ENGINEERING DESIGN PORTFOLIO

ESC 102, PRAXIS II

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PROFESSIONAL STATEMENT

My name is Yinghui (Vivien) Fan. I am an Engineering Science (EngSci) Student of University of Toronto. The first year of Engsci provides me a lot of opportunities to develop individual engineering design skills. As going through the first year, I have developed my own engineering design process, and fully understood that engineering design is a process of developing (by applying physics, chemistry, material science, psychology, computer science, etc.) an idea into a design which solves a specific problem.

In the first year of EngSci, CIV 102, ESC 101, ESC 102, CSC 180, and CSC 190 are the main five design courses. From these courses, I learned how to make a strong claim, how to understand, develop and approach a problem, how to do researches, how to think logically, how to assess a design… basically how to design a better design. Moreover, I learned how to work with a team. in the future, I will keep work on developing engineering design skills, especially on researching and material selection.

This portfolio illustrates my personal design process and along with that are my core design achievements in the first year of EngSci – CIV 102 Beam Bridge Design project, CIV 102 Truss Bridge Design project, ESC 101 Cycling Eye-wear Design project, ESC 101 Design of The Cutter project, ESC 101 Final Exam Design Challenge, ESC 102 Alleviating Shoulder Pain from Wheelchair Sports, ESC 102 Improving Sanitation of Street Food Carts.

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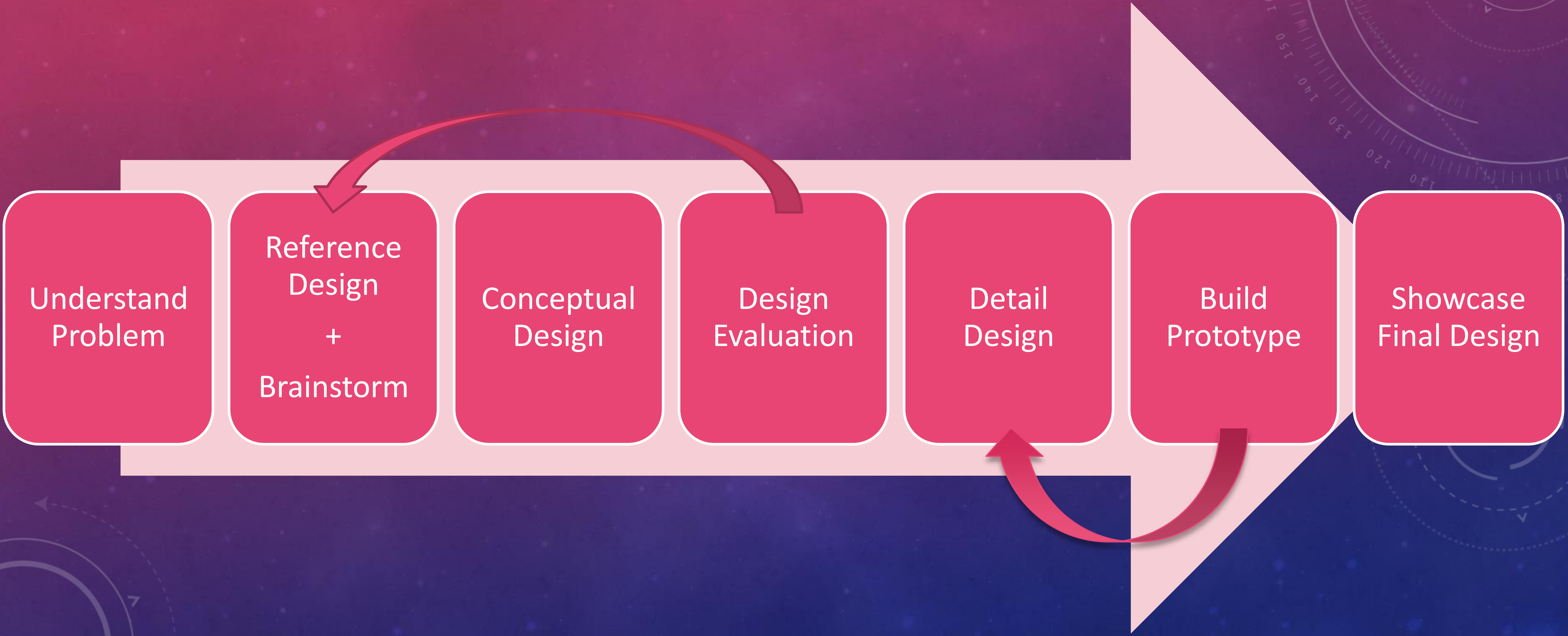
PERSONAL ENGINEERING DESIGN PROCESS



STEP 1: UNDERSTANDING THE PROBLEM

In order to come up with a qualified design, fully understandings on the given problem is extremely important. Understandings on the general background, the problem, stakeholders, objectives, constrains and criteria, etc., give me a very clear message on where to start and what to do next. Also, in this step, I would do further research on background information if needed.

