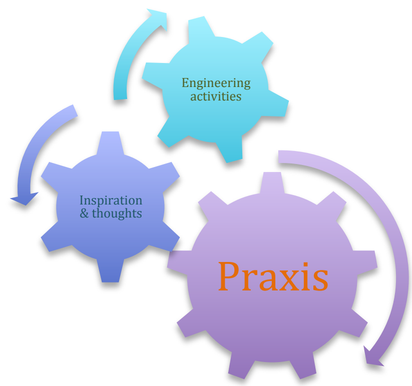
Praxis? Praxis. Praxis!

---Record of Praxis Experience

Introduction:

After the ESC 101 learning procedure, six specific engineering activities are outlined in this report, focusing on a design of a simulated ship, the first and second tear down in Studio, the Conceptual and Detailed Design Report and the CIV 102 Truss Bridge Design. A demonstration of engineering design thinking considering the subway ventilation system is also discussed. Detailed experience notes and evidences are included in the appendices.

What's Praxis?

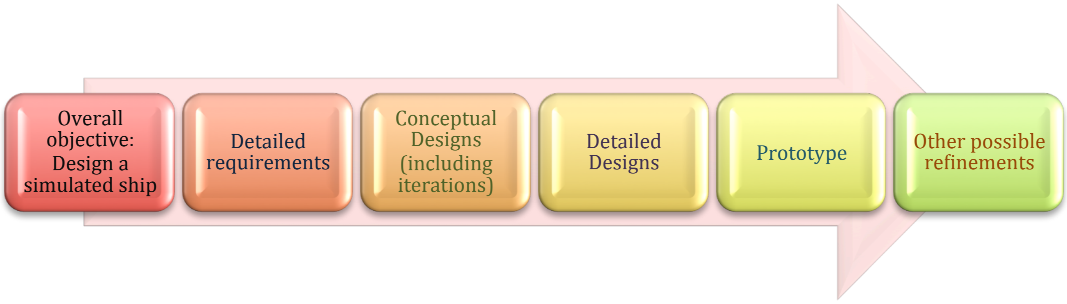


Two figures above explain the basic understanding of Praxis, which is a mechanism grounded on both Engineering activities and the inspirations gained from which. From the first design project (i.e. the simulated ship) to the final one (i.e. the Truss Bridge) listed, various Praxis knowledge and methods are used and analyzed in real practice, which in return enriches and improves my Praxis theory itself.

This is Praxis.

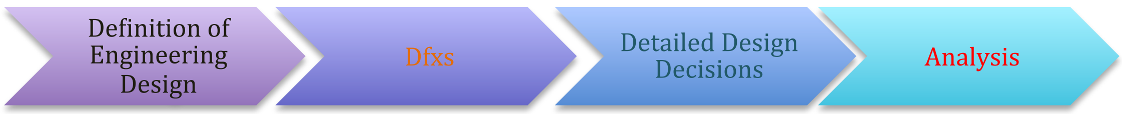
A. The Design of a Simulated Ship.
(>>Appendix A)
Overall objective: Design a simulated ship that could behave well in race.

As a design project completed before gaining a perspective of Praxis, much could have been improved during the whole design and prototype procedure (like the Pugh chart added in Appendix A). The design of the simulated ship did not pay much attention to defining and clarifying the requirements or refining the conceptual design to meet the listed objectives, which made the whole project messy and hard to correct within the limited time period. After acknowledging the Praxis skills, an improved procedure could be as follows:



B. The Tear Down of a Toaster
Overall Objective: Tear down a toaster and discuss about the design decisions (>>Appendix B)

In Studio, a toaster was torn down and evaluated, the note listed in Appendix B thoroughly went through the whole tear down procedure and discussed about various design decisions of the toaster, including both good and bad ones on basis of the Dfxs listed and my definition of engineering definition. Also, as this is just the first tear down, the report was not completed in good arrangement. Instead of focusing on the detailed engineering decisions found out during the tear down, the report may weigh on the Dfxs listed and pair these with the corresponding decisions (i.e. the report shall not go in the order of tearing down procedure, but the order of Dfxs).



C. The Tear Down of a Helicopter
Overall objective: Tear down a toy helicopter and discuss about the design decisions
(>>Appendix C)

The second tear down was operated with a toy helicopter, the device design report (partly from the midterm paper) was written in the order listed in part B (i.e. the order of Dfxs). Two design factors, usability and safety were discussed on basis of the observations during the tear down. Though researching a lot on usability and safety factors, the report focused too much on the user manuals and the controller, neglecting other important design decisions of the device (like the airscrew). A more comprehensive and convincing version of the report should include more involving detailed design decisions with respects to the Dfxs.

D. Praxis Conceptual Design
Overall objective: Make conceptual designs of a musical keyboard cleaner.
(>>Appendix D)

Beginning with the Dfx decomposition as well as establishing detailed objectives and requirements of the design with teammates, the conceptual designs experienced several times of iteration and a totally refinement (some original designs were abandoned during which). During the whole design procedure, two alternative parts (ultrasonic cleaner and magic glove) were completed by me. The design of the ultrasonic cleaner involves some diverge thinking, where the task of cleaning the keyboard was diverged to cleaning any dust in tiny spaces, and was finally compared to the cleaner of teeth, but during the refinement it was abandoned after discussion with other teammates because of its drawbacks (like high price) compared with other designs in the Pugh Chart. The design of the glove (shown in the final report) experienced several times of iteration, and was firstly designed in two parts but later converted into an all-in-one product which can clean the keyboard unit neatly and clearly. The importance of clarifying objectives is again stressed here, as during the overall refinement the objectives were changed and had a great impact on the final decision making (the formerly preferred roller was abandoned under the new objectives). Also the iterations of design proved to be powerful in terms of refining the design.

E. Detailed Design Report
Overall objective: Make detailed designs (materials of vectors and planes) on basis of the conceptual design report of 3D Vector Operation Learning Tools.
(>>Appendix E)

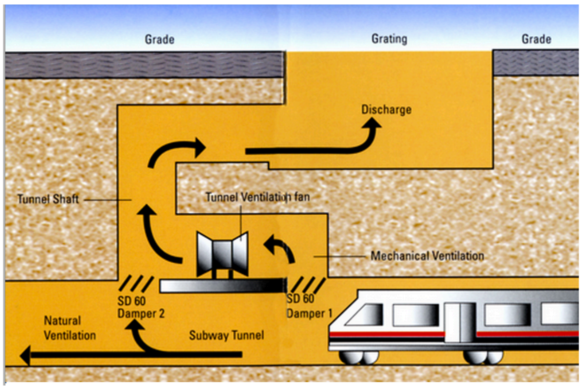
After refining the objectives and requirements, different kinds of materials were compared in a Pugh chart using the provided software (Cambridge Engineering Selector). The use of Pugh chart proved to be very efficient during the process of iteration and comparison, which directly displayed the advantages and disadvantages of certain designs in different areas of objectives. Given the weights of the objectives (the importance of each objective may differ), the detailed decision can be made after several times of iteration.

