Architectural and Robotic Engineering Design Processes

From miniature, individual robots to colossal, largescale buildings - the underlying foundations for success are fundamentally the same.

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(Excluding title page, citations, credits and all picture captions)

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Introduction

Architecture as a STEM Career

"If you take a look at the most fantastic schemes that are considered impossible… you realize that they can be possible if we advance technology a little bit." - Michio Kaku

We have opted to focus on the STEM career of Architecture and we shall investigate how this profession utilizes the Design Process. We'll highlight the similarities in how we have used the engineering version in VEX ourselves.

We have chosen Architecture as our entire team takes a very keen interest in this field. We know many people who are training or working in industry and have tapped into a rich variety of these resources when researching for this report.

We researched into the design process of The Shard, London to understand the process of designing and constructing buildings. Through speaking to architects, we've been given a deep insight into how they are successful and how this correlates to our own experiences whilst taking part in VEX. There has been a great shift to making sustainable buildings and this is something we try to achieve also by reusing parts from previous builds and doing minimal 3D printing as it uses vast resources and the parts aren't always reusable.

Engineering Design Process

How is this used by Architects

"As an architect you design for the present, with an awareness of the past for a future which is essentially unknown" - Norman Foster

An architect oversees the process of erecting buildings from their conception until construction.

The architect first must define what specifications the building will have and what constraints it must adhere to. Research will then be conducted followed by brainstorming ideas that will eventually lead to the design of a building on paper. Small scale prototypes can be created and feedback sought. Issues raised are actioned and the designs refined and improved until a viable solution is created. Then detailed blueprints are produced and delivered to the construction team.

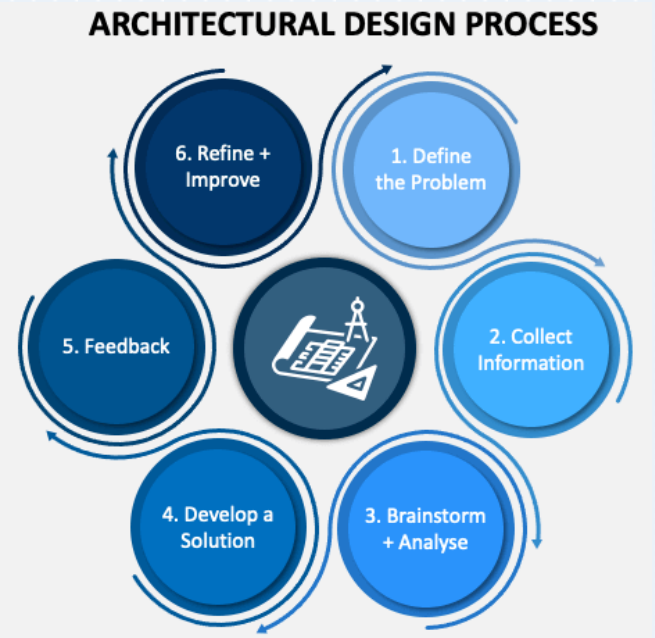


Figure 1 The Architectural Design Process

The term architect derives from the Greek (arkhi-, chief + tekton, builder), chief builder. This corresponds directly to what we, as part of our VEX team, do. We design and build robots that aim to win challenges, the same way architects design and build buildings for us to live in and use. The design process used by architects is shown in Figure 1 and the engineering design process we have used when building and developing our robot is shown in Figure 2.

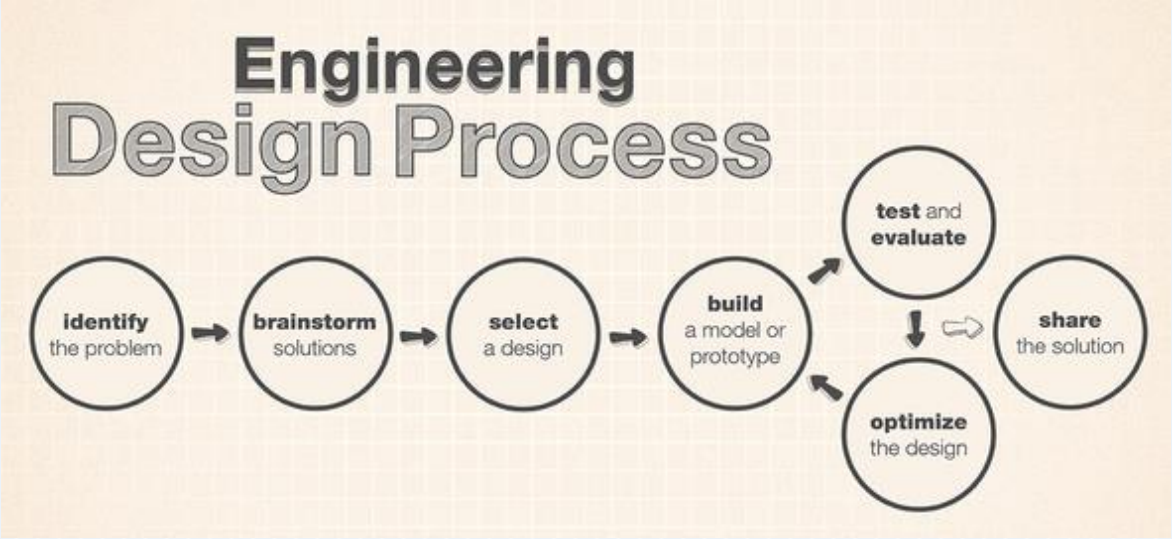


Figure 2 Robotics Engineering Design Process

Similarities and Differences

Between Architecture and VEX Robotics

"One can state, without exaggeration, that the observation of and the search for similarities and differences are the basis of all human knowledge." - Alfred Nobel

Define / Identify Problem

As detailed in the first step in both design processes, before any designing can begin, the problem must be identified and defined clearly. This is to ensure the building or robot created will meet all the requirements and work within the constraints detailed.