ARTIFACT II – BEAM BRIDGE DESIGN

This was a team project I involved in CIV 102. The project required us to design and construct a strong model railway bridge using limited matboard. After fully understanding on the instruction of this project, my teammates and I researched on different types of beam (I-beam, π-beam, wide-flange beam, etc.), on what type of beams upper years made frequently, and on which type of beam is the strongest (by comparing their moment of inertia). After finishing analyzing all data we decided to go with a π-beam.

Group: Tom Zhang, Yuron Milwid, Yinghui Fan

ARTIFACT VI – ALLEVIATING SHOULDER PAIN FROM WHEELCHAIR SPORTS

In this Praxis II project, we were required to write a Request for Proposal (RFP) to improve quality of life of community in need in the area of Toronto. My praxis group chose wheelchair users who play sports casually as our focusing community.

Figure 1 is a screen shot of the final version of the RPF on the stakeholders section. I did researches on definitions of Quality of Life from many different point of views, then select and combine a new definition of quality of life for the purpose of this RFP. Then I researched on how wheelchair sports effect quality of lives of wheelchair users, and used my research to support my claim that wheelchair sports have positive influences on the quality of lives. Finally, I stated that shoulder pain has bad influence on quality of life by negatively influencing the factor of health. In this way, I proved the role wheelchair sports play in wheelchair users' lives and why solving the shoulder pain problem is important to wheelchair users.

Group: Cheng-yun Li, Lance Ye, Gavin Din, Yinghui fan

4.1 Wheelchair Users

Figure 5 indicates the importance of solving the problem of this RFP to wheelchair users. While playing team sports, wheelchair users build up supportive relationships with other wheelchair users [14], coaches and wheelchair associations, etc.[15]. Wheelchair sports help them to build up positive self-images by improving their performance and to restore activity of mind and self-confidence [16].

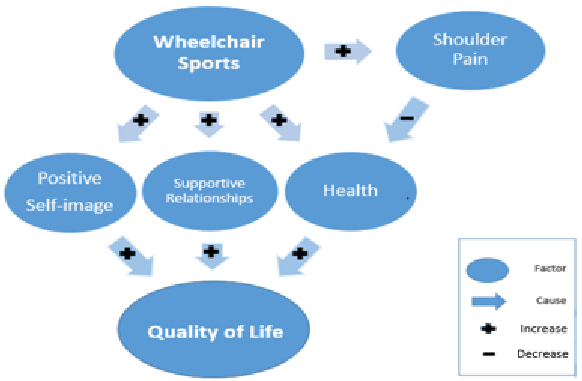


Figure 5 A diagram shows the relationships between various factors contributing to the quality of life.

Also, proper amount of sports help them to get and keep healthy [14].
All these three factors, supportive relationships, positive self-image and health, influence their quality of lives; improving these three factors would have a positive influence on wheelchair users quality of lives. However, shoulder pain from wheelchair sports has a negative effect on their quality of lives by having a negative effect on health. In conclusion, as the priority stakeholders, wheelchair users desire to enjoy the sports without concern.

Figure 1 – A paragraph in Stakeholders section from the RFP

ARTIFACT VII – IMPROVING SANITATION OF STREET FOOD CARTS

This is the Praxis II showcase project. My group worked on a RFP of Improving Sanitation of Street Food Carts. After more background research, we agreed as a team that the given problem was no longer an unsolved problem. Therefore, we decided to design products that are better than current solutions.

For my part, I was working on the garbage disposal system. Figure 2 is a comparison of the original and reframed RFP on the objectives, constrains, and criteria section. Researching on current solutions and rodent infections, I found currently street vendors use either simple garbage cans with no lid on them or garbage bags putted directly on the ground, and neither of the solution keeps odor from spreading. Moreover, I found that garbage cans with loose lids or no lid, contains wasted food, meat or fruits are most likely having rodents in or around. Therefore, I then reframed the part of RFP for the garbage disposal system as Figure 2 shows.

