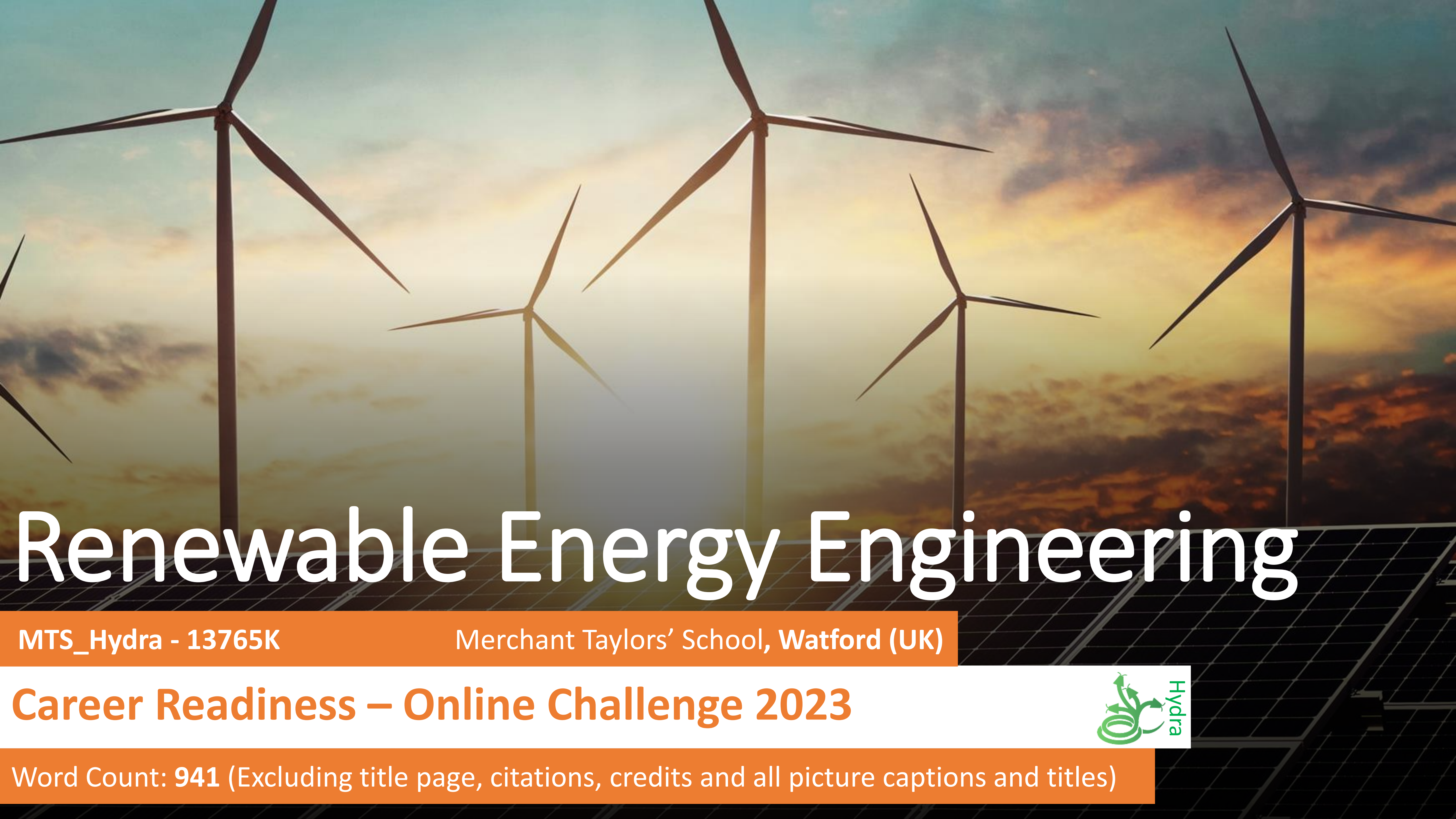
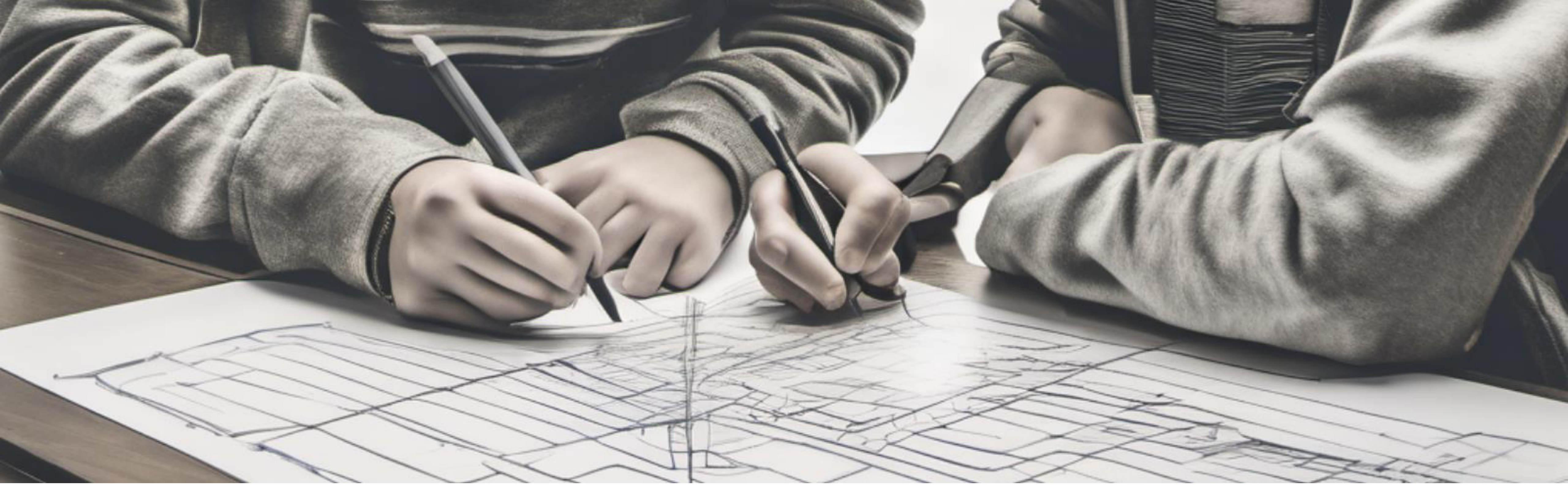


