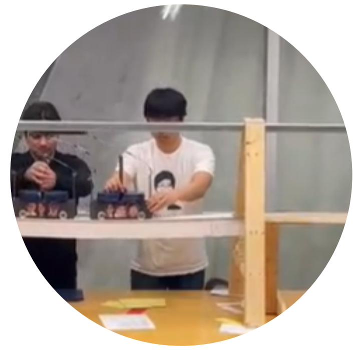
INTRODUCTION





Engineer in Action

This student design portfolio is intended to serve as a documentation of all engineering design products designed by the author, I, Anusha Fatima Alam, as a first-year undergraduate student at U of T pursuing engineering science.

<u>The key aspects covered in this engineering handbook include:</u>

- My positionality as a student engineer
- Praxis I Project
- Praxis II Project
- CIV102 Bridge Project

<u>Note from the Author:</u> Many experiences, design works and evidences documented in this handbook are a result of a collaborative effort of me and members of my team and therefore, as per the University of Toronto Code of Academic Behaviour and the Professional Engineers Ontario Code of Ethics, I would like to give credit to the teammates listed below:

- Zhinuo Chen, Michael Collins and Connor Wilson (for the Praxis I Project)
- Natasha Yang and Keli Chen (for the CIV102 Bridge Project)
- Alec Yu, Osiris Xiao and Simona Tenche (for the Praxis II Project)

POSITIONALITY

Although science does indeed amuse and fascinate us with new theories and discoveries, it is engineering that helps us materialize this knowledge to be of some function to change the world. I, Anusha Fatima Alam, as a budding engineering scientist and motivated learner, have developed values that have shaped my identity and defined my workspace as an engineer to materialize this scientific knowledge. In this section, I will be defining my values as a prospective engineer, how I perceive engineering, design and engineering design, and how I incorporate my values into my engineering workspace.

(a) My values beyond engineering...

Growing up as an international student in a culturally diverse environment, I have gained an appreciation for equity, inclusion, integrity, creativity, international mindedness, intellectual curiosity and leadership.

Leadership and intellectual curiosity are essential to motivate me to acquire new knowledge, take the lead to devise solutions and seize opportunities to improve systems and take action in engineering solutions. Equity and inclusion are vital for maintaining a positive mindset among us engineers from different backgrounds, ethnic groups and experiences working towards a common goal. Integrity is vital for us to take credit and pride for work that belongs to us and engineer original solutions. Last but not the least creativity is an asset that leads to the solution to problems and development of various design iterations. As a prospective engineer, I believe that these values in conjunction stimulate innovation and the willingness to ideate.

(b) Engineering...A process or an outcome?

In my perspective, engineering is an intricate process of finding solutions to real life problems. It's in its very essence the application of scientific knowledge. It exploits scientific research, mathematical models and empirical evidence to develop solutions that fit the constraints, requirements and serve the purpose/function/opportunity it was developed for. This engineering process has been simplified by models and frameworks to have a standard process for all engineers.

I believe that engineers usually tend to indulge themselves in the process of applying their technical knowledge into improving systems and finding solutions to real life problems and opportunities. A commonality that I have observed among all engineers is that their practice involves understanding the inadequacy of a system or phenomena and finding a feasible approach or solution to minimize the human effort.

