2022 Career Readiness Online Challenge

Team: 1011J

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Introduction

Chapter 1 - Introduction

I am shocked.

It is amazing to me, even several weeks later as I am writing this, of how incredible this place is. Beneath my feet, was the **largest cyclotron in the entire world…**

Hi! My name is Eric Xie, a robotics student at **Ten Ton Robotics.**

I have always been interested in physical sciences, for example, **astronomy and physics.** Therefore, when I decided to tackle this challenge in my first year of robotics, I thought it would be a good idea to combine **engineering** with **science**, so I could learn more about both of these subjects.

In the story below, I will take you through my experience at **TRIUMF - Canada's particle accelerator center and national laboratory** - as well as their engineering process.

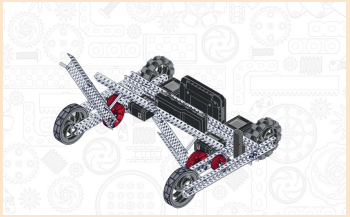
Spoiler alert: the cyclotron was literally mind-blowing! So put on your helmet and let's get started!

02
VEX Robotics Engineering Process

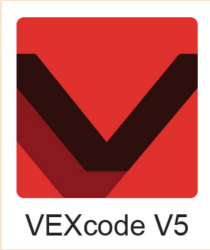
Chapter 2 - VEX Robotics Engineering Process

Before we get into the tour, let me introduce you to the Engineering Process at VEX Robotics. It is made up of 6 sections.

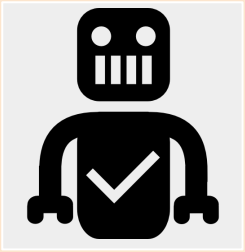
*1) **Idea -** Research and collect designs on Youtube and VEX Forum.*



*2) **Build -** Prototyping.*



*3) **Code -** Give out orders to accomplish tasks in autonomous and driver control periods.*



*4) **Test -** See if the robot and all the programming work as expected.*

*5) **Drive -** Be familiar with maneuvering your creation.*

*6) **Fix -** Find out and fix the problems that arise.*

03

TRIUMF Tour

Chapter 3 - TRIUMF Tour (1/4)

My mouth gaped open as I stepped into the Meson Hall of TRIUMF. The ceiling itself was higher than Costco warehouse (1).

“This is our main cyclotron, which has the power of 520 million electron volts!” (2), explained **Michael Trinczek**, the Irradiation Manager at TRIUMF (3). He led us on top of the machine, where engineers are conducting maintenance.

Mike then led us to a model of the machine (4), and explained how the contraption accelerates protons to ¾ the speed of light!

(1) TRIUMF - Meson Hall

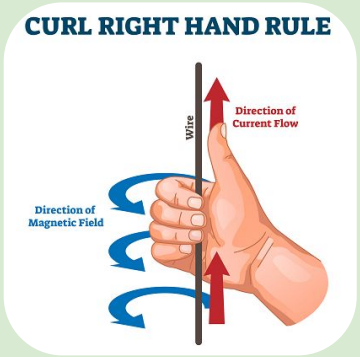
(2) Cyclotron

(3) Michael Trinczek

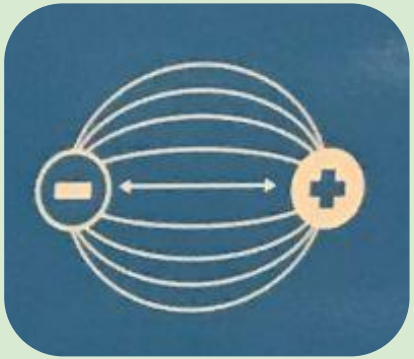
(4) Model

Chapter 3 - TRIUMF Tour (2/4)