Renewable Energy Engineering

MTS_Hydra - 13765K Merchant Taylors' School, **Watford (UK)**

Career Readiness – Online Challenge 2023

Word Count: **941** (Excluding title page, citations, credits and all picture captions and titles)



Introduction
A Career in Engineering in Renewable Energy

Our team has chosen to explore the STEM career of Renewable Energy Engineering, focusing on how this profession employs the Design Process. Drawing parallels with our experiences in VEX, we've found similarities in the engineering design process. With a shared passion for this field, we've gathered insights from professionals and utilized various resources. Specifically, our research delves into the design process of photovoltaic modules (Solar Panels). Conversations with industry engineers have provided valuable perspectives that align with our own VEX experiences. As a team, we are committed to addressing the growing urgency of reducing carbon footprints and promoting sustainability, a goal mirrored in our approach to VEX competitions.

Why Renewable Energy Engineering?

"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**

Exploring renewable energy engineering in our Career Readiness Challenge is paramount as it spotlights a field crucial to addressing pressing global issues. Renewable energy engineers are at the forefront of designing sustainable solutions, fostering environmental responsibility, and combating climate change through innovative technologies. As the world intensifies its focus on clean energy, understanding the engineering design process in the context of renewable energy not only equips participants for future STEM careers but also underscores the relevance of their contributions in shaping a greener, more sustainable world. This exploration serves as a beacon, guiding participants toward a career path that aligns passion with purpose, encouraging them to envision and contribute to a future powered by responsible and renewable energy solutions.

Photovoltaic Modules (Solar Panels)

Renewable energy engineering is a specialized field that applies engineering principles to harness sustainable energy sources such as solar, wind, hydro-electric, geothermal, and biomass.

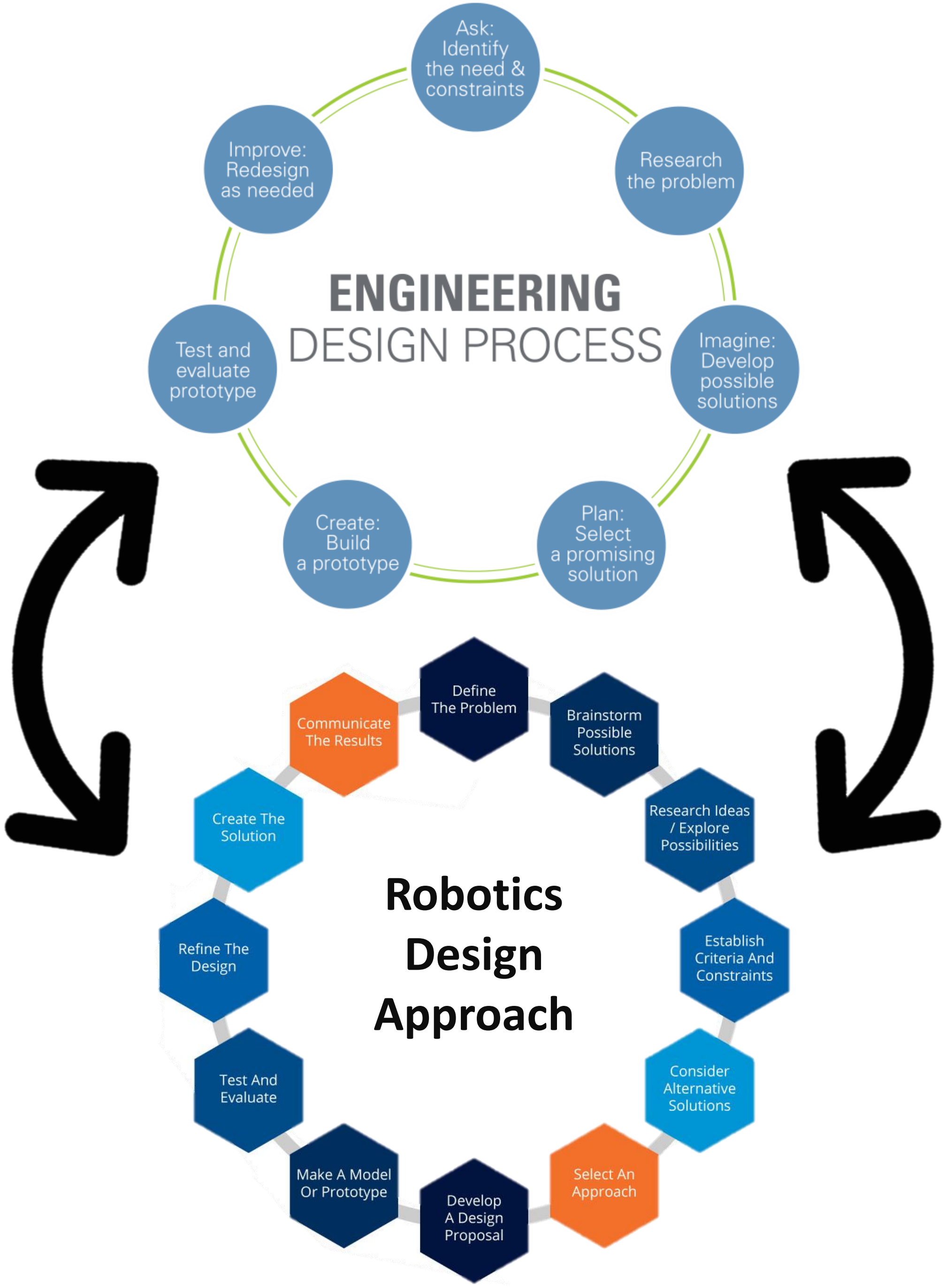
Photovoltaic modules, commonly known as solar panels, is an example of a renewable resource and works by transferring sunlight into electricity through the photovoltaic effect. Solar cells, typically made of semiconductor materials like silicon, generate an electric current when exposed to sunlight. This current is converted from direct current (DC) to alternating current (AC) by an inverter for household use. Installed on roofs, solar panels capture sunlight optimally, contributing to a residence's energy needs. Excess electricity can be fed into the grid, promoting net metering and reducing greenhouse gas emissions. With a long lifespan and minimal maintenance requirements, Solar Panels stand as a cost-effective and sustainable solution, playing a crucial role in the global shift towards cleaner energy sources.