Group: Cheng-yun Li , Lance Ye, Gavin Ding, Yinghui Fan

Original RFP

- **Objective**
  - Improve the sanitation of street vendors' working environment
- **Constraints**
  - Less than 20% of the car's price
- **Criteria**
  - Durability and maintainability (metric: $/year spent on maintenance and operation, lesser is preferred)
  - Efficient garbage disposal system (metric: mass of the garbage that can be stored without leaking it's scent, more is preferred)

RFP Reframing

- Objective
  - Portable and flexible garbage disposal system
- Constraints
  - Less than $20
  - Must has a lid
- Criteria
  - Portability (metric: smaller size is preferred)
  - Comfort level of the street cart operator (metric: less time is required to operate is better)
  - Efficiency (metric: mass can be held and capacity, the higher the better)

Figure 2 – Original vs. Reframed RFP

STEP 2: REFERENCE DESIGN + BRAINSTORM

“A good design is based on existing technology and a new design is based on disruptive technology.” (Lecture 32, ESC 102)

In order to design a product that customers would buy, it has to be better than existing designs in some perspectives. Therefore, this step, researching on reference designs, provides a good starting point. I record all ideas come up in mind while researching and studying reference designs no matter crazy or silly the idea is.

ARTIFACT VII – IMPROVING SANITATION OF STREET FOOD CARTS

Figure 3 is a list of reference designs of garbage disposal system and their features. While studying these three reference designs, I came up with two ideas, one was to combine the trash can rack with the hand free bin, use lever principal to open up the lid of the trash can rack. The other idea was to have a garbage can made of two layer – the outside layer to insulate heat, ice between two layers, and inner layer to store garbage.

Figure 3 – Reference Designs of Garbage Bins

STEP 3: CONCEPTUAL DESIGN

In this step, I am going to actually develop conceptual designs from the ideas that I brainstormed before.

ARTIFACT III – CYCLING EYE-WEAR CONCEPTUAL DESIGN

This was a conceptual design group project in Praxis I. The Design brief required us to design a product to clear eye-wear more efficiently. But after researching and surveying, my group reframed the problem to be solving for cycling eye-wear cleaning issue.

Figure 4 shows the conceptual design of a cycling eye-wear. The shield has a extremely smooth surface, and the dirt would be washed off by air (aerodynamics).