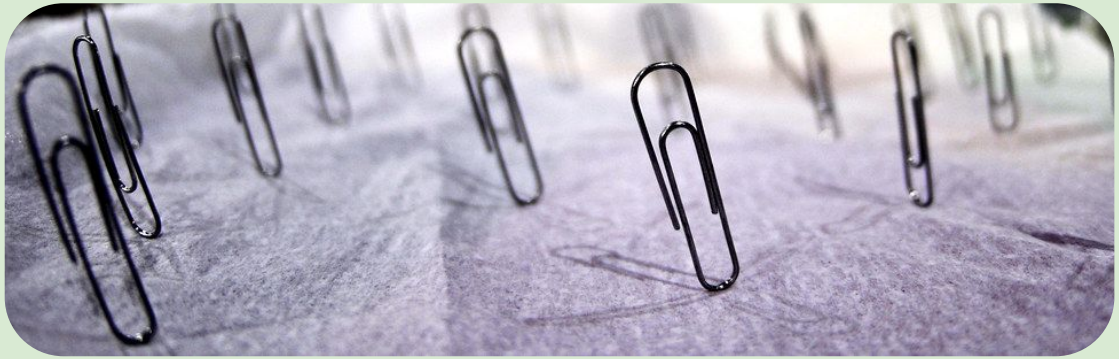
"First of all, the **magnetic field** determines the direction of the protons - clockwise or counterclockwise (5). The field is so strong that paper clips can stand up on their ends (7)! Secondly, the **electric field** flips **23 million** times a second to accelerate the protons as it shoots out of the beamline to near **speed-light** (6)!"
I am thrilled to see the beast in action, but alas, the cyclotron isn't in operation today.



(5) Magnetic Field



(6) Electric Field



(7) Paper Clips Standing Up

Chapter 3 - TRIUMF Tour (3/4)

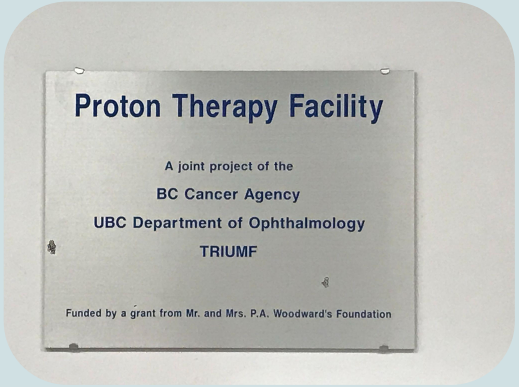
"What do you do with such high-energy particles?" I asked curiously.

"Let me show you an example", Mike responded.

Our group was led downstairs to a little chamber named **"Proton Therapy Facility"** (8) (9).

I've never seen anything like this place. Two holes jutted out from the wall, precisely locating where high-energy protons are flying out from (10). They would go straight into the patient's eye and hopefully kill the cancer cells.

I winced at this idea (11).



(8) Sign

(9) Danger Zone

(10) Beamline 1 & 2

(11) Radiation Remained $5.9 * 10^{-7}$ Sieverts per Hour

Chapter 3 - TRIUMF Tour (4/4)

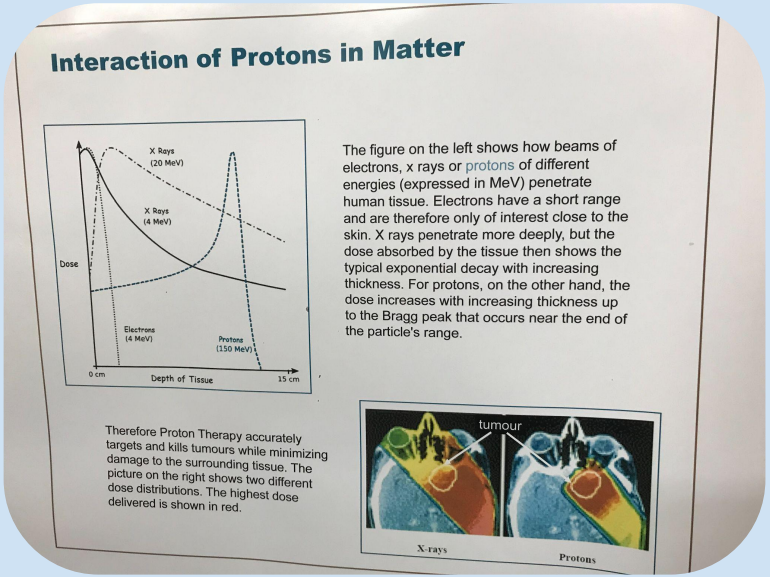
"Why don't we use X-ray instead of protons? Isn't that more ubiquitous?" I wondered.

Mike pointed to a poster on the wall (12) (13).