We decided to delve deeper into this piece of technology as it holds the potential to revolutionize our own household, ushering in not only personal benefits but also contributing significantly to the creation of a cleaner and more sustainable future for generations to come.

Engineering Design Approach

How is this used in Renewable Energy Engineering

In Renewable Energy Engineering, the Design Approach plays a pivotal role in developing sustainable and efficient solutions. The process typically begins with a thorough analysis of the project requirements, considering factors such as site conditions, resource availability, and environmental impact. Engineers then conceptualise various design options, evaluating their feasibility and performance through simulations and modelling. Iterative prototyping and testing refine the design, addressing challenges and optimizing efficiency. Additionally, considerations for cost-effectiveness and long-term maintenance are integrated into the design process. This systematic approach ensures that renewable energy projects are not only technically sound but also economically viable and environmentally friendly, aligning with the overarching goal of advancing sustainable energy solutions.



Identifying the Problem

In the initial step of both design processes, clear identification and definition of the problem are imperative. This ensures that the subsequent creation, whether it be solar panels or a robot, aligns seamlessly with all specified requirements and operates effectively within the outlined constraints.

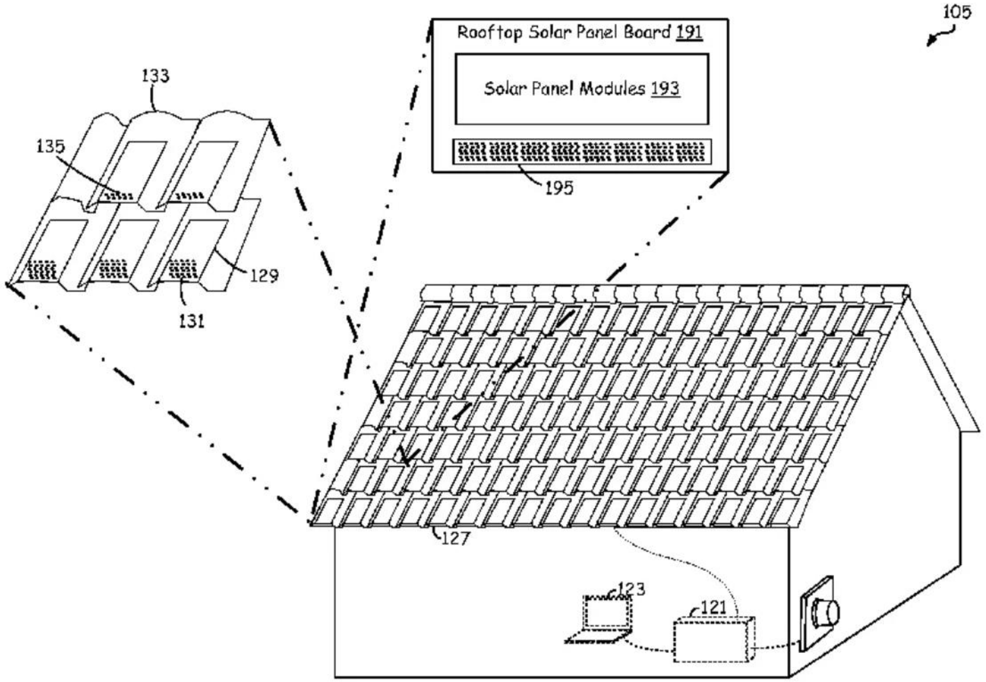
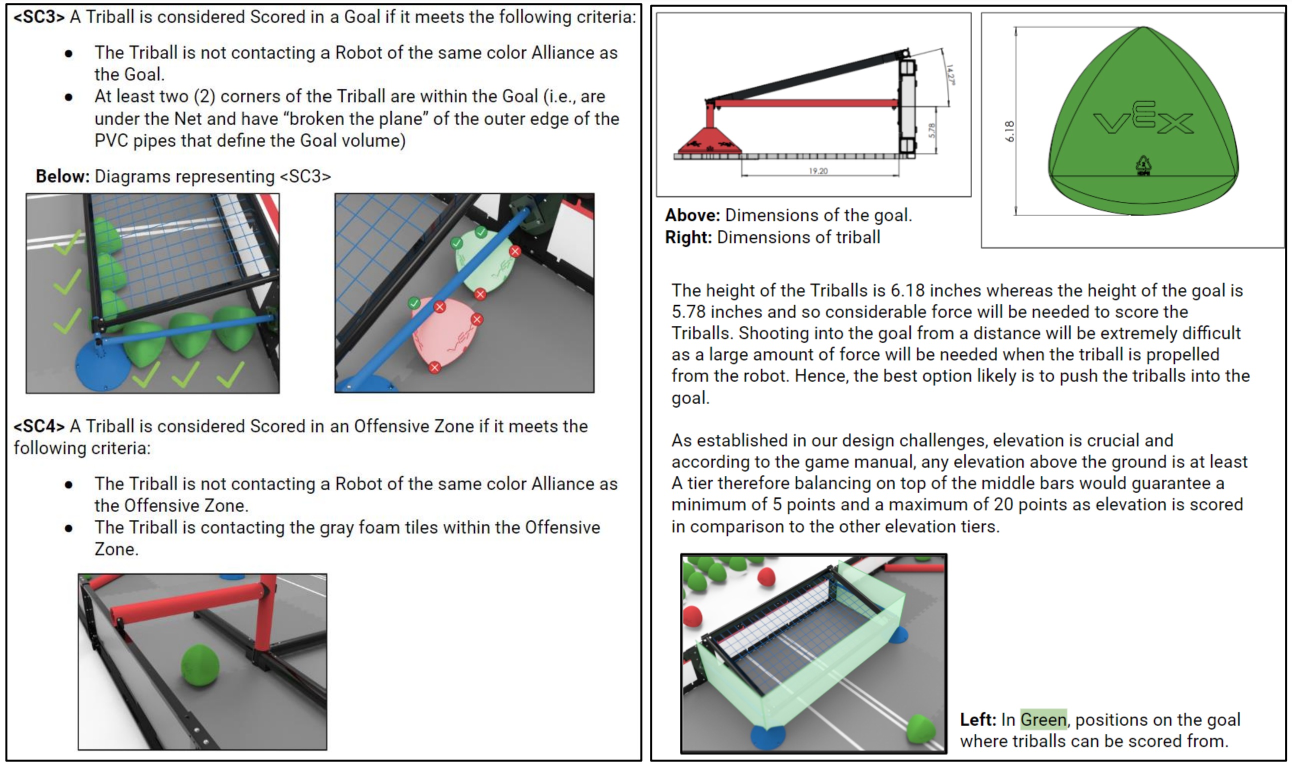