Group: Mathew Mackey, Manali Bhattacharyya, Tom Zhang, Yinghui Fan

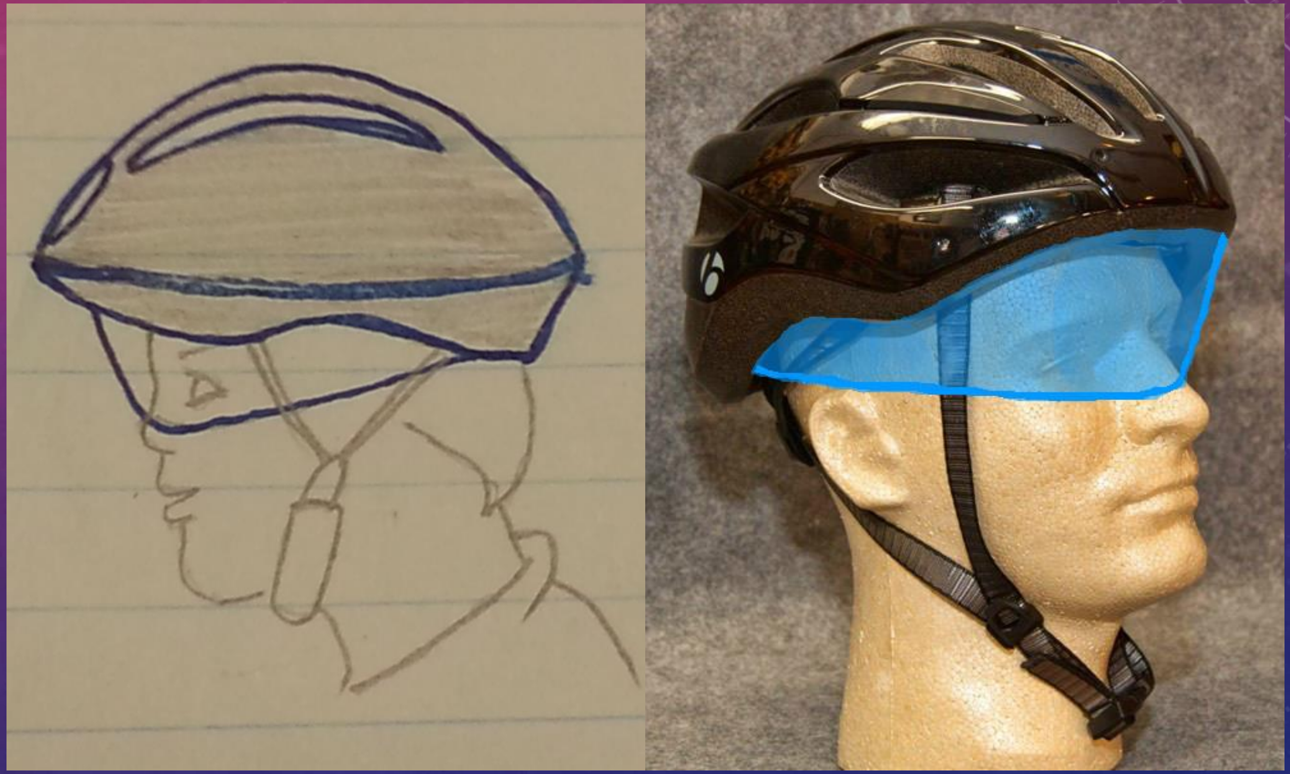


Figure 4 – Conceptual Design of Cycling Eye-wear

ARTIFACT VII – IMPROVING SANITATION PROBLEM OF STREET FOOD CARTS

Figure 5 shows two conceptual designs I had for the garbage disposal system. The key features of the two designs were similar but slightly different. Both (a) and (b) solutions were combinations of garbage hocks and foot-operators. Design (a) applied level principal; design (b) applied hydrodynamics.