Brainstorm /Analyze / Collect Information

In both processes, the next stages will be to collect as much information as possible to ensure the best solution is created. After analyzing the information obtained during this research process, brainstorming can commence in the form of sketches to help visualize what the final design will be. Figure 3 is a sketch of our own robot and Figure 4 is that of architect Renzo Piano.

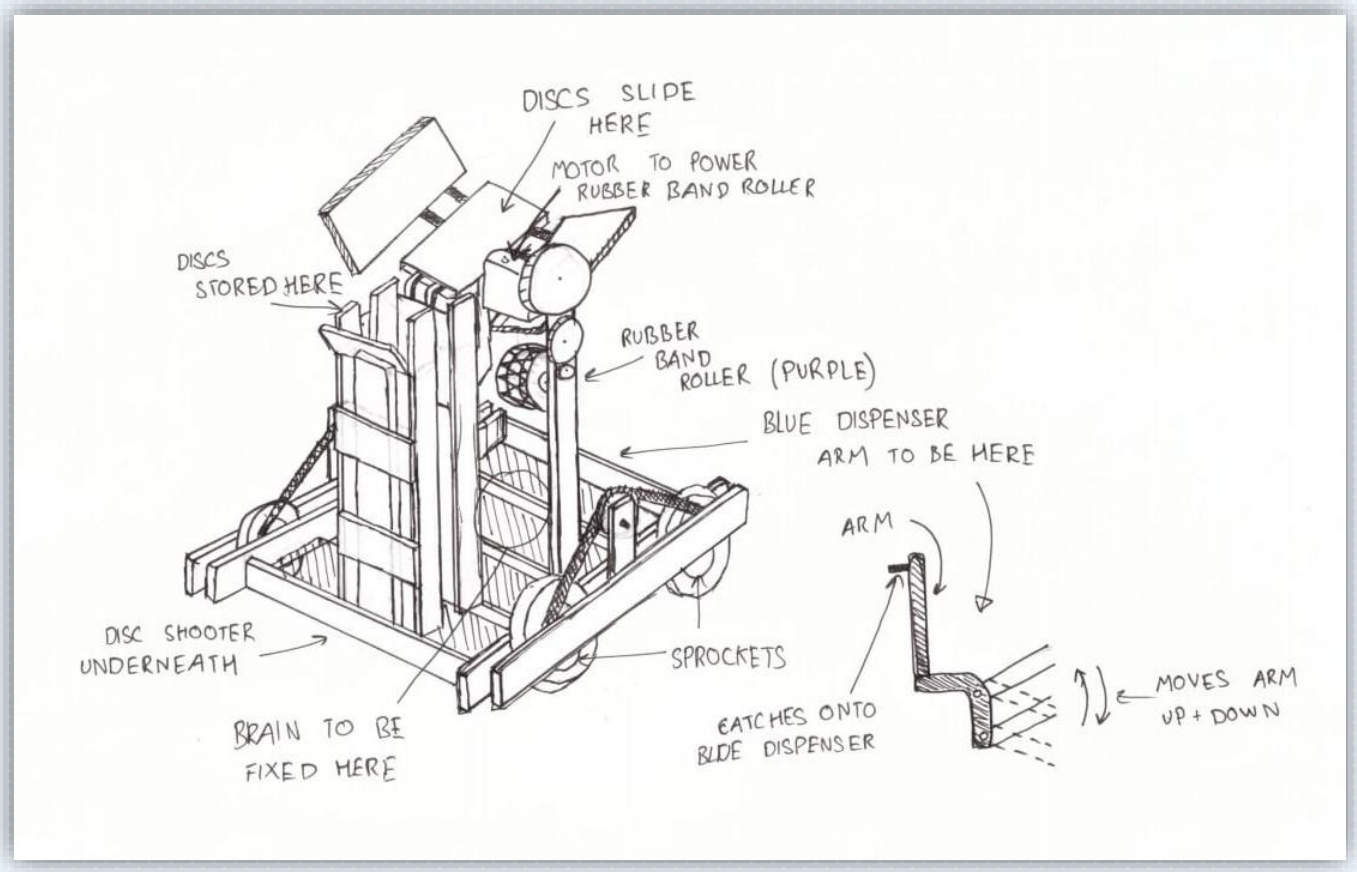
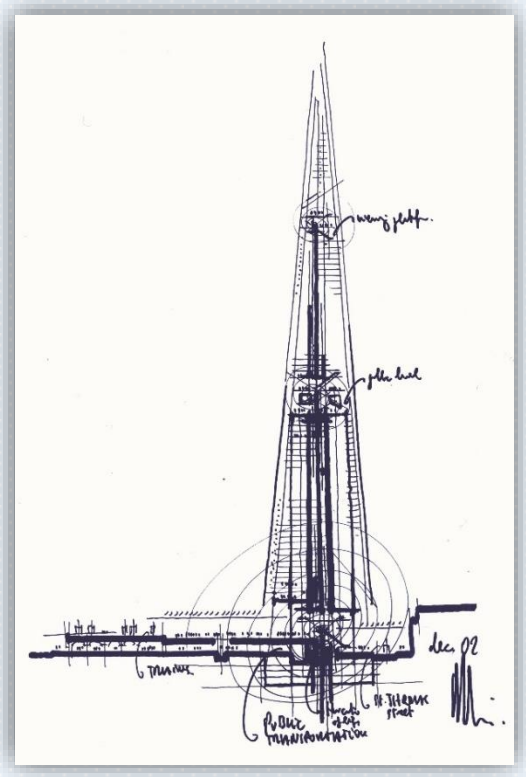


Figure 3 This shows an annotated sketch for our robot that we created whilst brainstorming ideas



