VRC High School Career Readiness Online Challenge 2022

The Engineering Design Process in Cybersecurity

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In July 2018, the personal information of 1.5 million SingHealth patients was stolen by foreign hackers, obtaining their names, IC numbers, birthdates and more, as reported by TODAY Singapore. Digital technologies have undoubtedly integrated into our daily lives, but when sensitive information and networks that keep the world moving are at risk of being compromised, the constant threat of cyber-attacks elicits the need to better secure our digital world.

This is where cybersecurity comes of critical importance, protecting the Internet and computing systems that support our day-to-day digital services. Seeing how the STEM skills I picked up under the Vex Robotics Program were applicable in the programming and engineering design approach in cybersecurity, I became deeply interested in this field.

As such, I decided to intern as an Associate Red Team Engineer at the Singapore Government Technology Agency's (Govtech) Cyber Security Group to learn more about a career in cybersecurity. I approached this internship with the hope of improving my skills and learning more about what a cybersecurity specialist does.

Under the Advanced Cyber Attack Simulation division, I was involved in the development of customised software solutions to uncover cyber vulnerabilities, through mimicking how an adversary might mount an attack; helping to identify vulnerabilities and stress-test response strategies to better secure ICT Systems. Being able to get a glimpse of cybersecurity at this level, I was grateful to attain such an enriching opportunity.

Under the VRC Program, I have become extensively familiar with the engineering design process in competitive robotics. This iterative framework of establishing the problem, brainstorming solutions, rigorous testing and continuous refining turned out to apply not just to robotics, but to cybersecurity as well.

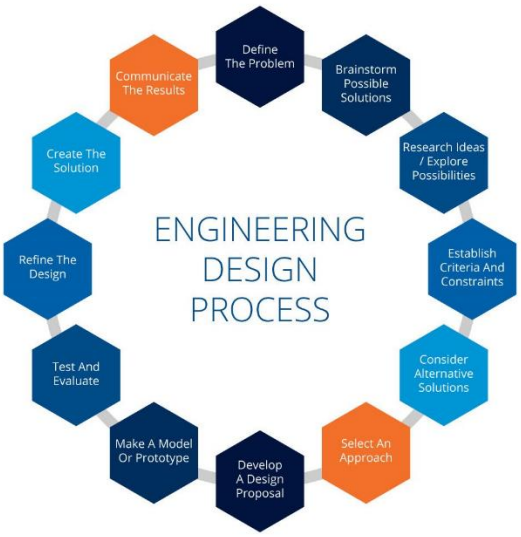

Figure 1 (right): The iterative procedure of the engineering design process

During my internship, I gained a deeper insight into their engineering design process. Govtech functions on a scrum structure, where each product is created in iterative "sprints" within 1-2 weeks. This short time period allows for more flexibility, as any changes can easily be worked into the next sprint. Each sprint consists of three major components, closely following the engineering design process.