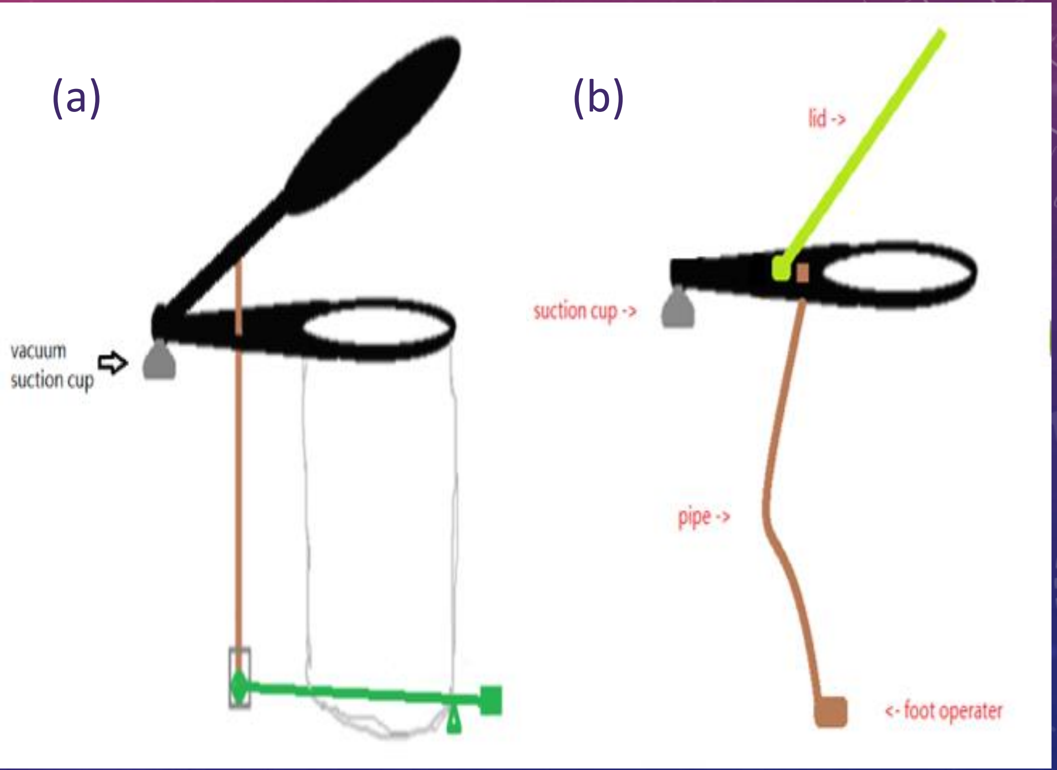


Figure 5 – Conceptual Designs of Garbage Hock

STEP 4: DESIGN EVALUATION

This is a very important step. In order to have a good final design, evaluate the conceptual using engineering design decision metrics to test the qualities of conceptual designs. After the result of the comparison, I go back to step 2, ***Reference Design + Brainstorm***, and redesign until I am satisfied with the conceptual design.

ARTIFACT III – CYCLING EYE-WEAR DESIGN

Table 1 is a decision weighting metrics we used in the Cycling Eye-wear Design project to came up with a final design from the three conceptual candidate designs.

Selecting a Design

Criterion	Weight	Eyeglass wipers (reference)	Helmet Wind Screen	Multiple Lenses with Helmet Cleaner	Eyeglass wipers (reference)	Helmet Wind Screen	Multiple Lenses with Helmet Cleaner
How well proposed design restricts the effects of rain, snow while cycling	0.25	5	3	0	1.25	0.75	0
How well proposed cleans effects of dirt, debris while cycling	0.25	5	6	7	1.25	1.50	1.75
Portability of design	0.1	5	4	4	0.5	0.4	0.4
Speed at which design cleans	0.05	5	3	5	0.25	0.15	0.25
Aesthetic appeal of design	0.05	5	6	3	0.25	0.3	0.15
Extent to which design reduces distraction	0.3	5	9	7	1.5	2.7	2.1
				TOTAL	5	5.8	4.65

Using our criteria we decided on before the design phase, we constructed a weighted decision matrix to decide which design was the preferred solution. We assigned the weights relative to what we felt were the most important aspects of the designs. As reducing distraction was the main problem we were aiming to solve, we assigned it the greatest weight. How well the device cleans and prevents the effects of rain and snow were equally important. The portability, aesthetic appeal, and speed of the design were relatively unimportant compared to the other criteria.

We used the first design, the eyeglass wipers, as a reference and assigned it all fives on a ten point scale. We then used this reference point to assign other values. Ideally in this process we would have used the metric associated with each criteria, however it is impossible to do so without actual models of the designs. Therefore, we assigned the values seen in the table after debating as a group. The helmet windscreen ended up with the highest score. The design is very simple conceptually and easy to implement. However, it is also effective at restricting the effects of rain and snow and also cleans dirt and debris effectively by the force of aerodynamic drag. The device essentially causes no distraction to the cyclist, as no user interaction is required for the device to work. The design is lightweight, and is also extremely stylish. For all of these reasons, the helmet with a wind screen attached is the most feasible and efficient solution.

Table 1 – Decision Metrics Table

ARTIFACT V – PRAXIS I FINAL EXAM DESIGN CHALLENGE

This is a design challenge of designing an all-weather pedestrian link between the Galbraith Building and the Bahen Centre for Information Technology.

For this design challenge, I had three candidate designs. The first solution was a bridge links the second floors of the Bahen Centre and the Galbraith Building. The second solution was a subway pedestrian link which goes under the ground. And the third solution was a three-floor building links the Bahen centre and the Galbraith Building across the road, and a tunnel goes under the building for cars.

Table 2 shows the decision metrics table I made in the exam journal post. I used this table to evaluate my three candidate pedestrian link design.

Eveluations

Weighted Decision Metric:

prespectives	weights	the first solution	the second solution	the thrid solution
safety	0.5	5	3	5
time efficiecy	0.2	5	6	9
wheelchair friendly	0.1	5	6	8
aetheic appeal	0.1	5	9	4
cost	0.1	5	5	1
total score	1.0	5	4.7	5.6

As the table above shows that the third solution is the best solution. This is because the solution completely isolates pedestrian and traffics; therefore provides the safest enviornment for both the pedestrians and the car drivers. The design also provides three ways of traveling from the Bahen Centre and the Galbraith Building which saves students a lot of time going down stairs to cross the road and go up stairs again when they arrive the other building. The solution provides two wheelchair entrances in total, has no stairs at all and and people in wheelchairs on the pavement are also protected by the design. Therefore, this solution is the best solution amoung the three's.