F. CIV 102 Truss Bridge Design
Overall objective: Design a truss bridge to support given loads and cross a 100 m long valley within reasonable budget.
(>>Appendix F)

The design and the calculations of the project were mostly completed by me. The bridge was originally designed to have one part only to reduce the cost (the cost of the column in middle can then be saved), however in this case the height of the bridge would be so high (to support the loads) that the budget could be even higher than that of the design with columns. Considering a column in the river has a cost far higher than two columns not in river, the bridge was finally designed to be divided in three different parts, where the side parts are designed to use the design mentioned in the lecture and the main part adopted the idea of an existing bridge in South Africa. The whole design process is like a practice of Praxis-style design thinking, from clarifying objectives to comparing conceptual designs and making the detailed decisions of the HSS materials, the final design fulfilled all the objectives very well while all the calculations done by me were correct.

Everything involves Praxis!

Walking on the College Street, it is hard not to pay attention to the ventilation exhaust port which discharged heated air out. Out of interest, I tried to figure out how the subway ventilation system works. And what impacts could the ports exert on the nearby environment.



A typical design of the ventilation system is shown in the figure[1], where a fan is used to exhaust the waste gas to the open air, also when the tunnel is under construction the fan can lead the fresh air in.

As the underground system is a relatively closed environment, the waste gas stored within is hard to be discharged. Using ventilation fans to exchange the gas with fresh air, the waste gas which may contain aluminum, manganese or other toxic substances would be discharged to the open air, in other words, the better the system behaves to make the air in tunnel fresher, the greater the impact would be the system exerts on the nearby system (though the ventilation system is designed to has filter function to some extent). And as observed in the walkabout, the ventilation ports are commonly constructed in the streets where there may be crowds of people passing by everyday, the whole system not only poisoned the citizens everyday, but also wasted the heated air from the tunnel.

Rather than trying to design a ventilation system which can filter the exhaust better, I came up with an idea that these exhaust could be gathered together with strong shafts and used as heating source to serve the city, and then the exhaust can be filtered more thoroughly together in certain factories. The design does not prevent the citizens from toxic exhaust, but provides a way to make use of the exhaust.

Taking a single SD60-V smoke damper into account, the minimum volume of the exhaust it discharged daily is 10.2*0.152*0.203*24*3600[2] = 27193 cubic meter. Assume the temperature of the exhaust is 20 degree and the environment temperature is 0 degree, the heating energy this damper loses everyday is Q = 1.29*27193*20*1013 = 710,700 kJ (the density and specific heat capacity of the normal air are here adopted), which can approximately heat up 1696 kg water[3]. If the design can be taken into use, the heating service of the city can be improved intensely.

Reference:
[1] "OLS Model SD60 Tunnel Ventilation Damper", http://www.connols-air.com/products/sd60.html
[2] "SD60-V Smoke Damper", http://www.ruskin.com/DownloadFile.aspx?z=0&f=2489
[3] "Heat, Work and Energy", http://www.engineeringtoolbox.com/heat-work-energy-d_292.html

Appendices:

A. ***Simulated Ship Design*** (Before College)

---The design and build of a simulated ship

Earlier this year, my friends and I took part in a design competition of simulated ships, where the fastest ship designed with a certain engine provided would be declared as the winner. After spending around one week at a local university laboratory, a ship was designed and prototyped. Though eventually the ship did not win the competition, a lot was gained during the procedure.

BLUEPRINT

As this was a race competition (where certain engines were given), the team all agreed that the key to increase the speed of the ship while racing is to decrease the resistance force of the ship. After discussion, we came up with two ways to manage this:

A. Reduce the weight of the ship as much as we can

B. Make the surface of the ship as smooth as we can

In the first design, we decided to use foam boards as raw material.

PURCHASING GOODS

Here is the purchase list:

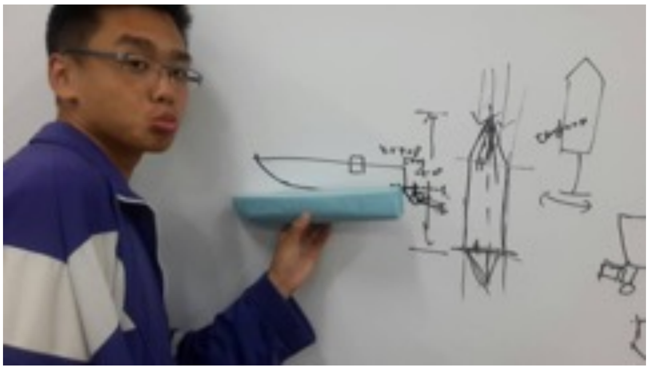
- scissors
- glue
- drawing pencils
- mat papers
- cutting knives
- foam board

BUILDING PROCEDURE I

Working in lab with teammates(building period I)

The first product (named after our friend Zongyuan) is a failure. Due to the fact that the material we chose was way too heavy to float above the water, the ship behaved very poor during the prototype, and a rather high water resistance was observed thanks to the glue we used. After the prototypes the first design was abandoned.

BUILD PROCEDURE II



Me with the blueprint and the product Zongyuan II

Later I came up with a brand new idea. Some waste blue foams in the lab were found by us, which were very light. A new ship using these materials was then designed and this time the university's foam-cutting machine was used by us to carve the ship out of a complete foam.

Within three days' work we successfully built the ship, and for more decorations we spent 2 more days.

FINAL PROTOTYPE

The test in water was not so satisfying, Zongyuan II was too light to make the center of gravity stay below the water, causing instability during moving. But at that time the competition was near the corner. So we focused more on correcting rather than rebuilding. The correction did work a little. The results were better than the earlier ones.

COMPETITION

I was sick during the competition day, so I missed the scene. But my friends went there with Zongyuan II. The result was not so good, we did not win the race, and Zongyuan II was broken after the race(the weight was too much on that day).

THINK BACK

The failure of Zongyuan I & II indicate that I was still an amateur in engineering design. Before the real prototype procedure, little was considered about the requirements, constraints and criteria, and in fact the Zongyuan I did not satisfy our listed two requirements at all. The complicated situations the ship may confront in the water were not considered appropriately, which shall have been considered in the design process. In conclusion, the design process of the simulated ships inspired me the importance of clarifying the requirements and making design decisions based on the constraints and criteria.