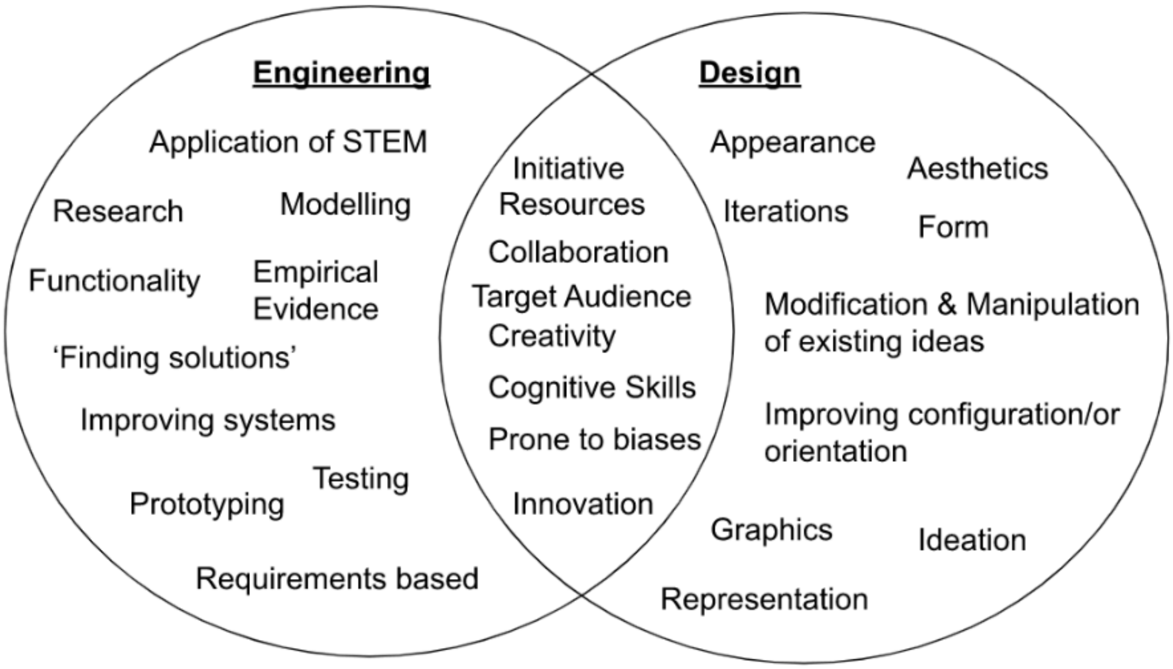
(c) What is Design?

In my perspective, design, simply put, is an iterative process of ideation and development of new ideas – one that is not constrained by feasibility, calculations, requirements or testing. Although feasibility, calculations and testing do not constrain the process of design, these can and are used to measure and assess design against each other. Design assimilates representation via various mediums and forms including but not limited to graphics, fine arts, prototyping and digital multimedia. I think this is because designs revolve on how products physically appear and attract the target audience. A design takes manipulation of form (either from shape, assembly, size or color of a product or commodity) to appeal to an audience visually or conform to market trends/norms.

(d) How about Engineering Design?

As opposed to engineering which is based on the premises of function, design is more form based and tends to revolve around aesthetic and appearances. Unlike engineering which acknowledges the feasibility of solutions (whether it is attainable with the given constraints and resources availability), requirements outlined and the scientific practicality.

Engineering design is a combination of both form and function. It tends to utilize benefits of both processes engineering and design to yield more radical results and outcomes. Mathematically, I would call engineering design a union of engineering and design (see figure 1).



<u>Figure 1</u> Venn Diagram Differentiating Engineering Vs. Design (Candidate)

POSITIONALITY

In my perspective engineering design materializes the design iterations to engineer solutions. It takes advantage of the iterative design process to accumulate diverse potential solutions which can then be assessed according to the requirements, feasibility and the DfX principles (to allow us engineers to make informed decisions and reliable recommendations). It is simply capitalizing the process of design thinking and engineering simultaneously to make the outcome appealing and functional.

(e) How do I incorporate my values in my workspace?

As a prospective engineer, I tend to indulge in many activities where I showcase my values (highlighted in the earlier section) from classroom projects to competitions. In these collaborative environments, I get to exploit integrity and intellectual curiosity. One such example of engineering design was the CIV Bridge project, wherein I was able to employ creativity, and integrity, to perform calculations, make an original design, build a bridge through an iterative process of design and test its success. More such projects (like Praxis I and Praxis II) will be explained in detail in the later sections.

Ultimately, using an asset of values like integrity, intellectual curiosity and inclusion has allowed me as an engineer to explore a vast range of tools and knowledge to bring practical ideas and potential solutions to my pool of design space and well informed decisions in the realm of engineering.

(f) Biases to acknowledge:

As a student engineer who upholds integrity, I would like to acknowledge a few biases before presenting my engineering work in this portfolio.