Table 2 – Decision Metrics Table

ARTIFACT VII – IMPROVING SANITATION PROBLEM OF STREET FOOD CARTS

Table 3 shows the decision metrics I used to evaluate the designs of garbage disposal system for Improving Sanitation Problem of Street Food Carts

Decision Metrics

	Hand-free Trash Can	Trash Can Rack	Minus frozen garbage container	Foot-operating Track hock (stick)	Foot-operating Track hock (pipe)
Cost (25%)	5	9	2	8	8
Portability (25%)	3	9	3	8	9
Efficiency (25%)	6	2	6	6	7
Odorless (10%)	7	5	9	6	6
Convenience (15%)	7	5	5	7	8
Total	5.25	6.25	4.4	7.15	7.8

Table 3– Decision Metrics Table

STEP 5: DETAIL DESIGN

Since I already have a satisfied conceptual candidate design, in this step, I am now going to do the detail design. Detail design including choose the right material to do the job, find out the dimensions of all components of the design.

ARTIFACT IV – DESIGN OF THE CUTTER

This was a Praxis I detail design group Project. The cutter was a vegetable/fruit cutter. I focused on designing the dimensions of the main box. Figure 6 are the dimension of the main box, and the justification of each dimension are listed below. These justification came from researches of reference designs, common fruits' and vegetables' sizes, common thickness of fruits and vegetables are needed in kitchen, common sizes of fruit dishes and salad bowls and common size of human hands, etc.

Group: Mathew Mackey, Manali Bhattacharyya, Tom Zhang, Yinghui Fan

Dimensions

6 x 6 x 10 inch box:

- 6 inch wide:
  - The same width as current vegetable slicers on the market [1]
    - The world first vegetable slicer was invented in 1570 [2], the width of a vegetable slicer has been improving for over four hundred years. Therefore, we used current vegetable slicers as reference.
- 6 inch tall:
  - Same as width
    - Most vegetable and fruits are round
- 7 inch long food holding are:
  - The same length of half a cucumber [3]
    - Cucumber is the longest vegetable that people usually chop into slices[3]
- 2 inch long extra space for slice thickness adjustment device
    - Move freely in a 6 x 6 x 2 area
    - Popular thickness choice: 0.25, 0.5, 0.75, or 1.0 in [4]
- 1 inch long extra space for fully compressed spring

6 inch long Legs:

- Enough space for fruit dishes [5] and salad bowls [6] go underneath

11 inch long handle:

- 8 inch inside the box when nothing is inside the box
- 3 inch extra handle is provided for users to hold
  - An average hand: 3 inch wide[7]

6 x 1 inch food dropping gap:

- 6 x 1 inch
- allows different slices to drop into a food container

Figure 6 – Dimensions for the Cutter

ARTIFACT VII – IMPROVING SANITATION OF STREET FOOD CARTS

Figure 7 shows my design on dimensions and material selections for the design of the garbage disposal system for Improving Sanitation of Street Food Carts. Dimensions were based on calculations of moments and researches on sizes of garbage bag, etc. And for material selection, since I knew that I need light materials for the lid and base, I did researches on different types of plastics and made a table of their properties and then compared. After that I selected the ideal materials for the lid and base.