Figure 1: Enpulz, LLC's "Displayed design issue with Solar Panel Light Indicator," patented January 1, 2013



<SC3> A Triball is considered Scored in a Goal if it meets the following criteria:

- The Triball is not contacting a Robot of the same color Alliance as the Goal.
- At least two (2) corners of the Triball are within the Goal (i.e., are under the Net and have "broken the plane" of the outer edge of the PVC pipes that define the Goal volume)

Below: Diagrams representing <SC3>

<SC4> A Triball is considered Scored in an Offensive Zone if it meets the following criteria:

- The Triball is not contacting a Robot of the same color Alliance as the Offensive Zone.
- The Triball is contacting the gray foam tiles within the Offensive Zone.

Above: Dimensions of the goal.
Right: Dimensions of triball

The height of the Triballs is 6.18 inches whereas the height of the goal is 5.78 inches and so considerable force will be needed to score the Triballs. Shooting into the goal from a distance will be extremely difficult as a large amount of force will be needed when the triball is propelled from the robot. Hence, the best option likely is to push the triballs into the goal.

As established in our design challenges, elevation is crucial and according to the game manual, any elevation above the ground is at least A tier therefore balancing on top of the middle bars would guarantee a minimum of 5 points and a maximum of 20 points as elevation is scored in comparison to the other elevation tiers.

Left: In Green, positions on the goal where triballs can be scored from.

Figure 2: Example of 2 Pages from our Engineering Notebook identifying some of the problems in the Game that would affect our robot design.

Brainstorming

In the initial stages, both processes focus on gathering information which ensures the foundation for an optimal solution. Following a thorough analysis, the creative journey unfolds through brainstorming sessions and the manifestation of conceptual sketches and diagrams, breathing life into the envisioned final design.

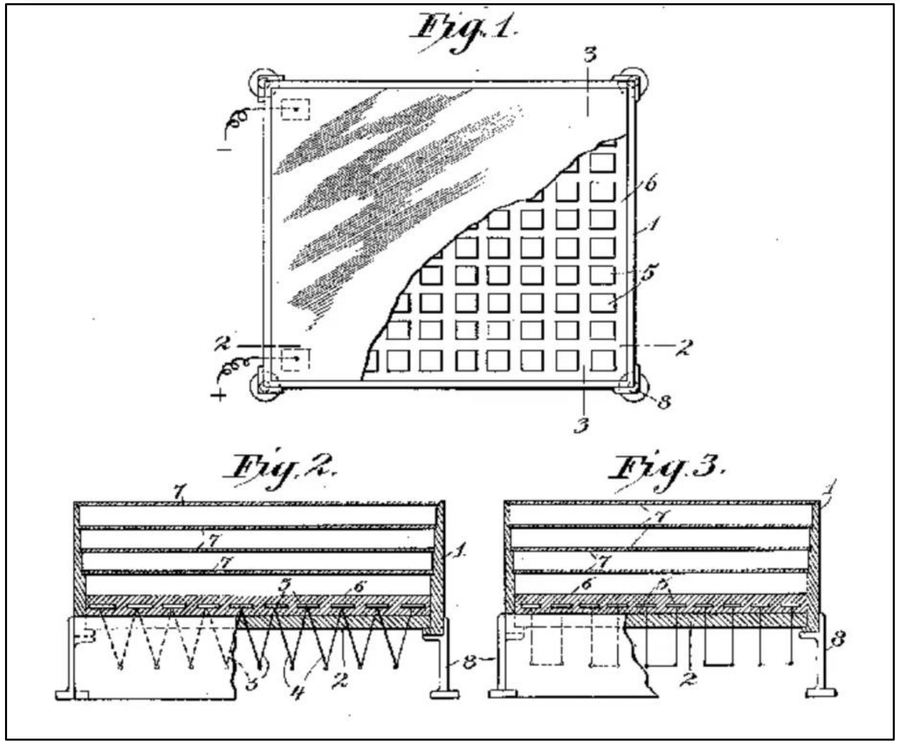


Figure 3: W.W. Coblentz's "Thermal Generator" patented October 28, 1913.