*A possible refined requirements table is listed below

Objective	Metric	Constraint	Criteria	Justification
Reduce the weight of the ship	The weight of the ship	-	The less the better	According to the two ideas listed (A), while there are no strict weight comparison, may take Zongyuan I as a reference
Improve the smoothness of the surface of the ship	The coefficient of friction of the ship's surface	-	The less the better	According to the two ideas listed (B), while there are no appropriate evaluation method of this objective (may intuitionally refer to the hand feel of the surface)
Affordability	Cost of the material	-	The less the better	Considering the facilities and tools are free in the lab, the cost should only include the material for the construction

B. ***Teardown the Toaster (The Tear Down Note)***

---The exploration of engineering design

My definition of engineering design written in Praxis Survey II:

Engineering design is the construction or devices built in humans' beauty fashion, with humans' intelligence, by great minds. I believe engineering design, in a short word, is beauty. It's impulsion in a proper arrangement, it's elegance in a rocking way. It's the pyramids, it's the Pantheon, it's the Great Wall, it's the Ironman suit, it's the iPhone 4, it's the touching feeling that does touch your mind.

It is a little ambiguous to mention "beauty" here, apparently in this case we can hardly see the normal kind of "beauty" in a toaster. It's so simple in terms of decoration, while weighing more on the function. But we can still see the "beauty" in a different kind way--the beauty of clever designs.

When an engineer is designing something like toaster (which has already been commonly used in daily life), it could be very challenging because he has to use his very intelligence to cut budget and choose right materials to compete with other ones, and this is where clever designs are developed.

1.Protection during transport

The first thing we saw after opening the product box is a simple plastic bag covering our toaster (And there is also a thick paperboard underneath). Normally when we look at our brand new electrical products (or china purchase), we could find a bubble shell, but as this toaster is not so dear in price and fragile during transportation (the product contains many springs itself inside).

2.Material for the Shell

Now here is our toaster. The first thing we saw is the shell. And there can be multiple choices on deciding the right material for the shell.

There are normally two types of materials chosen to make the shell: plastic and iron. In the studio, ours is half-iron-half-plastic (The main body is iron while the support base is plastic), and my own toaster is plastic.


To understand this decision, we have to come through the following factors:

A. Conductivity for heat (customers are not expected to be injured out of a bread accident.)

B. Fabric ability (Good fabric ability leads to simple manufactory procedure.)

C. Price

D. Safety

E. Aesthetics

>>A. Conductivity for heat

Wood was thrown out by a teammate to be a good choice, and its better performance in this field may prove his opinion. However, in practice, the usual means to heat our bread is to use the infrared heating, which will results in a temperature around 100 degree. Hence wood may not be the best choice.

Iron	80	68	60
Iron, wrought	59		
Iron, cast	55		
Plastics, foamed (insulation materials)	0.03		
Timber	0.14		

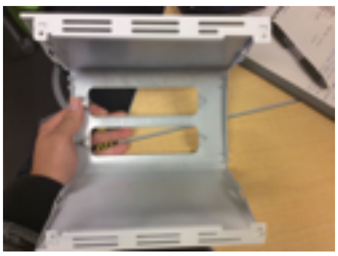
>>B. Fabric ability

Plastic and iron both show good fabric abilities, and plastic may perform better in factories.

>>C. Price

Plastic is much cheaper than iron in markets.

Plastic can be made through a chemical process that is relatively cheap. Most metals are made from ore. The cost of mining and transporting the ore combined with the refining process increase the cost dramatically.



>>D. Safety

During the teardown procedure, we found that our toaster’s iron part is formed pointy, which may increase the danger for younger customers.

>>E. Aesthetics

Iron sure does better in pleasing our eyes.

3. The tire

After a closer look of the toaster, the inconvenience caused by the length of the tire was noticed.

The tire here is not considered to be a good design practice. In real practice, the toaster has a strong possibility to be placed near the power supply, hence there is no need to provide a tire this long.

The better design may contain the tire in the body of the toaster, and the tire can be pulled out at whatever length needed (inspired by the vacuum machine). But it is also a problem to make room for this design inside the toaster. Thus, I think the more realistic improvement is to shorten the tire.

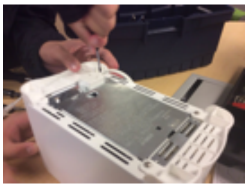
4.Why two slots?

Before physically tearing down the whole toaster, a question bumped into my mind: Why there must be two slots in a toaster? Then I googled online and found that there are also 4-slot toaster, but not commonly seen home.

Let's assume that there are 4 people in a family (Father, mother and two kids). Each of them is estimated to have two slices of bread during breakfast. Then the minimum time to make the breakfast ready is (8/2)*1=4min, which may leave it pretty much time to do other things (like cooking bacon). If the toaster were 4-slot, then this time would be 2min, though it seems that we save much time, but in reality users may feel very stressful, and when the estimated is within 5 minutes (considerably short time period), it seems not so meaningful to cut it by half any more. And if it were one-slot, the time taken (8 minutes) seems rather long.

So two-slot is a fairly good design, it may also explain why this the most common design on market.

5.The backboard



We may have to clean our toasters on a weekly basis due to the fact that there is too much bread foam in it. Toasters are always designed with a cleaning method. In this issue, the toaster tore down provided a backboard (with product information carved on it)

This board is easy to open in our tests, proving its convenience and functionality. Out of the curiosity, we had a look at the inside structure.

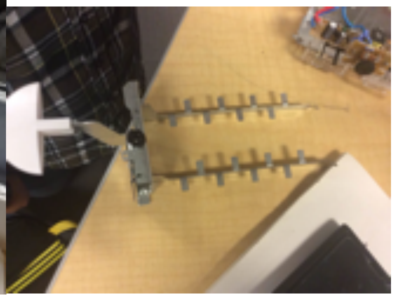
The board uses a metal stick to maintain its position, and makes it easy to open. Though simple, it is proved to be very efficient.

6.The bounce system

There are two kinds of methods of the bounce system observed that day (one we acknowledged from another team).

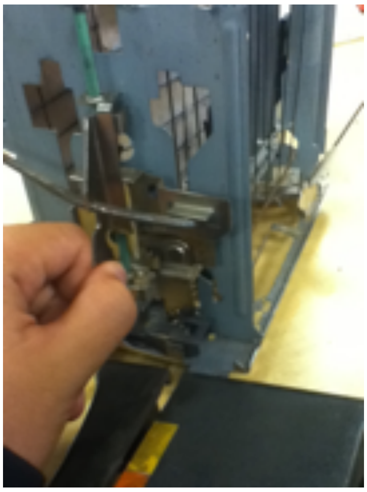
First one (ours):





It can be seen that rather than using spring, the toaster we tore down used two bouncy iron wires to “bounce up” the bread, this design is very simple, and makes the cost lower(what we need are just two iron wires.)

Second:

It can be clearly seen that there is a big spring to “bounce up” the breads.

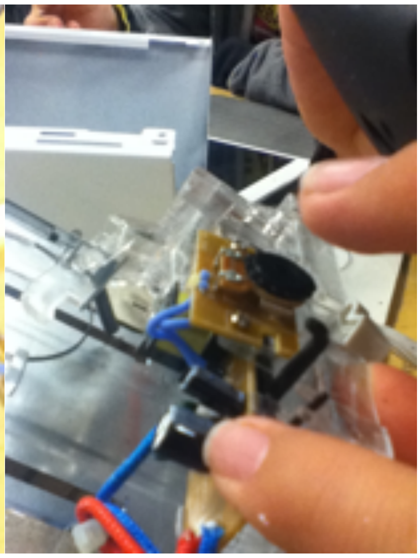
This design is very old-fashioned, but also may provide longer using time (iron wires may be out of service quicker due to the rust effect).