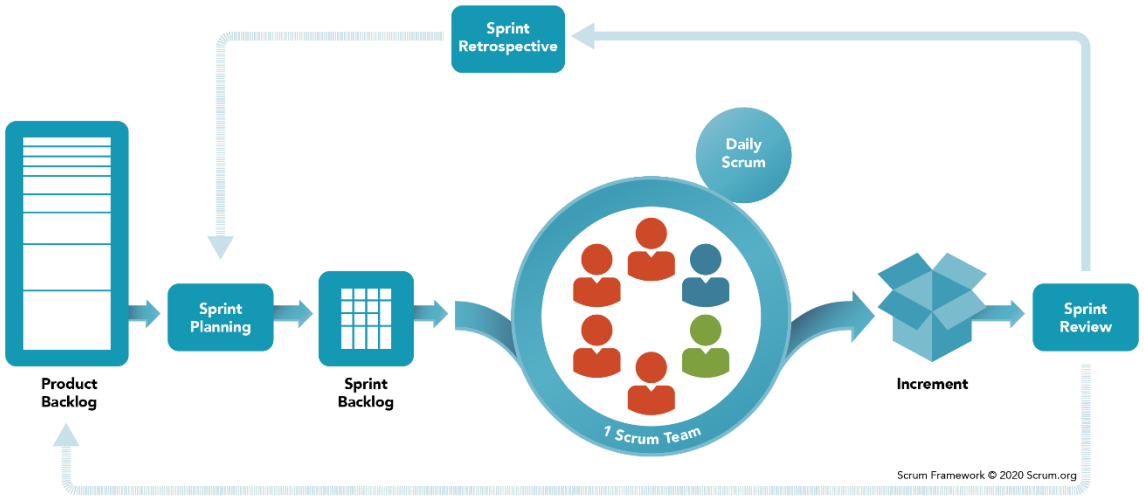

Figure 2: Flowchart diagram of the Scrum Structure Framework

Before any work can begin, the team will meet to prioritise features for the product and create a product backlog of features that they intend to add during the sprint. This is known as sprint planning, where team members brainstorm deliverables and formulate plans to achieve them.

Over the course of the sprint, daily meetings are held to ensure everybody is on the same page. At the start of each day, team members take turns presenting in stand-ups what features they created and implemented yesterday, their objectives for the day, and any roadblocks they encountered. This ensures that all team members are of the same understanding and working toward creating a unified product.

Concurrently, team members performs A/B testing over the course of product creation; a test where two versions of a product are rolled out to users. Whichever version attains the most clicked logged over the fixed time frame is noted to be more successful and will be adopted for long term use and continued development.

After every sprint, the team will meet to review progress and processes in a sprint retrospective. Over the course of this meeting, the team will gather feedback on features and functionality, and discuss strong points and areas of improvement. This is useful as good practices can be kept, while proposed improvements can be immediately adopted at the next sprint.

Overall, the engineering design process at Govtech was largely similar to the design approach I applied in Vex. Both approaches were fundamentally similar, but differed in terms of testing and refining, as can be seen in the table below:

Application of Engineering Design Process in:	Students in Vex Robotics	Cybersecurity
Similarities	Both follow the general framework of the engineering design process; in brainstorming ideas, evaluating solutions and rigorous testing.	
	Both are iterative processes of continual refinement to produce the most effective and appropriate solutions.	
Differences	In Vex, we evaluate our robot based on its functionality, autonomous code and strategical execution in competition.	In cybersecurity, products need to pass higher quality assurance tests on top of meeting their intended objectives. If any issues or bugs are found, solutions are returned to be prototyped and redeveloped.
	Based on the effectiveness of our robot, we refine and optimize various components as practically possible to perform consistently well.	Cybersecurity engineers have to further consider a balance between optimization, cost saving, end-user feedback and quality of life improvements in choosing the best way of further refining the product.

Figure 3: Table comparing the engineering design process in employed in cybersecurity and in Vex Robotics

My internship allowed me to apply the skills I gained from Vex in a new and exciting way. My experience with prototyping designs for different games has honed my divergent thinking skills, which I used to find ways to meet the various demands of consumers. Furthermore, Vex has also equipped me with a multitude of soft skills that I have been fortunate enough to use over the course of my internship.

In approaching each Vex game, we learnt to apply a broader engineering design approach towards strategizing, designing and programming. Analysing various aspects of the game allowed us to consider successful strategies under the constraints in place; before determining the tasks the robot needs to fulfil. This

allowed us to streamline our design choices towards prototyping efficient and optimal mechanisms towards our objectives.

Having worked in various teams, the importance of collaboration and communication across splitting tasks became clearer across various projects, where finding common ground helped direct our efforts towards a united objective. The VRC program acted as a competitive domain that simulated real-world scenarios, pushing me to adapt and perform in the heat of competition. The brief yet vital autonomous period also encouraged brainstorming and creative optimizations of code-based solutions to gain an edge in every match.

Team 8059Z for the VRC 2020-2021 Change Up Season

Overall, my experiences under the VRC Program have equipped me with a better understanding of the standard engineering approach and vital soft skills for STEM careers, engaging me to inquire, investigate and iterate ideas towards present-day issues.

(994 words)

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