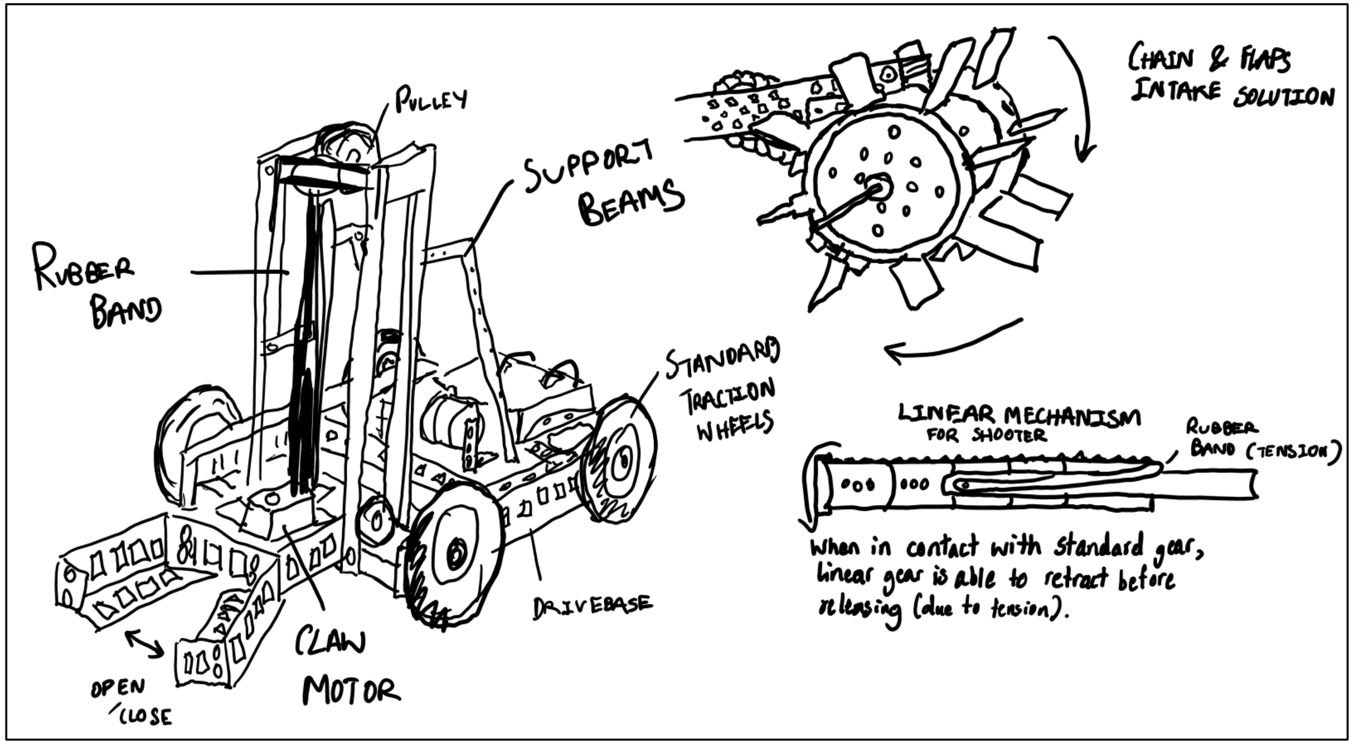


Figure 4: Our Lead Designer drafted this sketch during one of our first brainstorming sessions at the start of the season.

Develop a design
Select a solution
Build a prototype
Test the mechanism

In the next stage of both processes, initial ideas are honed to identify a viable solution, facilitating the development of small-scale models and prototypes. Thorough documentation in notebooks is key for engineers and our own processes, aiding in the translation of concepts into precise CAD drawings. This step ensures a detailed evaluation of how all components fit and function together seamlessly.

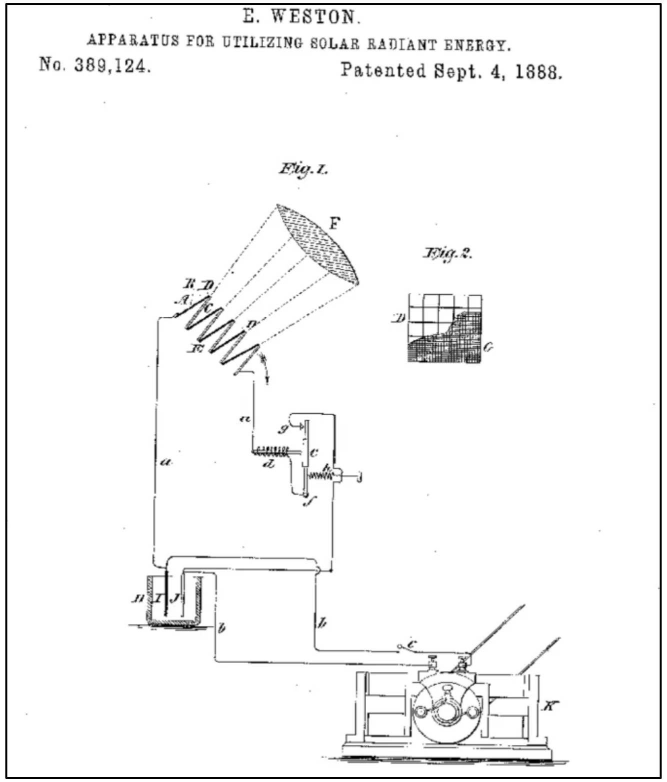
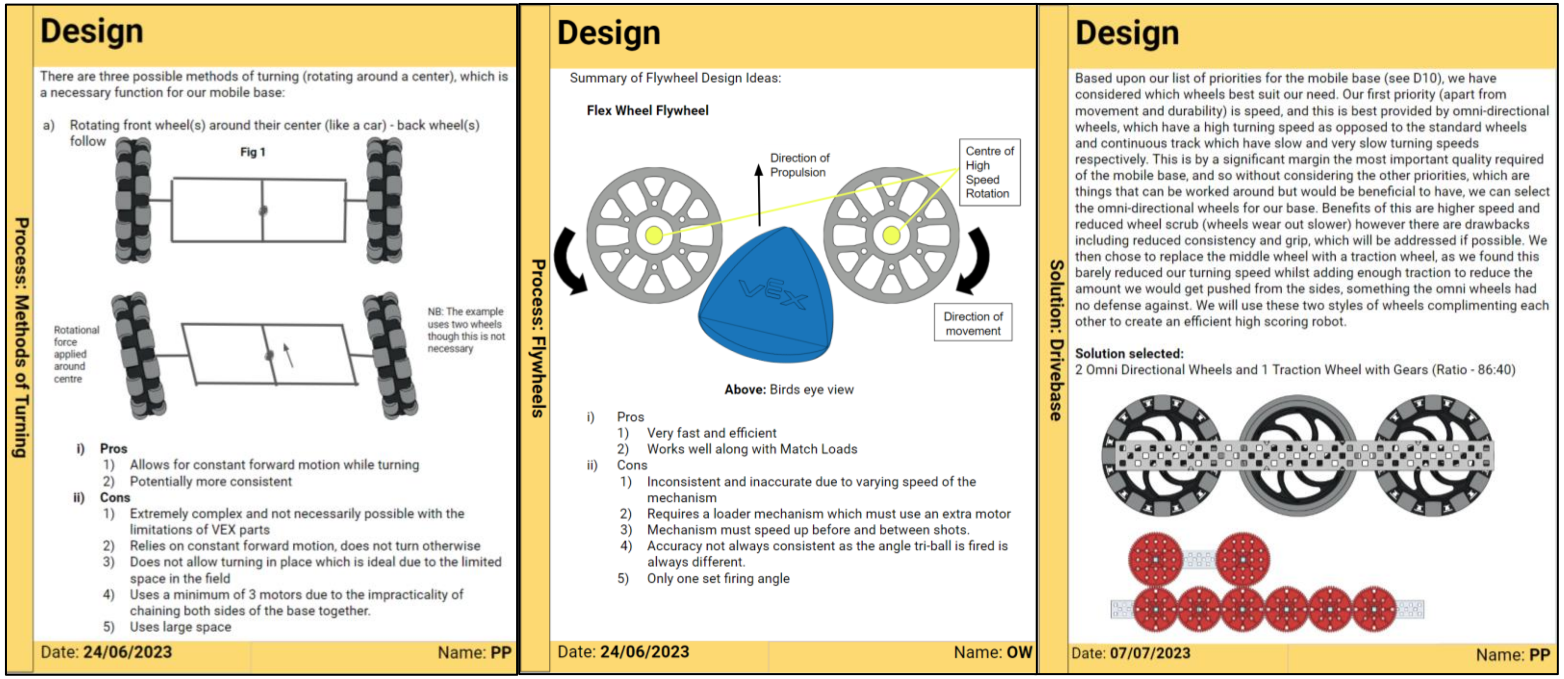