1. Firstly, I am still a budding engineer and I am still in the stage of learning concepts and honing my skills. Therefore I am still new to process of materializing knowledge given in class in order to shape my engineering workspace. As such, I accept that my understandings of the concepts may not be fully accurate and I may not have full expertise in utilizing the tools, models and frameworks as described in this handbook.
2. Additionally, another bias that is important to acknowledge is the fact that many activities and experiences in this handbook are done solely to meet the requirements for a graded course work. Therefore the motivation to present quality work in my workspace is to earn marks for projects like Praxis I & II, and the CIV Bridge Project. Although this may not seem important, I feel that it is essential for me to disclose my true motivations to the future readers.

Nevertheless I sincerely hope that my personal biases do not affect the content of this portfolio.

PRAXIS I (FALL 2022)

Praxis I was the first engineering design course where I along side with my team members worked on identifying an opportunity and solving this design opportunity with an engineering mindset.

Opporunity at Hand: Minimzing the disturbances cause by alarm clocks in shared spaces while minimizing the volume occupied, increasing affordability and effectiveness and not disrupting others in the shared environment

Recommended Solution: Temperature Mat

The temperature mat is comparatively the best solution because it is effective in waking up the user and impactless on decreasing sleep quality. Figure 1 shows a drawing of the device.