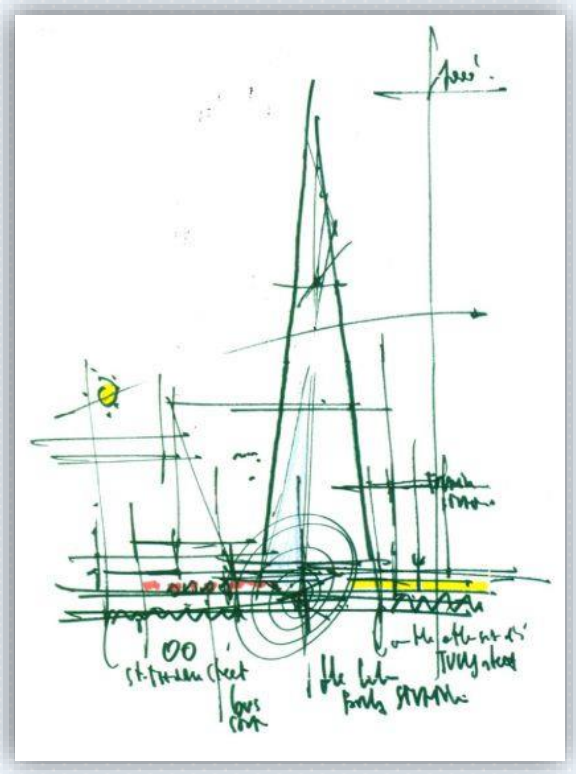


Figure 4

The architect Renzo Piano's initial brainstorming for The Shard

Develop a Solution / Select a Design / Build Model / Prototype

The next stage in both processes is to develop initial ideas further until a viable solution can be selected from which small scale models and prototypes can be built. Notebooks detailing the evolution of ideas (Figure 5 and 6) are very important to architects and ourselves. These can then be translated into scaled, accurate drawings in CAD software (Figures 7 and 8) to see how all the pieces will fit and work together.

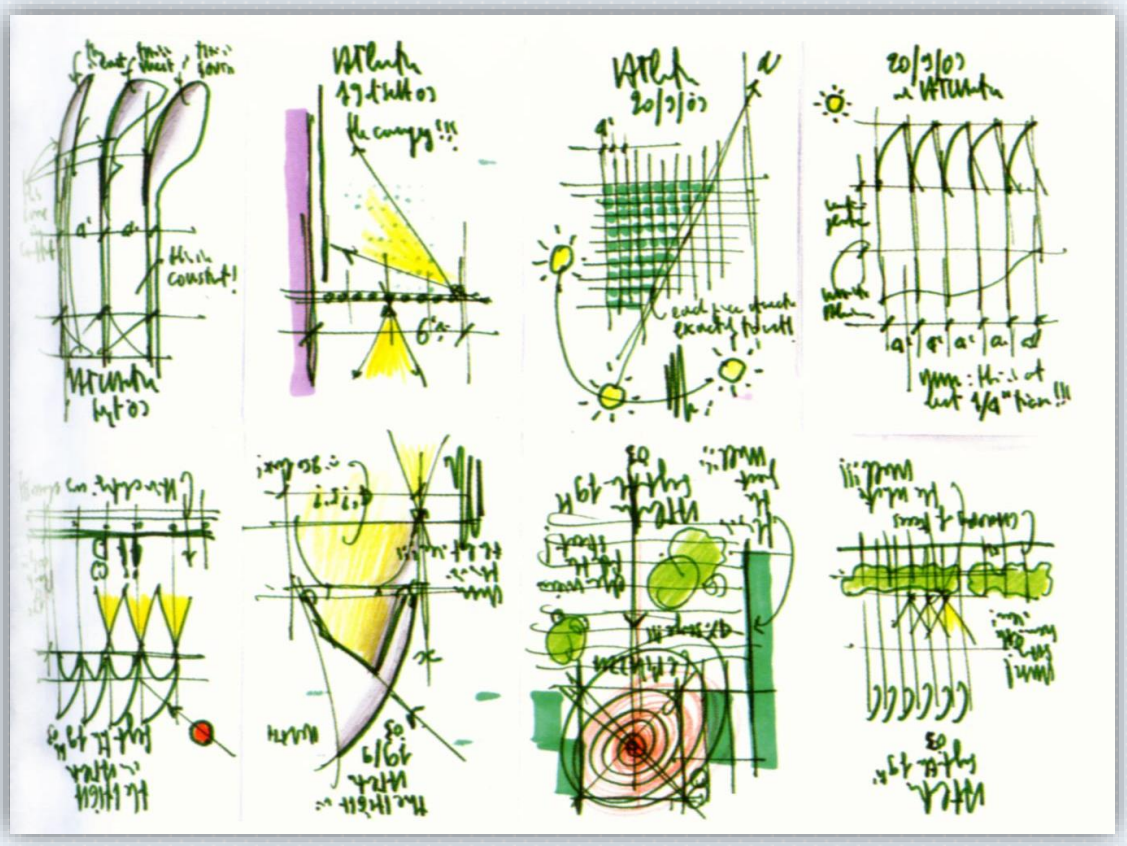


Figure 5

Example pages from architect Renzo Piano's notebooks where ideas are developed and notes kept. Annotations are added as ideas are refined.