Figure 5: Edward Weston's "Apparatus for Utilizing Solar Radiant Energy" patented September 4, 1888.



Design

Process: Methods of Turning

There are three possible methods of turning (rotating around a center), which is a necessary function for our mobile base:

a) Rotating front wheel(s) around their center (like a car) - back wheel(s) follow

Fig 1

Rotational force applied around centre

NB: The example uses two wheels though this is not necessary

i) **Pros**
1) Allows for constant forward motion while turning
2) Potentially more consistent

ii) **Cons**
1) Extremely complex and not necessarily possible with the limitations of VEX parts
2) Relies on constant forward motion, does not turn otherwise
3) Does not allow turning in place which is ideal due to the limited space in the field
4) Uses a minimum of 3 motors due to the impracticality of chaining both sides of the base together.
5) Uses large space

Date: **24/06/2023** Name: **PP**

Design

Process: Flywheels

Summary of Flywheel Design Ideas:

Flex Wheel Flywheel

Direction of Propulsion

Centre of High Speed Rotation

Direction of movement

Above: Birds eye view

i) Pros
1) Very fast and efficient
2) Works well along with Match Loads

ii) Cons
1) Inconsistent and inaccurate due to varying speed of the mechanism
2) Requires a loader mechanism which must use an extra motor
3) Mechanism must speed up before and between shots.
4) Accuracy not always consistent as the angle tri-ball is fired is always different.
5) Only one set firing angle

Date: **24/06/2023** Name: **OW**

Design

Solution: Drivebase

Based upon our list of priorities for the mobile base (see D10), we have considered which wheels best suit our need. Our first priority (apart from movement and durability) is speed, and this is best provided by omni-directional wheels, which have a high turning speed as opposed to the standard wheels and continuous track which have slow and very slow turning speeds respectively. This is by a significant margin the most important quality required of the mobile base, and so without considering the other priorities, which are things that can be worked around but would be beneficial to have, we can select the omni-directional wheels for our base. Benefits of this are higher speed and reduced wheel scrub (wheels wear out slower) however there are drawbacks including reduced consistency and grip, which will be addressed if possible. We then chose to replace the middle wheel with a traction wheel, as we found this barely reduced our turning speed whilst adding enough traction to reduce the amount we would get pushed from the sides, something the omni wheels had no defense against. We will use these two styles of wheels complimenting each other to create an efficient high scoring robot.

Solution selected:
2 Omni Directional Wheels and 1 Traction Wheel with Gears (Ratio - 86:40)

Date: **07/07/2023** Name: **PP**

Figure 6: Example of 3 Pages from our Engineering Notebook representing developing a design and selecting a solution.

Test/Evaluate

After the development of prototypes, rigorous testing ensues to verify the fulfilment of initial requirements. This comprehensive evaluation ensures not only the attainment of all objectives but also validates the seamless functionality of the final product within the specified client constraints.