7.The heating system

Most toasters on the market are designed to heat the bread using the infrared heating system, the question is how to provide this system?

Before tearing down and see exactly how, I thought that this could be constructed with a computer chip which can act as a time keeper (depending on the time we input) and processing machine(process the input information and then pass this to the heating wires.)

After tearing down:



I found the electromagnetic relay stuff learnt in junior high, which is not a computer chip but can also do all the functions I mentioned above.

In other teams' toasters there can be found similar things.

When we twist the button on the side of the toaster (with time like 1min and 30s on it), the lever system will lead to the change of the electromagnetic relay, and setting different time for heating. This fabulous invention is simple and cheap, that's why we don't pay too much on a toaster (no one has to pay additional fee to INTEL).

C. ***Teardown a helicopter (partly from the midterm paper)***

---An engineering device tear down report

Introduction

A mini helicopter bought in a chinatown toyshop was dismantled and examined. This report will discuss the design of this helicopter from two design perspectives: usability and safety, emphasizing the impact of design decisions on both perspectives. Improvement decisions to both perspectives will then be proposed.

Brief Description of the Device

Apart from the accessories shown in the image [Reference 3], this helicopter also consists of a controller and a screwdriver fit for the size of the screws. On the body of the helicopter, there is an 'ON-OFF' button for the main body of the device which controls the motion motors, and a lighting system also determined by the button was hidden in the head of the helicopter.

Decisions about Design Factors

A. Design for Usability

According to the work by Jakob Nielsen and professor Ben shneiderman[Reference 1] about the framework of system acceptability, the following metrics are set to measure the usability of the mini helicopter:

a. Whether it is easy to manipulate for a beginner.
(Learnability) Specifically in this case, more detailed metric to value this rule is designed as follows:

1. The drawing-sentence ratio

2. The thickness of the instruction manual (how much information should be gained before safe flight)

b. Whether there is any special design for easier approach.

1. The method designed to make it convenient for other user-groups (like video games).

2. Ways of charging.

To test if the helicopter satisfies the above metrics, the 'user observation method' concluded in ISO usability test methods [Reference 2] was used.

Following decisions of the device are highlighted to analyze the topic:

Firstly, the instruction manual [Reference 4]. The instruction is a 16-page booklet written in English and Chinese, which includes the basic settings of the helicopter and other specific points suggested about safety issues and charging methods, information about frequent errors are also concluded. As is shown, the instruction concludes many drawings rather than merely words, this largely increases the convenience for the readers, and obeys the rule b for easier approach to the helicopter. However, the booklets are too thick to read still, and it is inconvenient for the customers who know neither English nor Chinese to use the instruction.

With the support of Patricia A. Robinson and Ryn Etter's *Writing Designing Manuals* [Reference 10], a good design of instruction manual should be simple and deliberate, which makes it easy to read and follow. 16-page manual is relatively thicker for customers to follow compared to a simple

card with necessary controlling messages, and as mentioned in [Reference 10], the manual in Canada should be bilingual in English and French rather than English and Chinese.

Secondly, the controller of the device has a similar setting and look compared to the controllers of Xbox or PlayStation [Reference 5], These two playing platforms have millions of users[Reference 6], thus this design decision will provide easier approach to the ones who have(even only once) played with the Xbox or PlayStation controller, leading to simpler manipulation of the helicopter. This satisfies rule a and rule b at the same time. Nevertheless, the designer made a very user- unfriendly decision of the battery shield. For certain reason the shield was designed to be opened by unscrewing the screw on the top of the shield, which took a long time during the teardown procedure. This design dissatisfies the usability metric for users.

Thirdly, multiple and convenient methods of the charging. The main body of the helicopter, as mentioned above, has an independent motoring system, and hence the battery of the main body has to be recharged every 6 to 7 minutes[Reference 4]. The designer designed two ways of charging the battery: The first approach is to use the charging wire in the controller to charge the helicopter with the batteries in it, which means that customers do not need to bring 'charging platform' or 'backup batteries' with them while flying the device open-door. The second method is to use a USB cable, which means that the helicopter can be charged with a laptop, leading to the convenient user experience.

Compared to a helicopter charger [Reference 7] or an old-fashioned charging platform, these two approaches are more user-friendly because they do not need any plug or socket, which satisfies rule b.

B. Design for Safety

According to [Reference 8], the metrics set to measure safety are as bellow:

a. Whether it concerns the customer age (in this case 14+ recommended, so this is a toy designed for teenagers)
   1. Methods for guardians to control the playing time.

b. Whether it provides special approach to remind customers about the safety regulations (no matter mentioned in manual or not).
    1. Access to safety warnings.

The 'screw' issue of the controller can also be discussed in the area of safety issue. Despite mentioning in the manual that the helicopters can only be played in certain conditions, there is still possibility that the customers(teenagers) will play it in unexpected area or under dangerous conditions without parents permitting. The inconvenience caused by the screw can increase the factor of safety to some extent at this point. Considering the age of the customers, it is reasonable likely to claim that if the parents take the batteries off and screw the shield tightly, they will not have access to the helicopter any more. This satisfies rule a.

The lighting system was also a safety decision. The lights will automatically turn on when the button is turned to 'ON', which shows that the helicopter is working. With the helicopter turning on, it may be very dangerous to operate whatever behaviors on it, the lights provide the customers a safe guard. This satisfies rule b.

In [Reference 10], it also concludes that warning issues and the use of the device. The 'warning' symbols should be clearly highlighted both in instruction. Not only having achieved this, warnings about safety control were also printed on the main body of the helicopter, this strongly satisfies rule b.

Proper Alternative Improvement

A. Design for Usability

An alternative decision which would increase the usability of the device is to add a mere-drawing instruction in a card made of water-resist plastic. Drawings, compared to long sentences and regulations, would be more easy for users to learn the idea of how the helicopter works. This would also satisfy the customers who know neither English or Chinese. Additional regulations and other necessary things are designed to be kept in a manual that is written in English and French rather than English and Chinese.

The screw-battery-shield can be modified, too. A click-mechanism(like the cell-phone battery shield in[Reference 9]) can be used to take place of the original one to make it ;/p0pgiuu0upokjh;/;kjkeasier to open. At the same time this would destroy the safety design discussed above, but the design for usability is considered more here.

B. Design for Safety

A change that can be made to the helicopter to make it safer is adding a velocity-mode button on the controller, which can provide users different options to decide the speed their helicopters have. This decision of design may well improve the safety factor. (E = 1/2m*v*v, according to the kinetic energy law, less velocity leads to less energy the helicopter can exert on bodies).