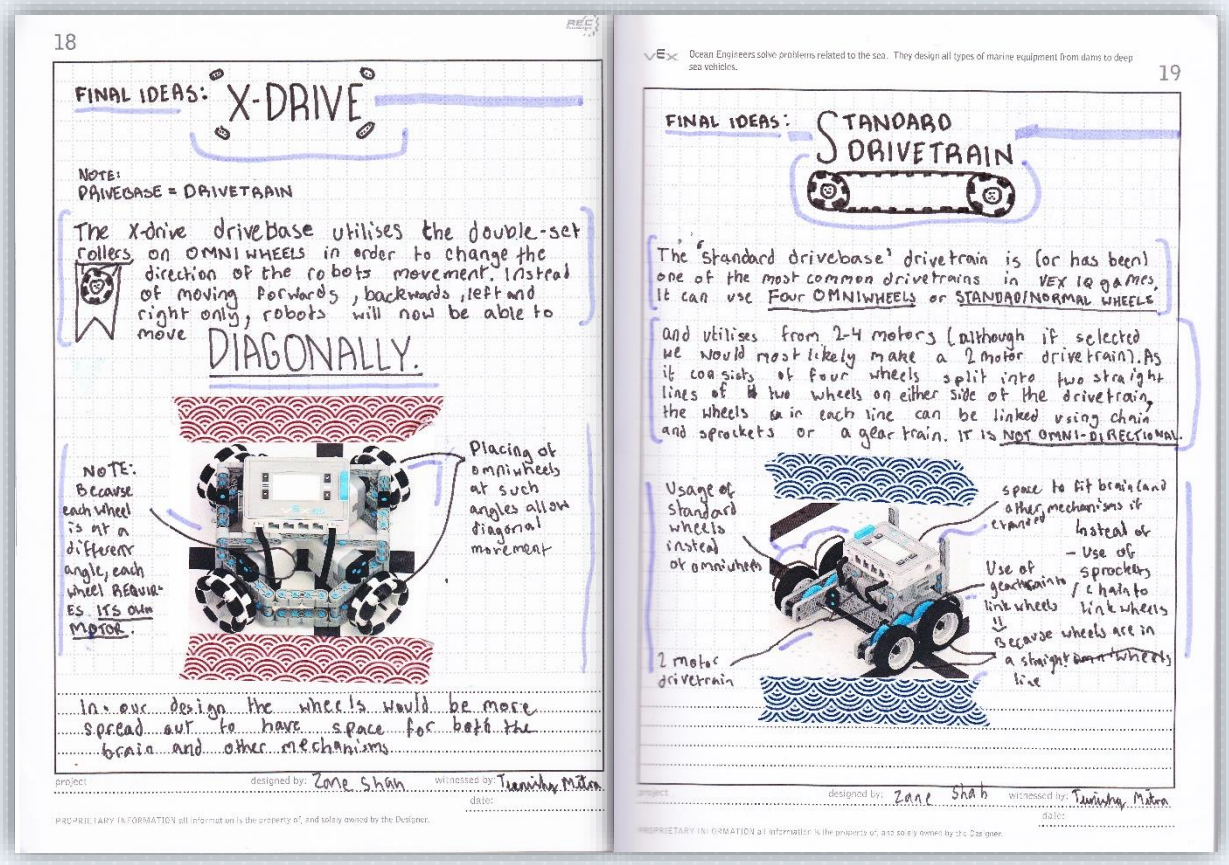


Figure 6

Two pages from our own design notebook which shoes the evolution of our ideas for our robot. The notes contained are added by the team and this record helps to keep a track of our thoughts and ideas.