Like a jigsaw puzzle being put together, I am delighted to understand the cyclotron and what it is used for.

Finally, I asked what I came here for: "What is your engineering design process? How did the facility come up with all of these amazing projects?"

"Well," Mike said, "that is a long procedure…".



(12) "Protons can penetrate deeper into the skin without causing mass destruction like X-rays or electrons. Thus the former is much safer and effective at killing tumors deep in the eye".

(13) Individual's Eyepiece

04 TRIUMF Engineering Process

Chapter 4 - TRIUMF Engineering Process (1/2)

1) ***Idea -***

Someone comes up with an idea. The leadership team decides if it's within the mission of TRIUMF.

Ex. They cannot start making video games out of nowhere.

2) ***Designing -***

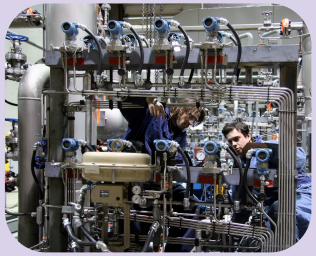
Come up with a design. Can it be physically made? Does it work in CAD?

3) ***Resourcing -***

Based on the design. What materials does it need? How many people does it require? How long does it take to build it?

4) ***Funding -***

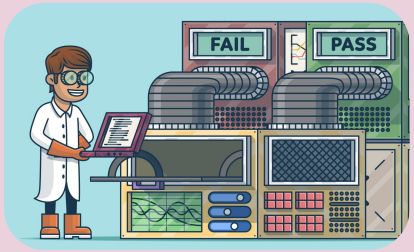
Demand for materials, people and time needed to build it.

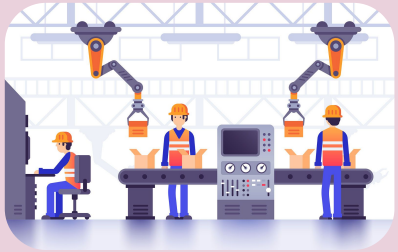


5) ***Construction -***

Assembling parts.

Chapter 4 - TRIUMF Engineering Process (2/2)





6) ***Testing -*** *Scientists and technicians make sure the system works.*

7) ***Commissioning -*** *Operation begins when the system is safe and has passed all tests.*

8) ***Training -*** *Recruit employees to operate the machine, especially if it's complicated like a cyclotron.*

9) ***Production -*** *Hand of the products to the final users.*

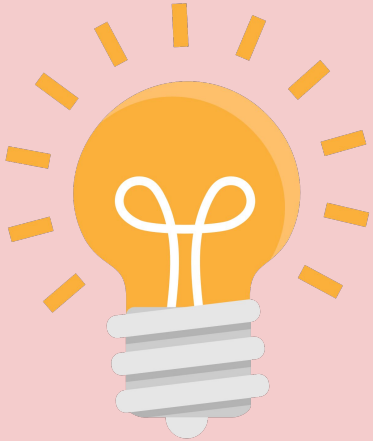
10) ****Decommissioning -*** *Optional. How to safely shut it down at the end of its life?*

05
Compare and Contrast

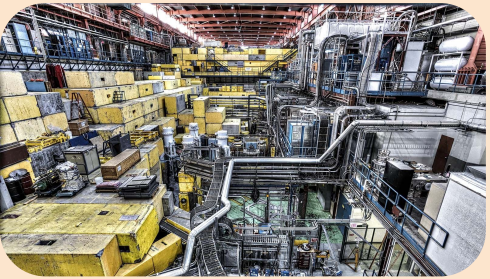
Chapter 5 - Compare & Contrast (1/2)

Similarities:

1. We both have the idea and design section where we decide what to make.
2. We both include the process of building where we assemble parts.
3. We both have the testing part where we examine if the systems work.