Conclusion

Therefore, many of the design decisions made to this device impacted its usability-the ease at which the helicopter can be operated and safety-its concern about the safety of the customers and the people nearby the operating scene, in both positive and negative ways. By making reasonable changes listed, the usability and safety index of the device may be greatly improved.

Reference:

Reference 1

Definition [edit]

ISO defines usability as "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." The word "usability" also refers to methods for improving ease-of-use during the design process. Usability consultant Jakob Nielsen and computer science professor Ben Shneiderman have written (separately) about a framework of system acceptability, where usability is a part of "usefulness" and is composed of:[4]

- Learnability: How easy is it for users to accomplish basic tasks the first time they encounter the design?
- Efficiency: Once users have learned the design, how quickly can they perform tasks?
- Memorability: When users return to the design after a period of not using it, how easily can they re-establish proficiency?
- Errors: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?
- Satisfaction: How pleasant is it to use the design?

Usability is often associated with the functionalities of the product (cf. ISO definition, below), in addition to being solely a characteristic of the user interface (cf. framework of system acceptability, also below, which separates *usefulness* into *usability* and *utility*). For example, in the context of mainstream consumer products, an automobile lacking a reverse gear could be considered *unusable* according to the former view, and *lacking in utility* according to the latter view.

When evaluating user interfaces for usability, the definition can be as simple as "the perception of a target user of the effectiveness (fit for purpose) and efficiency (work or time required to use) of the Interface"[*citation needed*]. Each component may be measured subjectively against criteria, e.g., Principles of User Interface Design, to provide a metric, often expressed as a percentage. It is important to distinguish between usability testing and usability engineering. Usability testing is the measurement of ease of use of a product or piece of software. In contrast, usability engineering (UE) is the research and design process that ensures a product with good usability.

Usability is a non-functional requirement. As with other non-functional requirements, usability cannot be directly measured but must be quantified by means of indirect measures or attributes such as, for example, the number of reported problems with ease-of-use of a system.

Reference 2

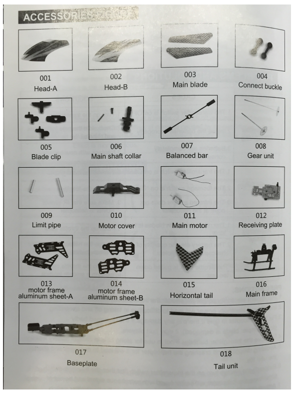
5.1.2 Observation of users

This method consists of the precise and systematic collection of information about the behaviour and the performance of users, in the context of specific tasks during the user's activity which may be carried out either in real-life situations or laboratories. Such observation is structured and based on predefined classifications of users' behaviour.

Much observation is based on taking detailed notes on what the users do and then analysing the data later.

The advantages and disadvantages of this method are as follows.

Reference 3



Reference 4

Helicopter Manual

Reference 5

Reference 6

Recent numbers released by Valve show a steady 30% rise in active accounts, bringing its total active users to 65 million.

This number overshadows Microsoft, where Xbox Live only boasts **48 million members**. On the other hand, Sony's PlayStation Network takes the lead with **110 million accounts**, though it's unknown if this number accurately represents active users since one person can create multiple free accounts.

Reference 7

110v Charger for SYMA Mini Helicopters S107 S105 S009 and others

by Syma

1 customer review

Price: CDN$ 5.99

In Stock.

Ships from and sold by Wadoy Wholesale (HK SHIPPING).

- 110V Charger for Syma Mini Helicopters
- Can be used on Syma Helicopters with small white Charging Plug
- Faster Charging with less Battery Drain on Transmitter.

Reference 8

Safety by design

From Wikipedia, the free encyclopedia

Safety by design is a concept and movement that encourages construction or product designers to "design out" health and safety risks during design development. The concept supports the view that along with quality, programme and cost; safety is determined during the design stage.[1][2][3][4][5][6][7]

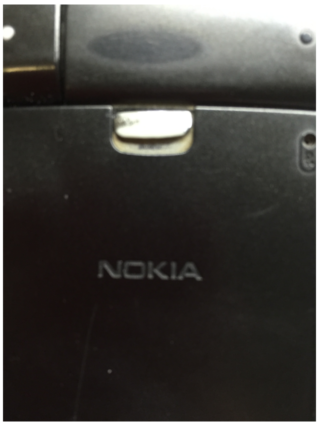
Within Europe, construction designers are legally bound to design out risks during design development to reduce hazards in the construction and end use phases via the Mobile Worksite Directive (also known as CDM regulations in the UK).[8] The concept supports this legal requirement.

Many non-governmental organizations have been established to support this aim, principally in the UK, Australia and the United States.[9][10][11]

Some Notified Bodies provide testing and design verification services to ensure compliance with the safety standards defined in regulation codes such as the American Society of Mechanical Engineers.[12]

References [edit]

Reference 9



Reference 10

Writing Designing Manuals, Patricia A. Robinson and Ryn Etter

D. ***Conceptual Design Report (based on the W12 refined CDR)***

---Conceptual design report of musical keyboard cleaner

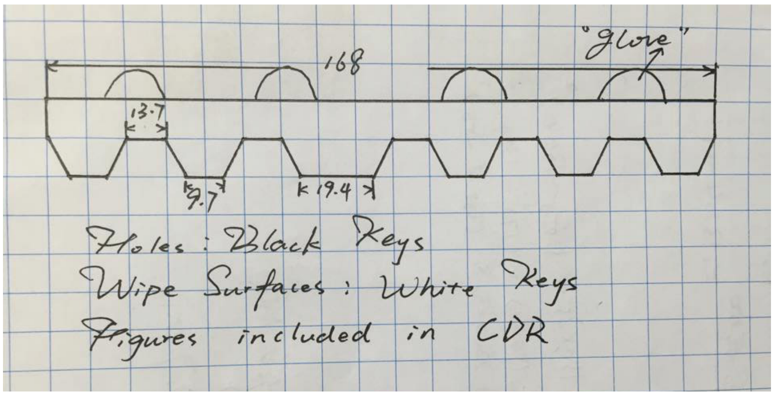
Musical keyboards are often shared and played regularly amongst a variety of users, and as such, a means of a quick and timely decontamination of its surface is a necessity. After discussion, my team came up with three different conceptual designs in total, and after prototyping eventually we adopted a design of Versaplow cleaner.