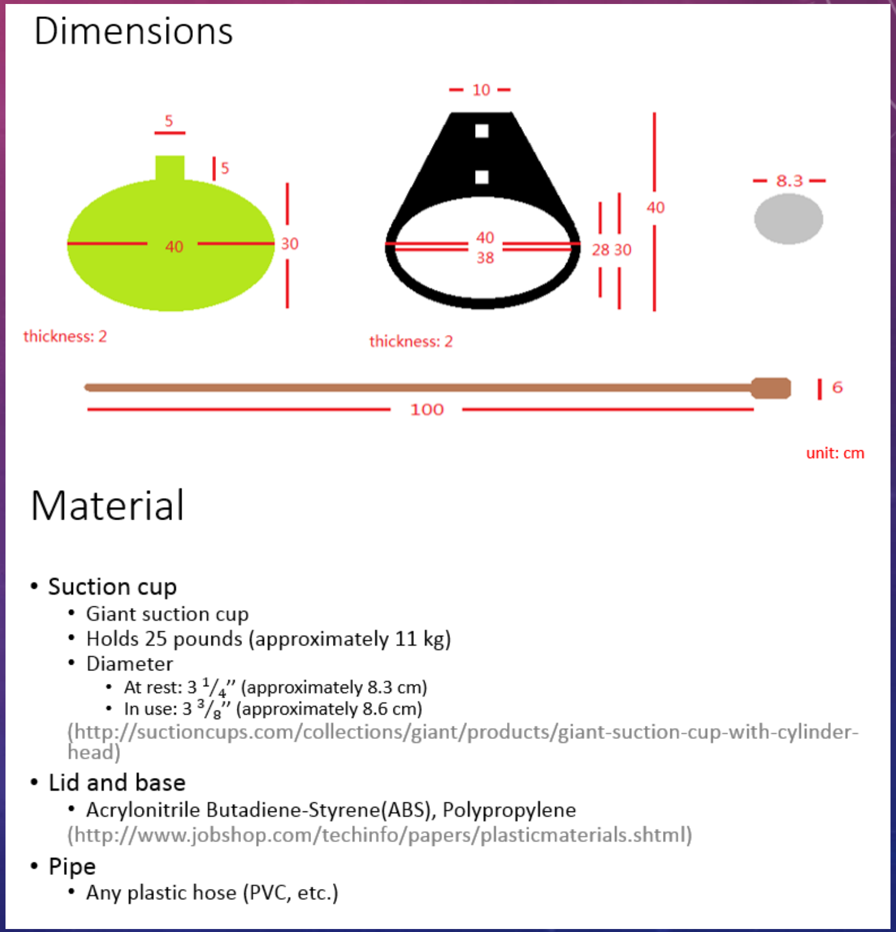


Figure 7 – Dimensions and Material Selections

STEP 6: BUILD PROTOTYPE

This step is to build up a prototype. Depends on what the prototype is for, it can be used to see how the product would look like, to alter its dimensions, to test its working principal and functionality. If the prototype does not pass the test, or it could meet the expectation of the original objective better, then I go back to step 5, ***Detail Design***, to modify the dimensions or to select new materials.

ARTIFACT II – BEAM BRIDGE DEIGN

Building this matboard beam bridge, we first measured and sketched every pieces we need for building this bridge. Then we cut them and glued them together. In figure 8, we were waiting for the glue to dry for diaphragms.

Figure 8 – Constructing the Matboard Beam Bridge

ARTIFACT VII – IMPROVING SANITATION PROBLEM OF STREET FOOD CARTS

This prototype of a foot-operating garbage hock was made of cardboard. The proposes of this prototype were first of all to test the working theorem and its functionality, and secondly to modify its dimensions. Figure 8 shows that the product passed the test of functionality, when I squeezed the foot operator, the lid opens simultaneously. Figure 9 shows the overall view of the prototype.

Figure 8 – Testing Its Functionality

Figure 9 – Prototype Is Attached on Piece of Glass

STEP 7: SHOWCASE FINAL DESIGN

This final step is to present the final design.

ARTIFACT I – TRUSS BRIDGE DESIGN

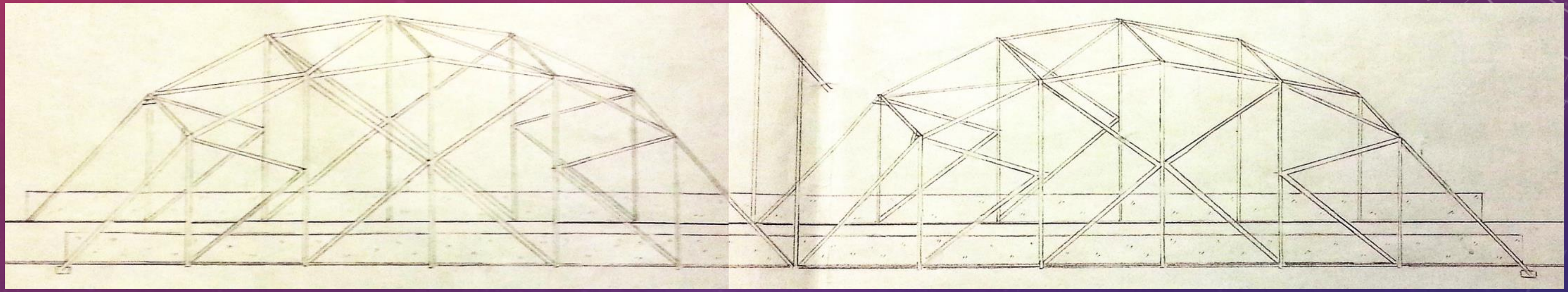


Figure 10 – Engineering Drawing of the Truss Bridge

This was a CIV 102 Truss Bridge Design group Project. This project required us to design a pedestrian bridge beneath a office building which was built over a highway. And figure 10 shows the final design of the truss bridge after all the calculations, material selection, elongation estimations, and budget estimations.