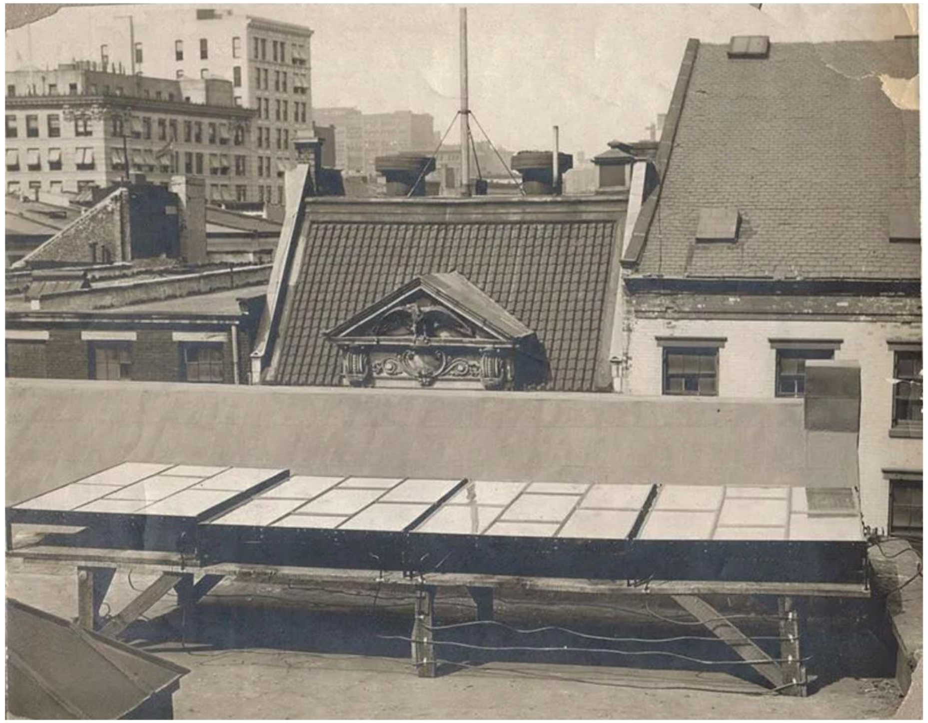


Figure 7: First ever Solar Panel installed by Charles Fritts in New York in 1984

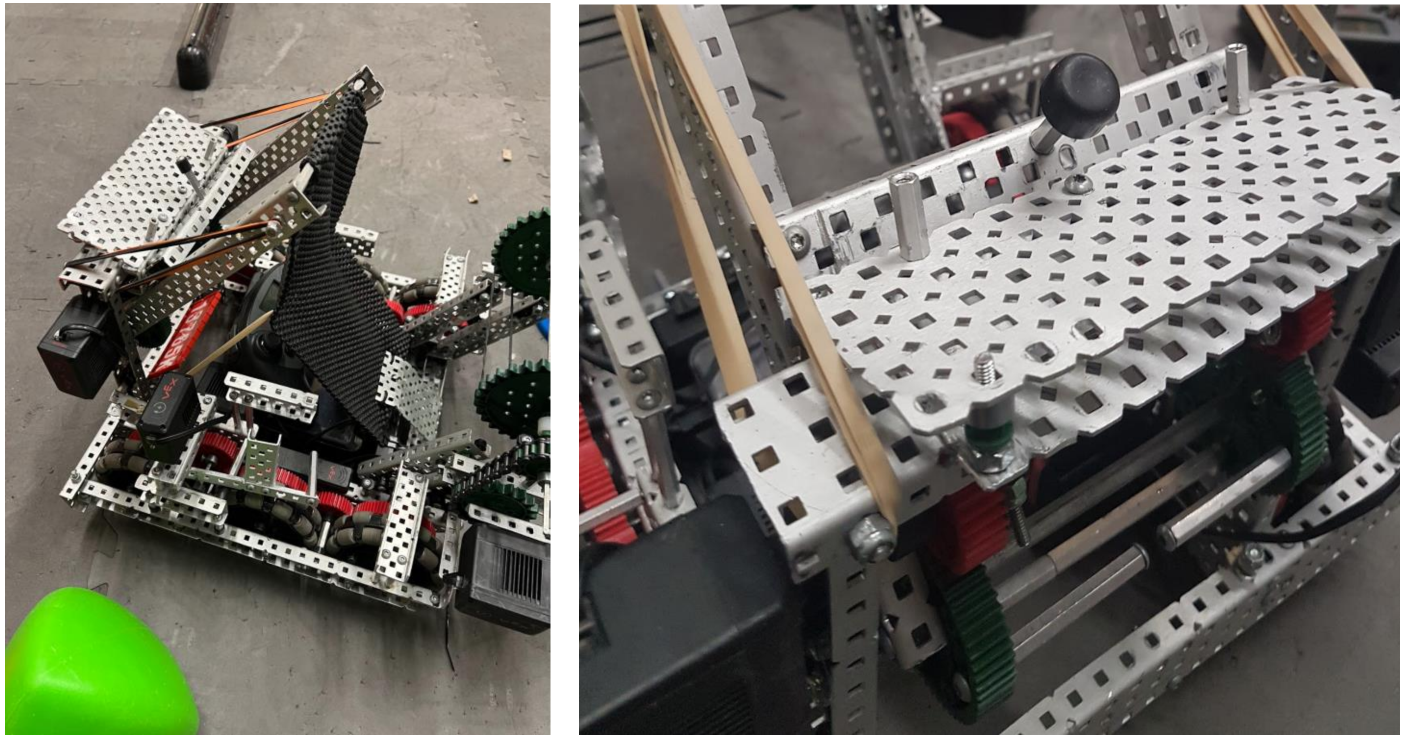


Figure 8: Images of the team testing new features on our robot – evaluating its performance during practice matches.

Enhance/Refine/Perfect

Continuous refinement driven by feedback and testing elevates the solution iteratively until it flawlessly meets all objectives, be it a solar panel or a robot. Once this is perfected, the design process is complete for both the engineers and ourselves and we move to construction with our detailed plans and blueprints (Figures 9 and 10).