Requirements

Objective	Metric	Constraint	Criteria	Justification
Reduce time consumption	Measured time for cleaning one standard piano keyboard (sec)	Time spent should be less than 352 seconds	The less the better	Since there is currently no closely related research showing how fast human hands move when cleaning piano, we assume that it takes a person 1 second to move the cloth from one end of a white / black key to the other end. To clean a key, it requires at least two rounds (one wet and one dry) per key, which is 4 seconds. There are 88 keys on a standard piano keyboard, which will take 88 * 4 = 352 seconds for a person to clean.
Improve usability	Time required to learn the operation (sec)	-	The quicker the better (to learn)	There is no hard constraint on learning time, because different people learn at different speeds.
Improve adjustability	Types of keyboards that can be cleaned (count)	Must be >=1	The more the better	If a cleaner cannot accommodate to a single type of musical keyboard, its existence would have no significance.
Affordability	Cost per unit ($)		The less the better	Price level in different countries are different and different people can afford different prices.
Protect Keyboard	Number of keyboard damaged	Must be zero	The less the better	The cleaner shall have no damage to the keyboard.

Effectiveness	how clean the musical keyboard can become after using the device once	-	the cleaner the better	Although the overall objective is to reduce the time consumption of cleaning a musical keyboard, it is still same important to really clean the keyboard, otherwise it would have less significance in improving efficiency.
Coverage	should be capable of cleaning all the keys on the keyboard, including extremities.	-	The more the better	Every single key is a part of a musical keyboard, therefore has significance in its existence. Thus, none of the keys should be ignored when cleaning the keyboard. Due to this reason, coverage should be added as a criterion of selecting the best alternative.

The magic glove of the three was designed by me:



Overall Design:

The Magic Glove is designed for cleaning general units of the keyboard. More specifically, general units are the regions such that whenever there are two black keys, there is a white key directly adjacent to each one, and similarly for when there are three black keys. [The piano is designed such that it alternates between two and three black keys successively.] However, the extremities of the musical keyboards cannot be cleaned by this design. The Magic Glove comprises of a 'glove', which is attached to the cleaning mechanism, allowing the user to insert their fingers for easy use.

How to Use It:

1. Insert one hand into the glove
2. Place the glove on top of the appropriate general unit such that the

openings of the device is directly covering the black keys
3. Clean the unit by sliding the device in a forward and back motion over the keys
4. Repeat the procedure until all the general units of the keyboard are cleaned

Highlights of Key Features:

1. The shape and size of the "glove" is specially designed based on the normal piano keyboard size (mentioned in the conceptual design report), which will fit the white keys and black keys perfectly.
2. On the surfaces of the gloves (i.e. the places where the gloves touch the keyboards), there shall be cleaning materials (chemical spray for example) to improve the cleaning effect.
3. The buttons on the top of each glove are designed to make it easier for users to put hands in it, and it is also convenient for users to hold it tightly. This improves the design factor of usability.

*Note:

The design of the glove experienced several times of iteration, the gloves were firstly designed in two parts but later it was converted into an all-in-one product which can clean the keyboard unit neatly and clearly. The prototype of this design was finished then where the design showed certain drawbacks in terms of efficiency and coverage compared to other designs.

The Pugh Chart

	VersaPlow	Magic Glove	Roller	Justification
Effectiveness	0	0	-	Since the VersaPlow and the Magic Glove have similar cleaning mechanism, they have the same effectiveness. By contrast, the roller was found to be inadequate as a candidate prototype as the generated friction between the roller and the surface was insufficient insofar as to remove the accumulation of dust.
Efficiency	0	-	+	Since there is a top cleaning area designed for VersaPlow, it takes VersaPlow less time to clean the white keys, compared to the Magic Glove. Meanwhile, Roller is faster than the other two, because it just has to roll on the surface once or twice.

Adjustability	0	0	-	Since the VersaPlow and the Magic Glove have similar cleaning mechanism, they have the same adjustability. However, for the roller, its curved surface cannot perfectly fit with the flat surface of the keyboard, therefore fails on adjustability.
Coverage	+	0	0	The VersaPlow is capable of cleaning the extremities, due to its special 'side cleaning area' design, while other designs are not capable.
Affordability	+	0	0	Estimated cost of Versaplow is $ 2.5, while that of a roller or a magic glove $ 4
Protection of keyboard	0	0	0	Since the VersaPlow and the Magic Glove have similar cleaning mechanism, they have the same effectiveness. By contrast, the roller was found to be inadequate as a candidate prototype as the generated friction between the roller and the surface was insufficient insofar as to remove the accumulation of dust.

E. ***Detailed Design Report (based on the DDR)***

---The detailed design of choosing materials for vectors and planes of a 3D Vector Operation Learning Tools

Concept Design Identification

3D Vector Operation Learning Tools

Summary of Recommended Option for Detailed Design

PET (45% glass fiber, recycled content) is an affordable plastic material which meets the requirements listed in the conceptual design report[1], providing a more stable and elastic structure compared with the other two alternative materials. Besides, the density of the material is relatively little to lift.

Context and Motivation

Since the main parts of the 3D Vector Operation Learning Tools are the vectors and planes, the materials of which can directly determine the design factors of usability and functionality of the product, thus it is very important to decide which material to use.

Requirements

Overall objective: improve the design factors of usability and functionality

Detailed Objective	Metric	Criteri a	Constraint	Justification
Lower-Price design to be widely used	US dollars per lb (pounds)	Lower the better	**Must be** less than $38.50 before tax (Price of an electronic device capable of running 3D applications)[1]	In order to appeal to institutions and general consumers, the cheaper the product is, the more likely consumers will be willing to spend money on it.
Higher Fracture Toughness design to meet the need of being "rigid enough to not sag under self weight"[1]	Ksi.in^0.5 (kilo force pound per square inch square root inches)	Higher the better	**Must be** higher than 0 Ksi.in^0.5.	As is covered in the conceptual design report, the material used to represent vectors shall be "rigid enough to not sag under self weight".
Higher Elastic Limit design to meet the need of being "elastic enough to span the width of the cage"[1]	Ksi (kilo pounds per square inch)	Higher the better	**Must be** higher than 0 ksi.	As is covered in the conceptual design report, the material used to represent vectors shall be "elastic enough to span the width of the cage".
Lower Density design to be easily lifted and used	Lb/in^3 (pounds per cubic inches)	Lower the better	**Must be** lower than 4630.5 N in terms of equivalent weight (The Olympics record for weightlifting)[3]	Shall be easily lifted or used by a regular person.