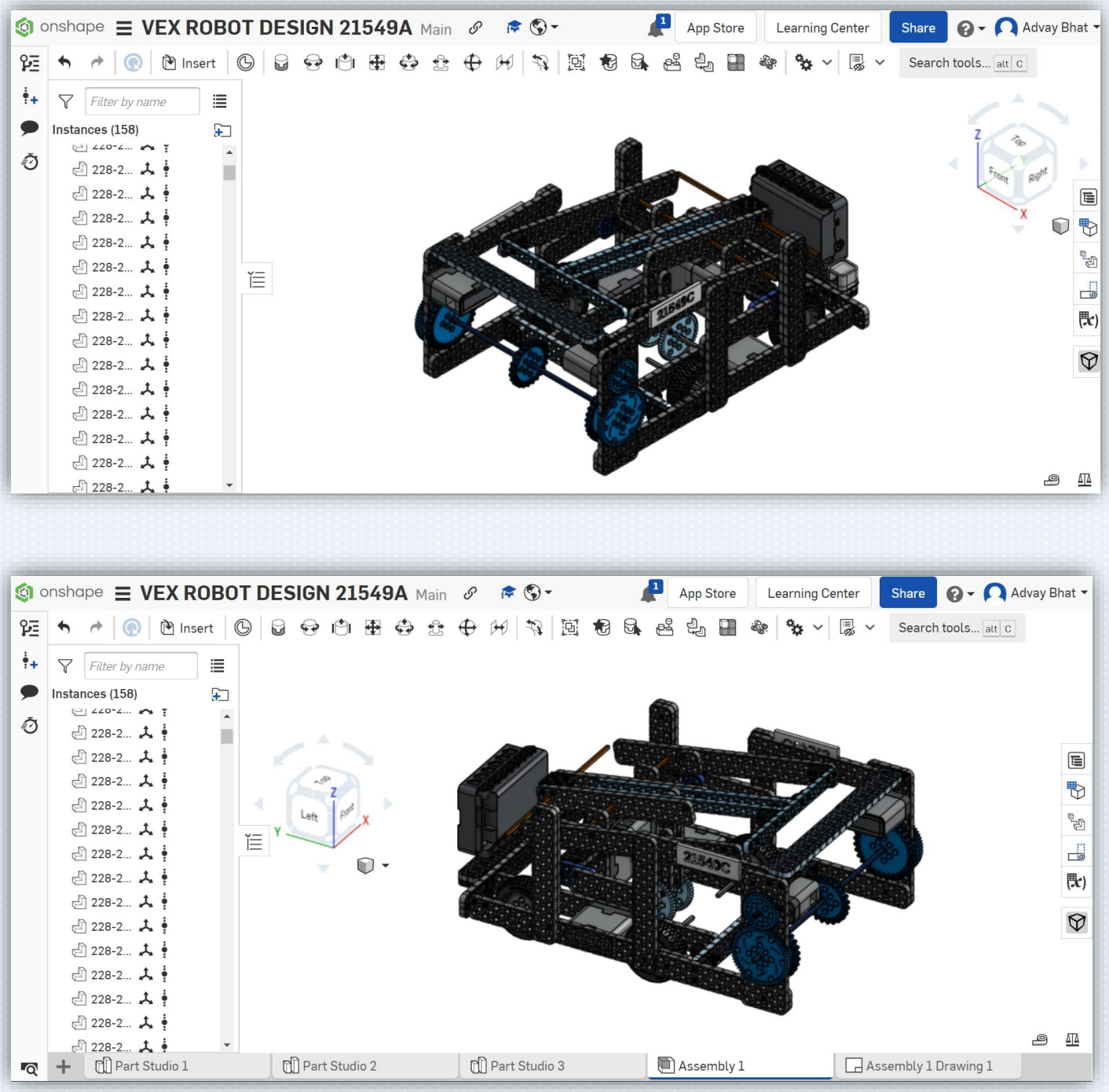


Figure 7 Screenshots of our robot being designed in OnShape

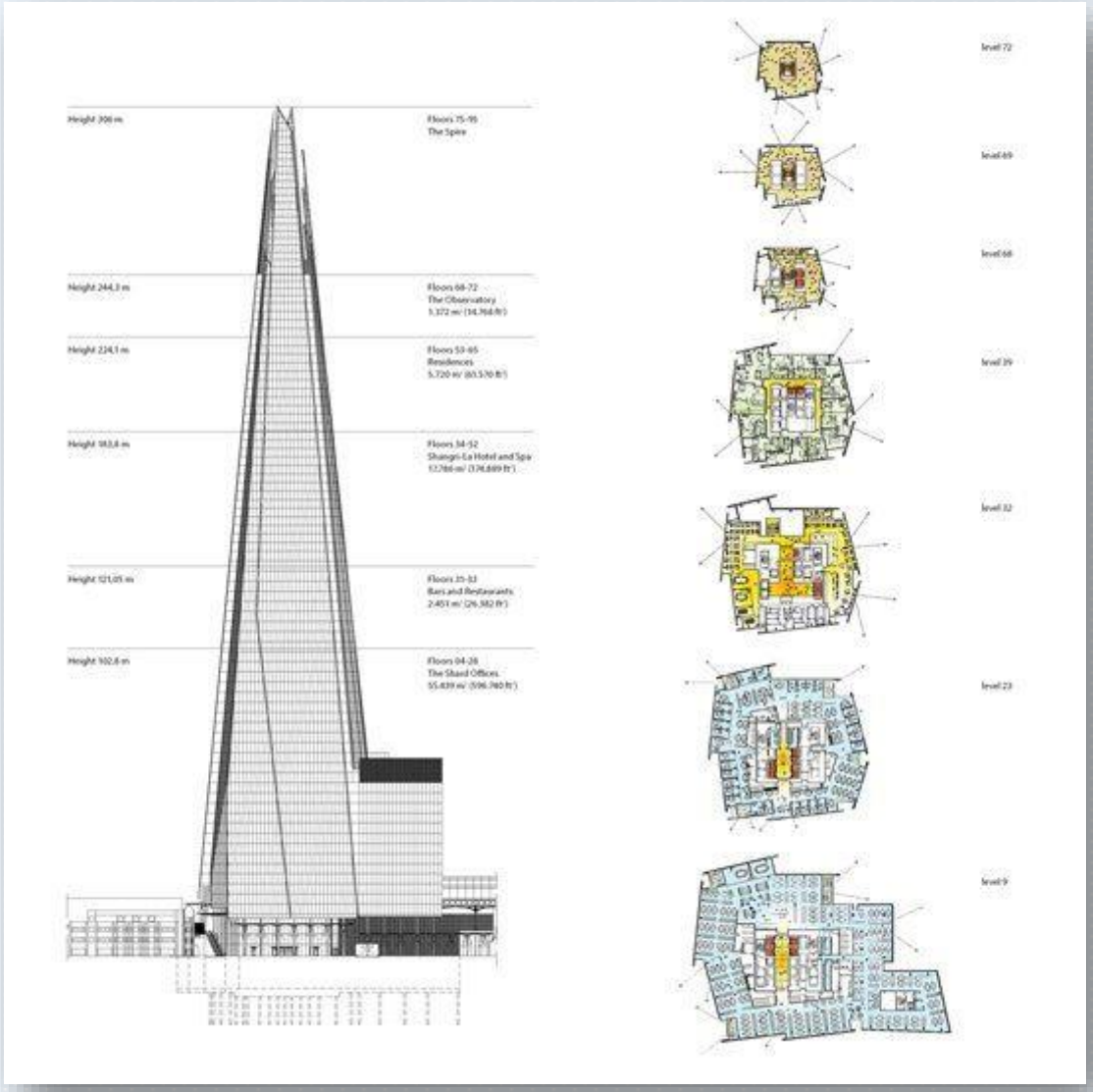


Figure 8 The architects working on what The Shard would look like in the CAD software.

Feedback / Test / Evaluate

Once prototypes and scaled models have been created, they are tested against the original requirements to ensure all objectives are met and the buildings and robots work well under the constraints demanded by the client.

Figure 9

A detailed prototype of what The Shard would look like within the London landscape.