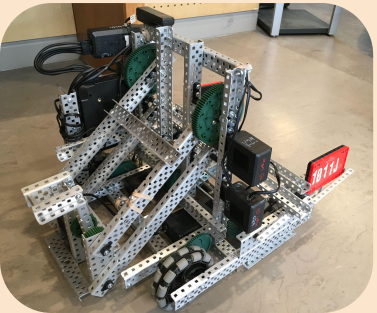


Chapter 5 - Compare & Contrast (2/2)



TRIUMF

VEX ROBOTICS COMPETITION TIPPING POINT



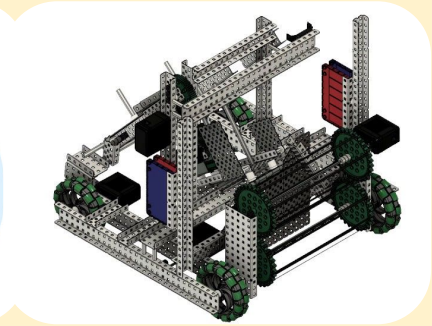
Differences:

1. TRIUMF tries to fix every error in the designing phase before building, while my team does all the fixing after building and testing.
2. TRIUMF has a resourcing section which I didn't mention in my engineering process, because the materials needed are usually in my kits, while the number of parts for TRIUMF is much higher.
3. TRIUMF includes a funding section where VEX Robotics doesn't need.
4. TRIUMF has collaborative training while VEX Robotics has competitive driving.
5. TRIUMF has production where they see the fruits of effort, while our robotics team goes to tournaments.
6. In the end, a successful project at TRIUMF is here to stay, while VEX Robots are taken apart after one year to prepare for the next year's game

06
Improvements

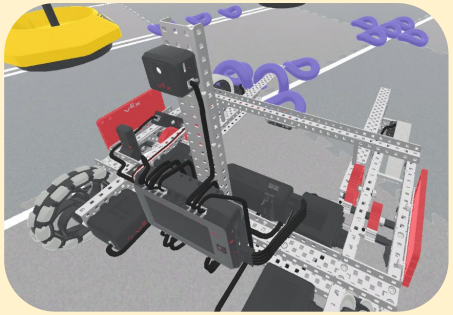
Chapter 6 - Improvements

(1) Share ideas



(2) Design in CAD

(3) Estimate resources



(4) Practice driving

Our VEX Robotics team can make a lot of improvements:

1) Share our ideas with our seniors and coaches before we start building to get second opinions on our designs.
2) Build a CAD in the designing phase so we can anticipate mistakes before they arise. We can save a lot of time this way.
3) Estimate the materials we need, like C-Channels and Pneumatics, so we can plan for them in advance.
4) Spend more time driving. As an example, without the training section from TRIUMF, the machine will be fully operational, but no one will know how to use it, therefore rendering it useless. The same logic applies to VEX Robotics: even if you have a perfect robot, without skilled driving, you cannot succeed in tournaments.

07
Conclusion

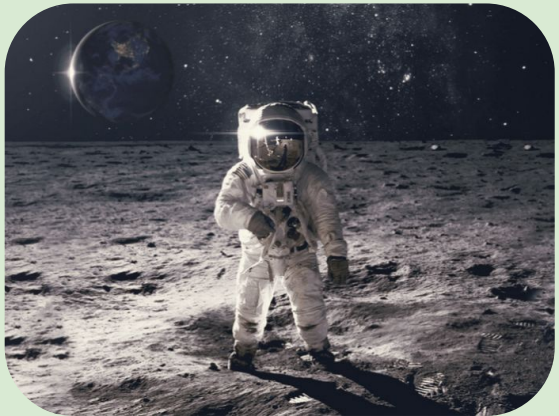
Chapter 7 - Compare & Contrast

I learned a great deal here in TRIUMF.

1) Robotics skills are greatly needed at TRIUMF to remotely handle radioactive materials.

2) My robotics team should improve in many ways. (See Chapter 6)

3) Last but not least, I am determined to pursue a career in the intersection of Science and Robotics, with my dream of becoming an Astronaut.