Alternatives Considered

Material	Price(USD /lb)	Fracture Toughness (Ksi.in^0.5)	Elastic Limit (Ksi)	Density (Lb/in^3)
Cyanate ester + high modulus carbon fiber composite, 0 unidirectional lamina	95.2-107(Avg.101.1)	11.6-182(Avg. 96.8)	274-367(Avg. 320.5)	0.0585-0.0603(Avg. 0.0594)
PET (45% glass fiber, recycled content)	1.13-1.53(Avg. 1.33)	5.38-7.01(Avg. 6.195)	21.7-23.9(Avg. 22.8)	0.0607-0.0621(Avg. 0.1228)
Bisphenol molding compound (low density glass-sphere filled)	2.21-2.43(Avg. 2.32)	0.495-0.927(Avg. 0.711)	2-3.2(Avg. 2.6)	0.0271-0.0361(Avg. 0.0316)

Detailed Justification of Selection against Alternatives

Material	Price(USD/lb)	Fracture Toughness (Ksi.in^0.5)	Elastic Limit (Ksi)	Density (Lb/in^3)
Cyanate ester + high modulus carbon fiber composite, 0 unidirectional lamina	--	+	++	-
PET (45% glass fiber, recycled content)	0	+	+	-
Bisphenol molding compound (low density glass-sphere filled)	0	0	0	0

- "Bisphenol molding compound (low density glass-sphere filled)" is considered as the reference material (0 for "same as", + for "better than", - for "worse than", ++ for "significantly better than", -- for "significantly worse than")

The alternatives are compared and graded upon four criteria identified in requirements: price, fracture toughness, elastic limit and density. The prioritization is placed at the fracture toughness and elastic limit as they are required in the conceptual design. There was only one iteration for the Pugh Chart since there were only three options, the third material, i.e. Bisphenol molding compound (low density glass-sphere filled) is randomly chosen as the reference design, the first two materials respectively show different performances compared with it. Despite the first material shows good in "fracture toughness" and "elastic limit", the price of which is relatively too high compared to the other two, while the second material performs well in the first three categories and the density of which is still acceptable for a regular person to lift. Hence the second material, i.e. PET (45% glass fiber, recycled content) is decided to be the chosen one. The good performance it shows in “fracture toughness” and “elastic limit” will directly improve the design factors of usability and functionality of the product.

References

[1] U. of. T. Praxis, "Conceptual Design Report for 3D Vector Operation Learning Tools," Toronto, 2014.

[2] "Density of Plastics," 2014. [Online]. Available: http://www.dotmar.com.au/density.html. [Accessed 13 11 2014].

[3] "Sideney Summer Olympics weightlifting event results," 2014. [Online]. Available: http://www.olympic.org/content/results-and-medalists/gamesandsportsummary/?sport=31728&games=2000%2f1&event=121599. [Accessed 13 11 2014].

[4] "Cambridge Engineering Selector," Unversity of Cambridge, 2012.

Appendices

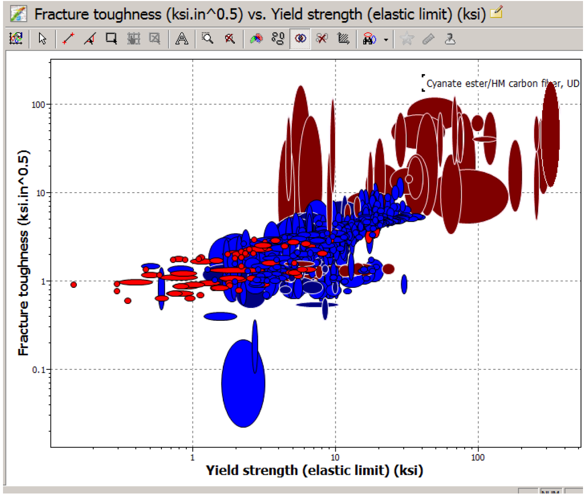


Figure 1. Fracture Toughness-Yield strength (elastic limit)

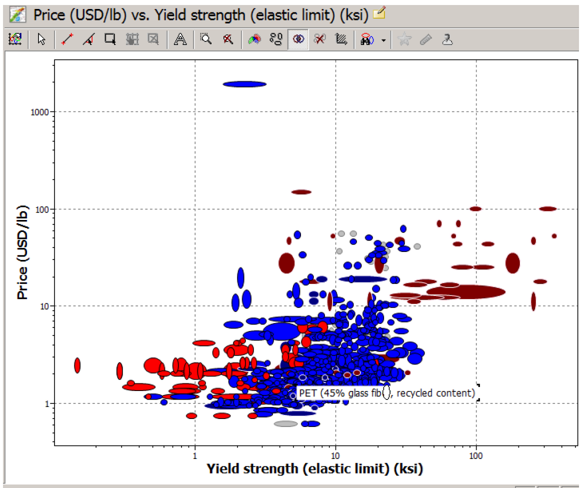


Figure 2. Price-Yield strength (elastic limit)

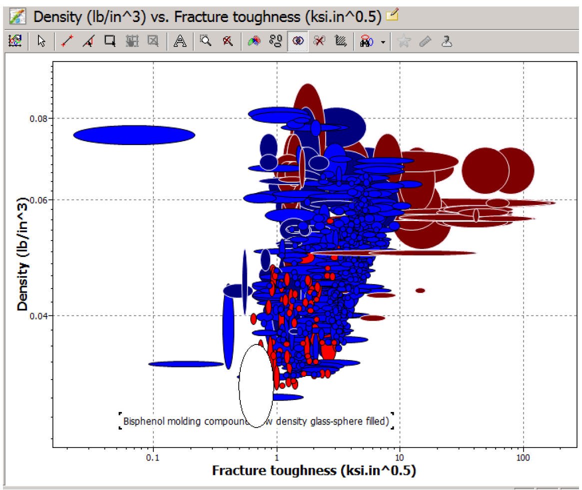


Figure 3. Density-Fracture Toughness

The procedure to get the three figures:

- Open the CES software[4].
- Respectively list "fracture toughness", "elastic limit", "price", "density" as the x or y axis. (As the second and thirds requirements, i.e. fracture toughness and elastic limit are to be considered more, they are much more frequently listed as x or y axis.)
- Find the responding best material on each graph that meets the

F. ***CIV 102 Truss Design (Partly from the Pedestrian Bridge Design Report)***

---Design a truss bridge to cross the valley

Abstract

The following document discusses the details of conceptually designing a pedestrian truss bridge over a valley. This report essentially outlines the details of the design process by highlighting the key design decisions. The key design decisions are listed in logical order.

Key Design Decisions and features

1. Columns will be used to support the truss bridge. By adding columns and splitting up the bridge into sections, the highest compression members in the trusses will decrease drastically. As a result, by using one or two columns, the money saved from cheaper HSS members outweigh the costs of the two columns. The use of columns allows for a cheaper and safer design.
2. Columns will not be in the center of the valley where the river is. The concrete footing in the river is more expensive. Furthermore, longer columns are needed for the center of the valley. Therefore, river columns are avoided to lower the cost of the truss.
3. Vertical columns will be used. Diagonal columns have higher compression members and are much harder to build than vertical columns, increasing cost drastically. Vertical columns also require simpler and clearer design calculations.
4. Two columns will be used to separate the bridge into three sections. Since the river is ~45m wide, and columns must be vertical, the middle section must be at least 45m wide. Therefore, three sections of 26m, 48m, 26m is an appropriate choice for dividing up the truss bridge. Any more columns in the 26m sections would not be cost efficient, as the cost of the column will be greater than the money saved by having cheaper HSS members in the truss. Furthermore, two columns provide the most elegance for the bridge.
5. A hybrid between the warren truss and the bowstring truss will be used for the center span. This truss design was adopted from the “N1 Lynnwood Pipe Bridge” [1]. This truss design was chosen because it is simple, elegant, and the original truss is 72.5m long which is quite close to the 48m truss we are trying to design.
6. The Pratt deck truss will be used for the two shorter 26m sections. Only four very basic designs were considered for these smaller trusses. The K-truss is too expensive due to a high construction cost and a lot of members. [2] The Howe and Warren trusses had higher compression members than the Pratt truss under the same loads. Therefore, the Pratt truss was selected due to lower costs.