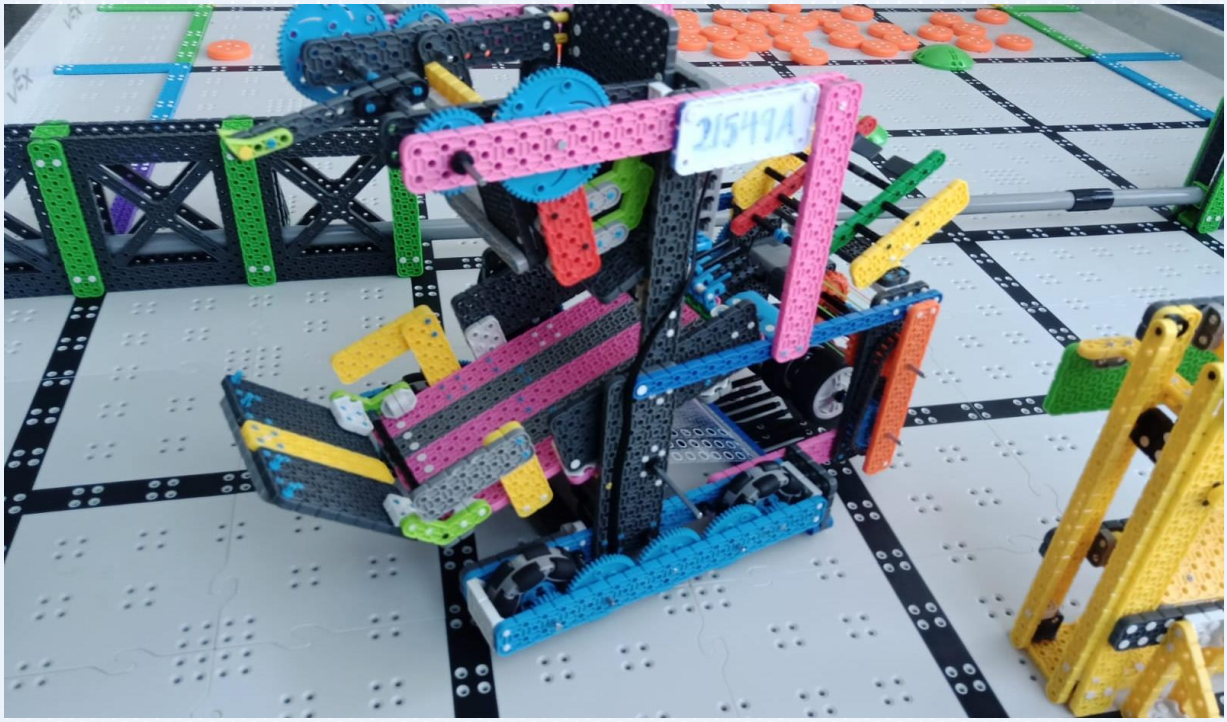


Figure 10

A photograph of our team testing out our bot on the field to see if it was working as it should.

Optimize / Refine / Improve

From feedback and test results obtained, changes can be made to improve the solution and this process becomes iterative until the final product, be it a building or a robot, fulfils all the objectives it set out to accomplish. Once this is perfected, the design process is complete for both the architect and ourselves and we move to construction with our detailed plans and blueprints (Figures 11 and 12).