08
Credits

Chapter 8 - Credits

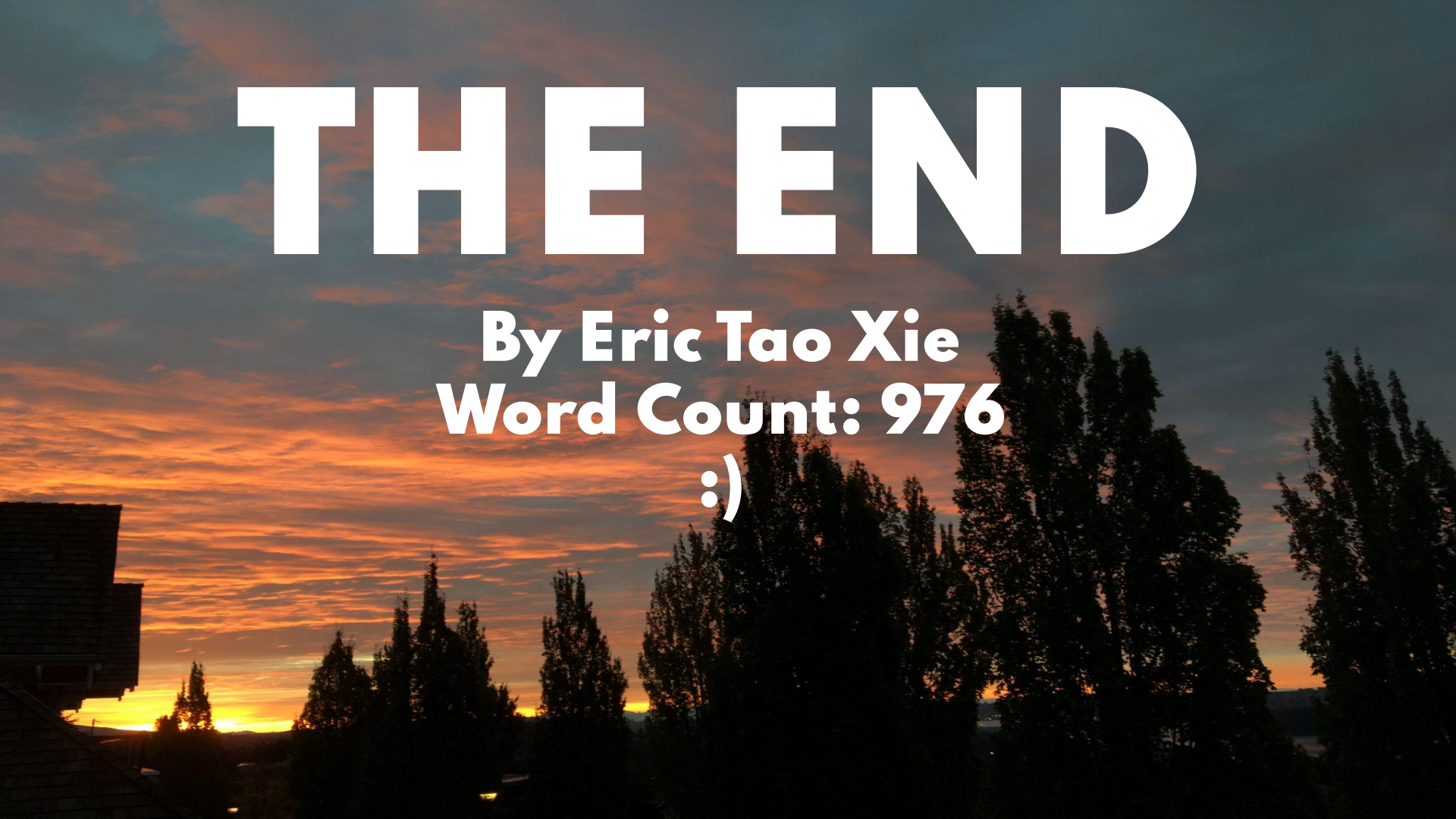
Thanks to Michael Trinczek for this unbelievable tour at TRIUMF.
I appreciate the company of my friend Borna Amjadi and my mom Ling Xu.
I thank my VEX Robotics coaches for their support.
Last but not least, I cannot complete this project without my 1011J teammates, Leo Yasuda and Daniel Pan.

For more information, go to triumf.ca, or watch this Linus Tech Tips Video!

Ending

As sunset settled over Metro Vancouver, cars bustled around on the highway. Scattered clouds and the twilight sky brought an indiscernible calm over me as I pondered over my conversation with Michael Trinczek and the tour at TRIUMF. The day had been captivating and I was more resolute than ever that I will be working in the STEM field. Combined with space exploration, perhaps, and just perhaps, I will find myself as an Astronaut in the distant future.

A wisp of a smile tugged at the side of my cheek as we moved forward, into the sunset and beyond.


THE END
By Eric Tao Xie
Word Count: 976
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