Conclusion

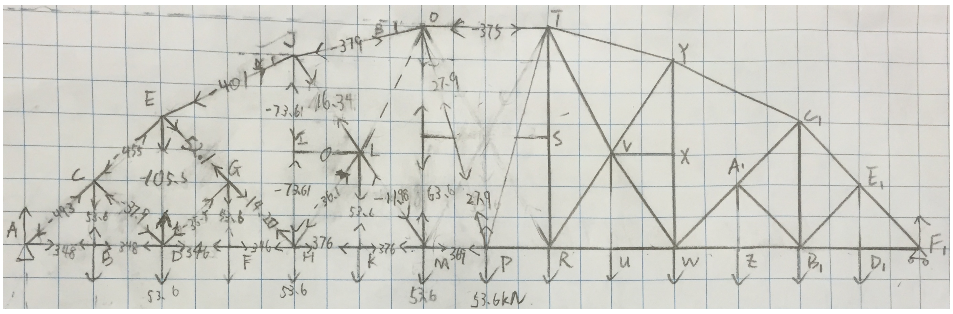
During the design process for this pedestrian truss bridge, cost, safety, aesthetics, and clear calculations were all carefully taken into consideration while making key design decisions. Most importantly, the bridge incorporates a design from an existing pedestrian bridge which had received an award for its ingenuity in design.

[1] http://www.chavani.co.za/content/n1-lynnwood-pipe-bridge
[2] http://www.garrettsbridges.com/design/k-truss-analysis/

The procedure of designing the bridge span:

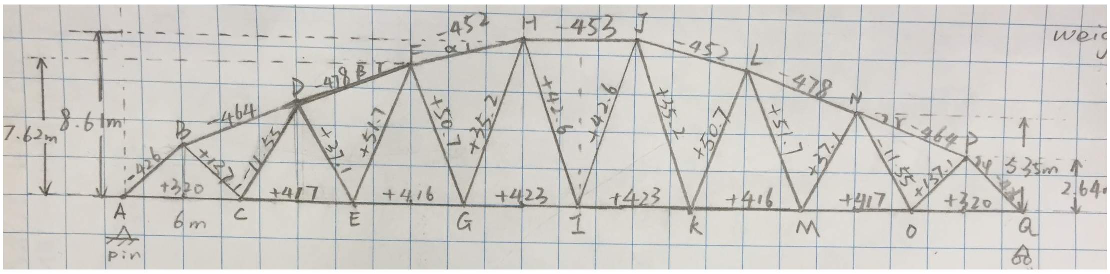
The overall objective of the task, as outlined in the RFP, is to design a bridge which has an effective span of at least 100 m to cross a valley, while more detailed objectives include reducing cost, supporting the loads and increasing the aesthetics of the bridge. In order to meet those objectives neatly, three different designs were evaluated, and two of which were decided to be included in the final design (for main body and sides respectively).

First design:



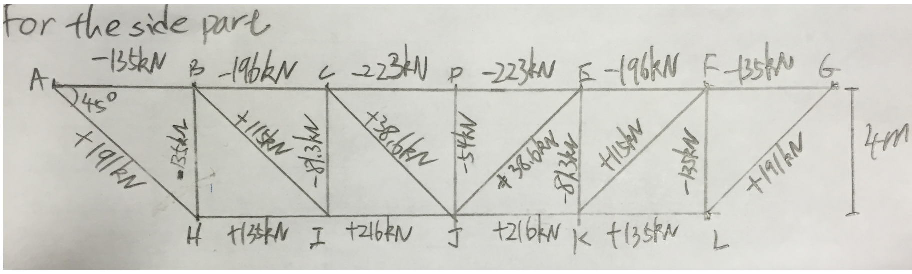
The first design was completed by one of my teammate and me, the advantage of which is that it shows well in aesthetics, and also it is an one-body-only design which crosses the valley all by itself. However, in further calculation procedure, I found that the calculations could not be completed with the CIV and calculus knowledge learnt, while the rough cost of the ridge is very high. Eventually we moved on to the other designs listed.

Second design:



The second design was also completed by one other teammate and me, which was adopted finally to be the main body of the bridge (48 m in length). The bridge was inspired by an existing bridge in South Africa, which has a length of 70 m, and the design here was conducted by scaling the original design (70 to 48), which does not cost too much on raw materials (the height of the bridge is considerably low compared to the first design) and is able to support the given load well. The other parts of the bridge were designed to adopt the third design.

Third design:



The third design was inspired by the design mentioned during the CIV 102 lecture and is easy to calculate as well as analyze. Two side parts of the span (24 m respectively), was designed to adopt this design, where the compression and tension are considerably little and the cost is reasonably low.

Pugh Chart

	First Design	Second Design	Third Design
Cost	0	+	+
The maximum compression	0	+	+

*The first design is considered as the reference material (0 for "same as", + for "better than", - for "worse than")

The final design in total cost around 130, 000 dollars, which is lower than most of the other designs, which proved to be economical while it can still support the given loads well.

G. ***To Infinity! (based on Praxis Survey I)***

---This is where everything begins

So, why engineering?

'Nasty' jobs, short life-span, a rather 'torturing' studying period... These are the reasons why my classmates in high school didn't choose engineering. However, maybe due to the family influence (my father himself is a respectable engineer) and the shock the 'invincible' Tony Starks and Mark Zuckerbergs have given me, I chose engineering anyway.

We are born on this tiny planet, we live, we struggle and we survive. Tools gift our ancestors the courage to say farewell to the wet, dirty and crowded caves; wisdom presents our elderly generations the magic to build wonders and change the world. The two above are the foundation of our society, relations and ourselves, which can be easily found on an engineer. In my own way, I'd rather compare engineers to the magicians of this world, it's the engineers that built up what the mass refer to as 'magnificence'.

From spacecraft to the hottest Bugatti Veyron, from cyber games to the latest iPhone, engineering is the key to every door. Just like Egyptians built up the pyramids, the new sexy of today is to use this key to find or moreover create doors.

In my motherland China, which is frequently described as a country without 'passion' or 'creativity', there was a Tony-Stark-style engineer about 400 years ago called Hu Wan. Wan is a man daring to explore the world with his own hands and intelligence, unbelievably he built himself a rocket and lift himself up to the sky. Though this was a tragedy to Hu, it also draws the spirits of engineering: To challenge and to infinity.

How can a teen not be excited when facing a new journey like this?

Engineering is the way to infinity!