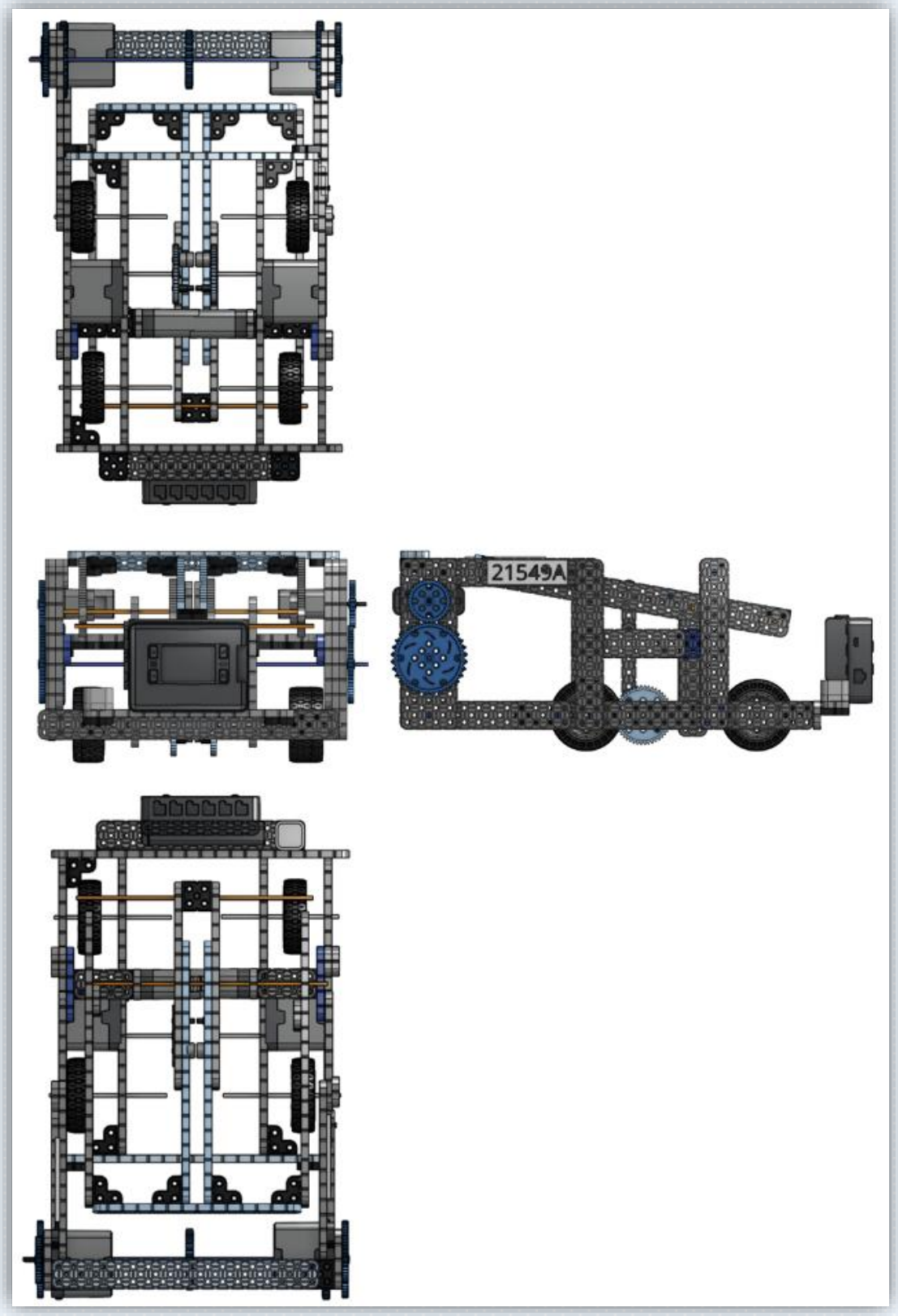
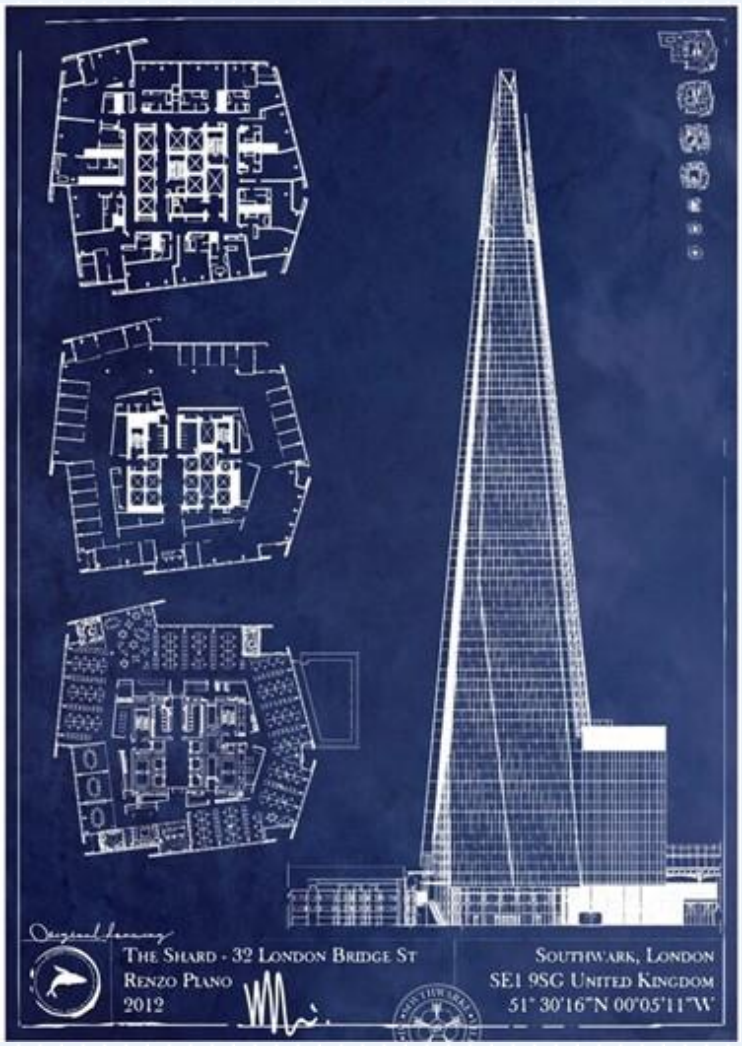


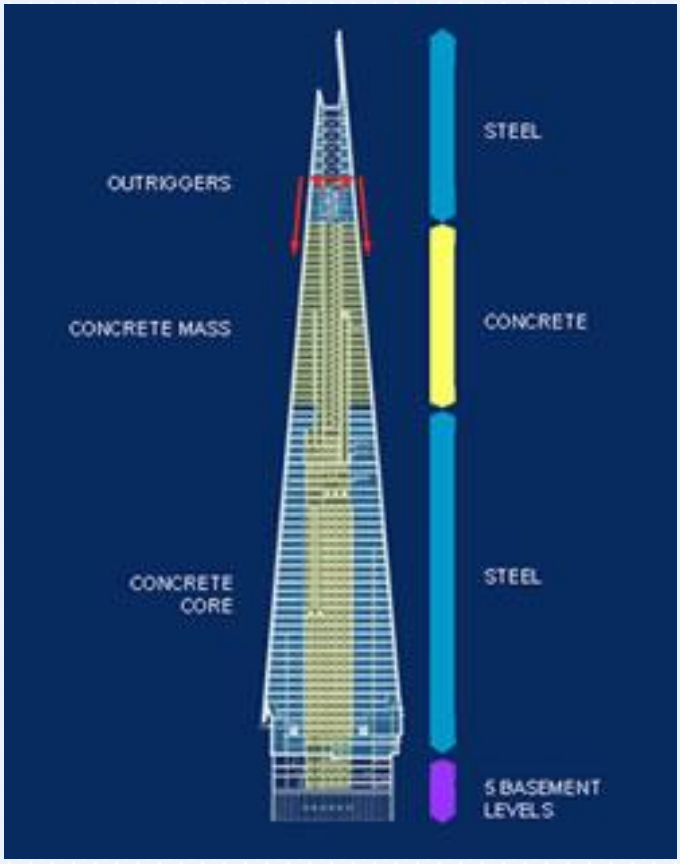
Figure 11

A detailed orthographic CAD image of our robot. The image shows the many angles of the robot to aid the building of our selected robot.



Figures 12

Blueprints produced by Architects to aid builders in construction of the selected design. Notes and measurements are added as needed.