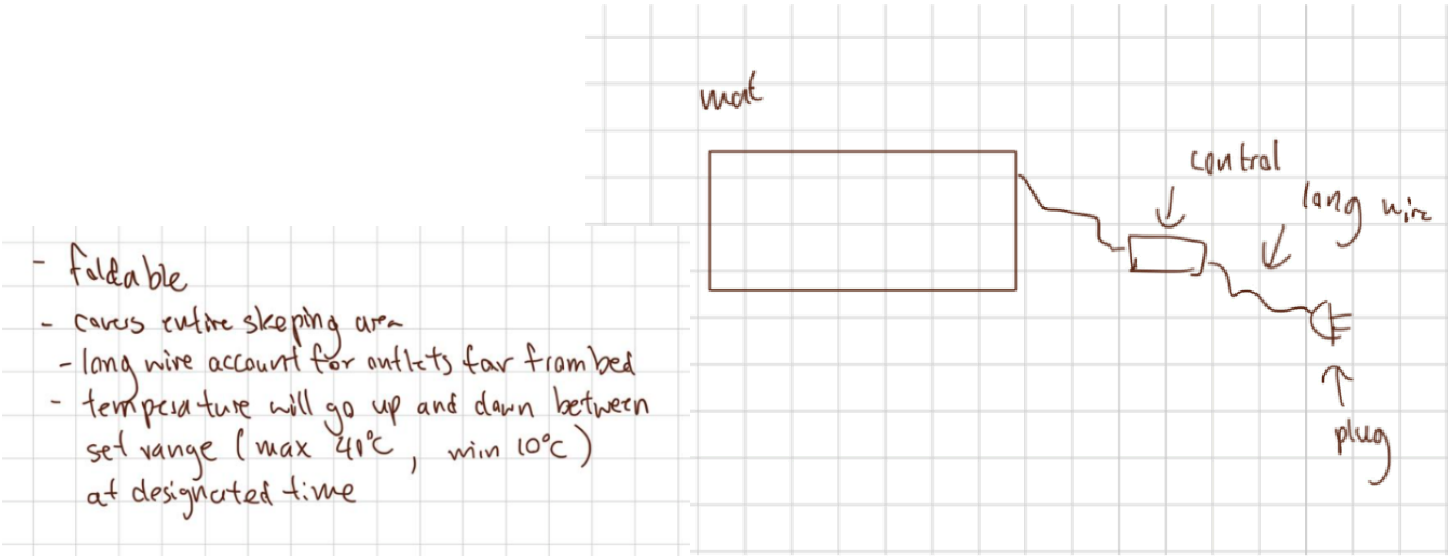


Figure 4: *Labeled Diagram of the Temperature Mat*

Three Primary Components

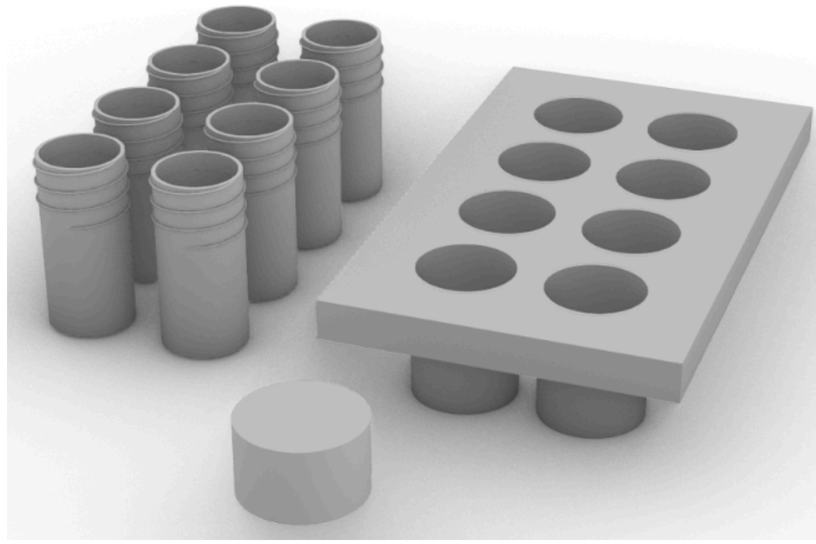
1. Double-bed-sized mat that can be placed underneath the bed-sheet
2. Thin heating and cooling elements integrated across the mat are capable of producing a temperature ranging 10-40 °C.
3. Wired-controller adjusts the alarm and wake-up temperature.

Reflection & Key Take Aways from this Project:

- **What went well?** Thorough justifications were made throughout the project for individual requirements and major design decisions.
- **What could be improved?** Develop a higher fidelty prototype for the temperature mat
- **Even Better if:** Check the credibility of sources (no CRAAP tests were done). Document more regularly why certain design were eliminated and show more evidence of converging.

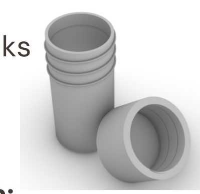
PRAXIS II (WINTER 2023)

Praxis II was a continuum to Praxis I where we as a team worked on solving an RFP designed by different design team.



Opportunity: The project's objective is to improve the sustainability of Swim Drink Fish's water sampling procedure by minimizing the amount of single-use plastic waste produced by their current apparatus.

Our recommended solution is an ice tray which is more sustainable then Swim Drink Fish's current sampling equipment: whirl packs (which are single-use plastic sampling containers).



Our design is a 3-Part Solution:

- **Pill Bottles:** A sampling container used for manually scooping the water from the testing location
- **Ice Tray:** A tray for holding x8 pill bottles to ease transportation and make it more accessible to hold and carry around.
- **Portable Microwave Sterilizer:** For sterilizing the pill bottles to minimize cross-contamination and maintain the accuracy of the sampling container

HOW IT MEETS THE OBJECTIVES?

Sustainable: Made from PLA (Biodegradable)
Benefits: Low carbon Footprint (80% lower than traditional plastics), compostable, made from renewable sources

Reusable and Durable:
Lasts 12 to 18 years at room temperature because of the material properties of PLA thermoplastic

Easy to clean:
Resources required to clean: Water, Portable Microwave Sterilizer, 1 staff member (can be cleaned in < 5 mins)

Allows for volunteer engagement:
Allows volunteers to engage in the sampling process by allowing them to manually scoop the water

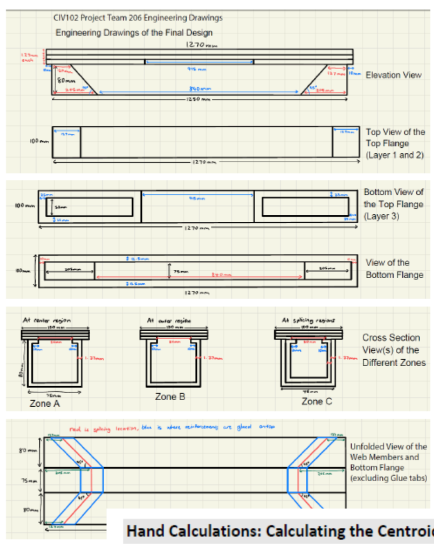
Reflection & Key Take Aways from this Project:

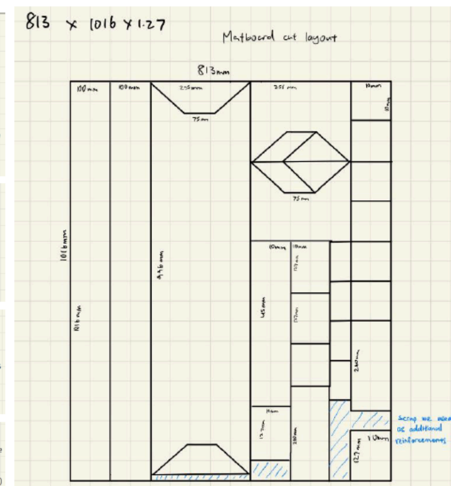
- **What went well?** Effective time-management and group collaboration (organized regular meetings and met internal group deadlines). The process was well-documented for showcase and had sufficient evidence for beta presentation.
- **What could be improved?** Have a more iterative design for the bottles and develop more high fidelty prototypes (especially for the steam sterilizer)
- **Even Better if:** Conduct more conclusive CRAAP tests that effectively evaluate the sources and find more convincing research to back up the verification and validation methods to test the requirements and uphold integrity

CIV102 BRIDGE PROJECT (FALL 2022)

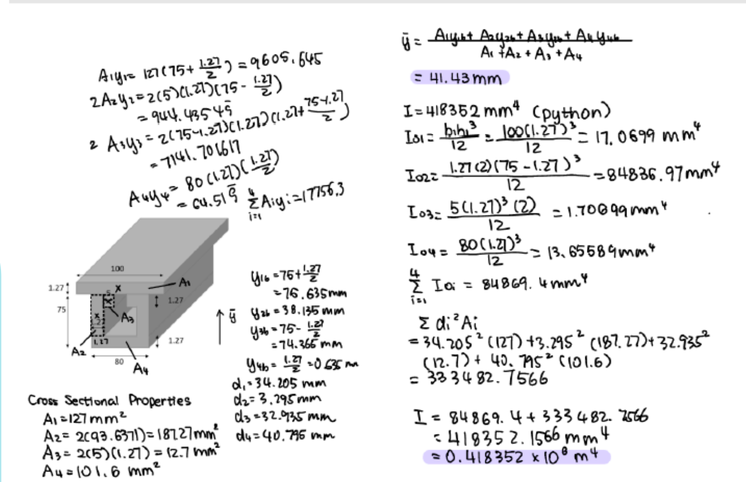
This was an non-engineering design course that incorporated engineering design while constructing and designing a Matboard bridge in the most optimum way to optimize the load and minimize the volume of matboard and contact cement used.

After assessing and analyzing the governing failures for a preliminary Design (Design 0), 3 different design iterations were considered to select the optimum design for the bridge construction. These design iterations were proposed by varying the geometric parameters and the cross-sectional properties while adhering to the material and feasibility constraints. FOS outputs from the python script for each design iterations are attached in the Eight different failing mechanisms were considered which include Matboard tension and compression, mid-flange, side-flange and web buckling, Matboard shear at the centroidal axis, at the webs and the glue shear. The optimum design was selected based on the highest factor of safety (FOS) across the eight failing mechanisms.





Hand Calculations: Calculating the Centroidal Axis and the Second Moment of Area:



Reflection & Key Take Aways from this Project:

- **What went well?** Group Effort, Team Work, A wide range of iterations and various different prototypes were developed, unique design iteration with diagonal splicing
- **What could be improved?** Improve the accuracy of the source code to calculate the failure load
- **Even Better if:** Improve the accuracy of the source code to calculate the failure load