Group: Elvis Yuan, Truman Tai, Yinghui Fan

ARTIFACT II – BEAM BRIDGE

Figure 11 shows the final model railway bridge.

Figure 11 – Final Model Railway Beam Bridge

ARTIFACT IV – DESIGN OF THE CUTTER

Figure 12 is the final poster of the Cutter. It was divided into three sections, the dimensions of the main box, the material of the main box and the spring inside, and the shape, dimension, and material of the blade.

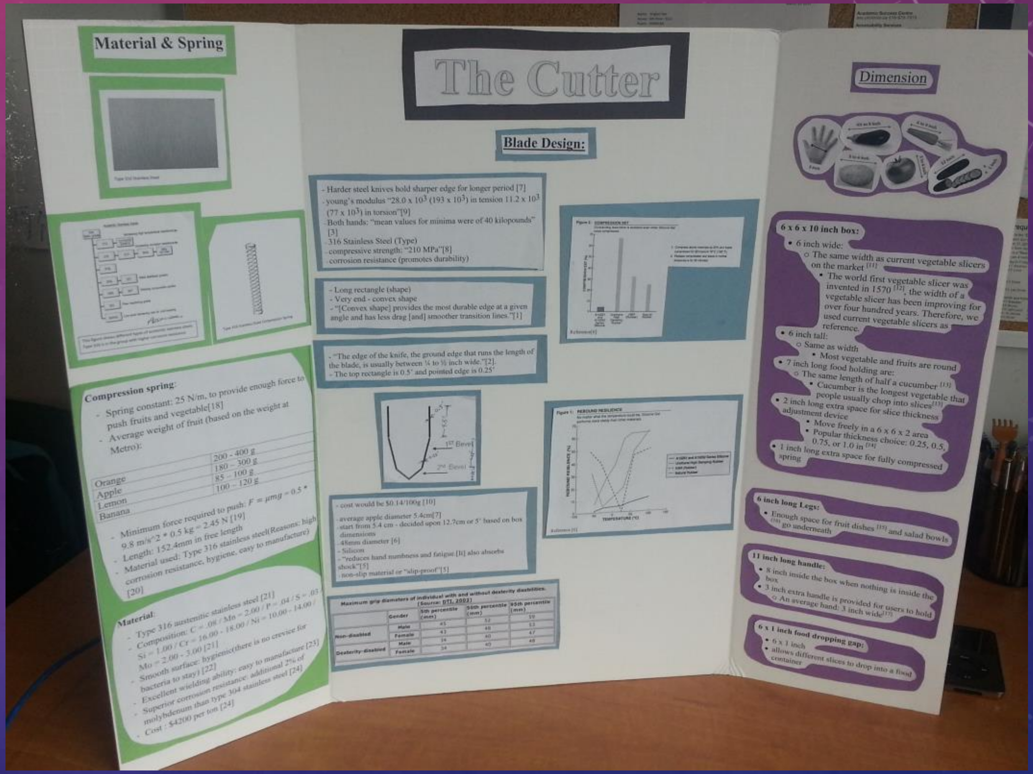


Figure 12 – Poster of The Cutter

ARTIFACT VII – IMPROVING SANITATION OF STREET FOOD CARTS

Figure 13 is the poster for showcasing our three designs for improving sanitation of street food carts. The poster was divided into four sections, a background introduction, and brief description on our three final design.

Figure 13 – Showcase Poster of the Solutions for Sanitation Problems of Vendor Carts

CONCLUSION

As this portfolio demonstrates, while designing a solution to the problem, I do a lot of researches to help me to approach the problem, to make strong claims, to brainstorm ideas, to support my ideas, to compare and access candidate designs, and to select materials and dimensions.

After the design projects I did in first year EngSci, now I fully understand that an engineering design is a lot more than an brilliant idea which solves problem magically. It is an application of a combination of all kinds of sciences - physics, chemistry, material science, psychology, computer science, etc.