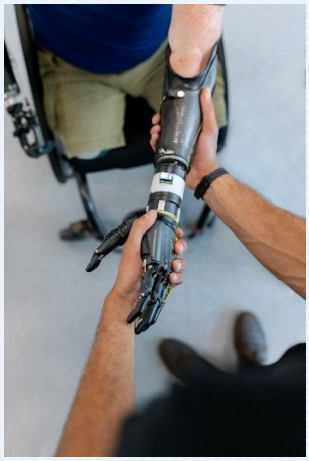
Future Career Planning

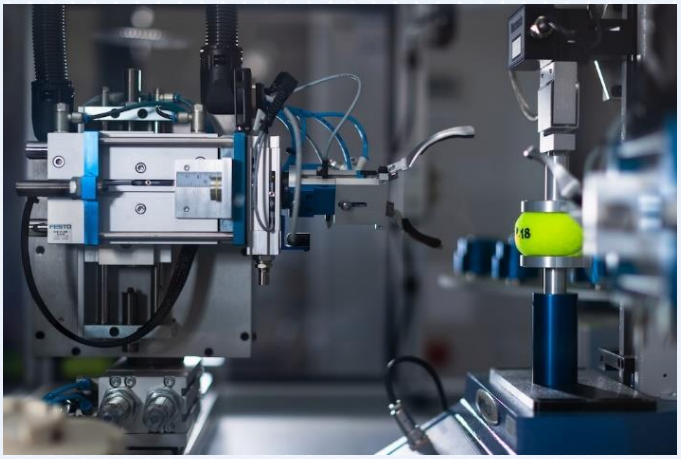
How VEX can help progress future profession

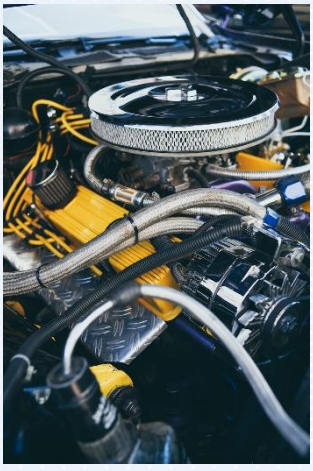
"Those who cannot remember the past are condemned to repeat it." - George Santayana, philosopher

The design processes detailed above have many similarities as they are fundamentally the same. The process of solving complex problems with well researched, documented and tested solutions is something that we can apply to all parts of our life. VEX has taught the members of our team how to approach difficult tasks in a very systematic and methodical way and break it down into components that can be researched and solutions designed for. It has taught us all how to work individually as well as collaboratively to make immense progress under stressful situations. We are able to find solutions via moments of genius when the outlook appeared bleak. We have learnt to be resilient and make the best use of our time whilst also making sure all successes are celebrated, no matter how big or small they may be.

These fundamental principles we have explored can be applied to any and all jobs which are based upon the foundation of STEM. As we have learnt about architecture which builds static, colossal buildings, the principles are essentially identical to what we use to design and build are small, movable robots. As with architects who build to leave a legacy, we too want to enter a STEM profession where our names and achievements will always be remembered and built upon.





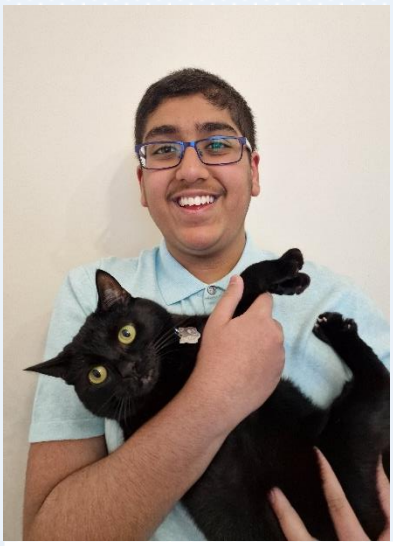


Credits

Advay

Advay is a driver and online challenger. A talented and dedicated individual who is always looking for ways to improve his skills and contribute to the success of the team. Advay always strives to create the most efficient driving routes.

Ahsan



Ahsan is a coder and a dedicated, driven, natural leader who's always willing to take on challenges and think outside the box. His deep understanding of robotic principles enables him to create algorithms to allow the robot to perform complex tasks.

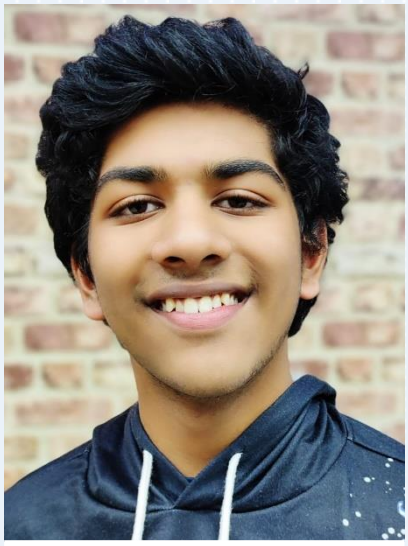
Ayaan

Ayaan is a talented designer and online challenger for our VEX robotics team. He has a passion for engineering and a natural aptitude for problem-solving. Ayaan is an invaluable member of the team.

Jeevan

Jeevan is a talented driver and builder who has a passion for creating innovative robots. With a background in engineering and a strong interest in problem-solving, he has been fascinated by the potential of robotics to transform the world around us.

Tunishq



Tunishq is responsible for writing the software that powers the team's robots. He has a strong understanding of programming languages such as C++ and Python, and is always working to improve his coding skills and he always gives everything his all.

Zane

Zane is our notebook writer and logger due to his attention to detail, ability to communicate effectively and dedication to our success. These skills allow him to accurately relay our competitions and new robots through the design process.

Citations

"If we knew what it was we were doing, it would not be called research, would it?" - Albert Einstein

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The Shard

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STEM Careers

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What is the Value of STEM Education?