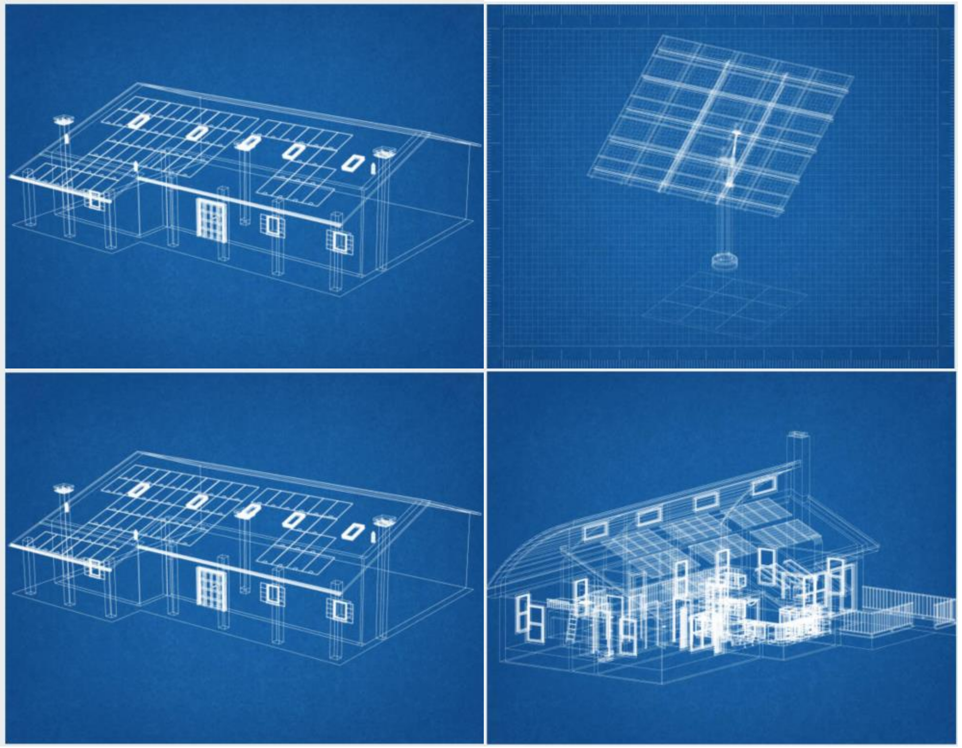


Figure 9: Blueprints of Solar Panels that are installed on homes.

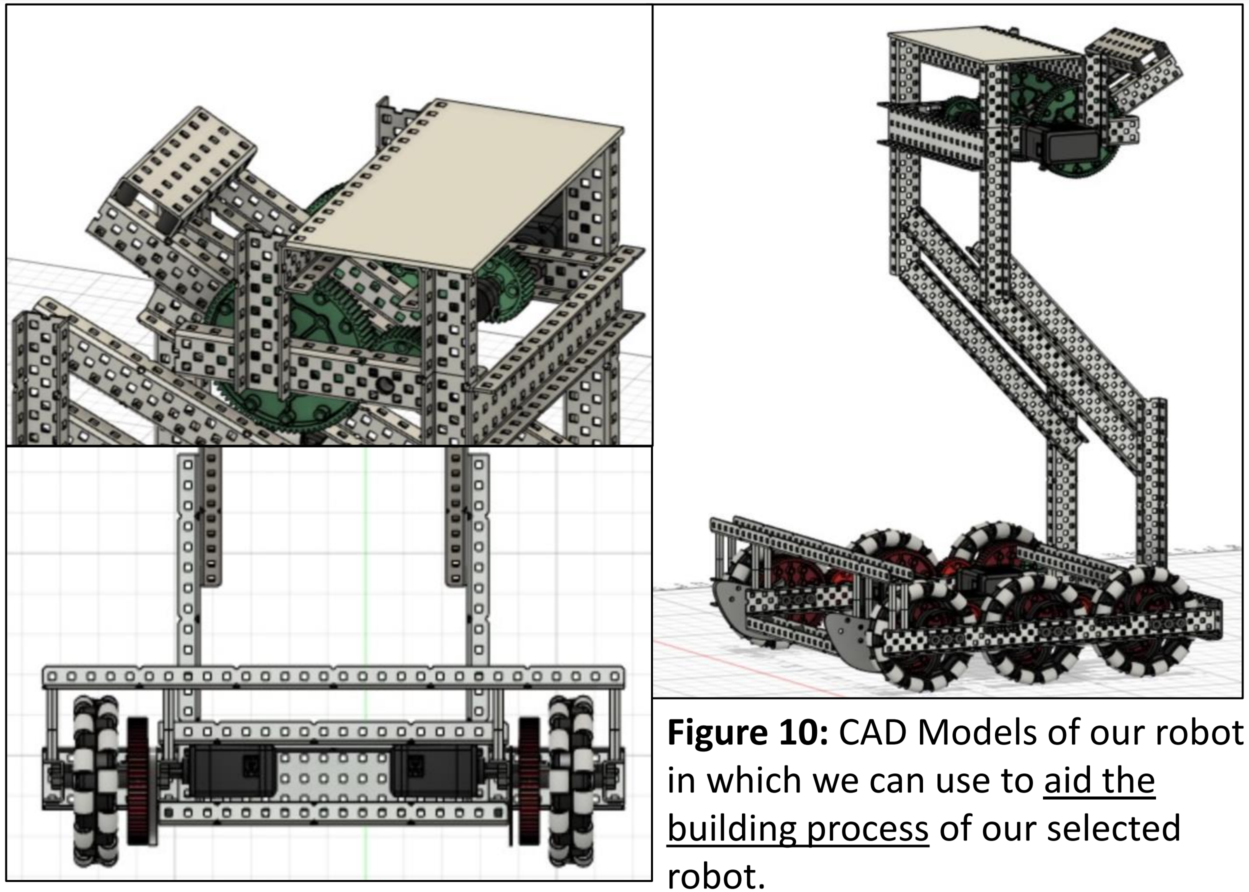


Figure 10: CAD Models of our robot in which we can use to aid the building process of our selected robot.

STEM Careers

How can VEX help us progress with a career in the future?

The shared design processes embody universal principles, advocating for a meticulous approach to unravelling complex problems through thorough research and the application of tested solutions. Our immersion in VEX has not only equipped us with versatile skills for independent and collaborative endeavors but has also nurtured resilience, effective time management, and a steadfast commitment to celebrating successes, regardless of scale.

These foundational principles seamlessly transcend the boundaries of various STEM professions, be it in the creation of monumental structures in architecture or the development of agile robots in our case. Much like architects aiming to leave an indelible legacy through their creations, our vision is to make a lasting impact in STEM fields, establishing a robust foundation for future innovations and advancements. In the convergence of creativity and technical acumen, we aspire to contribute to the ongoing narrative of progress and discovery.

CREDITS

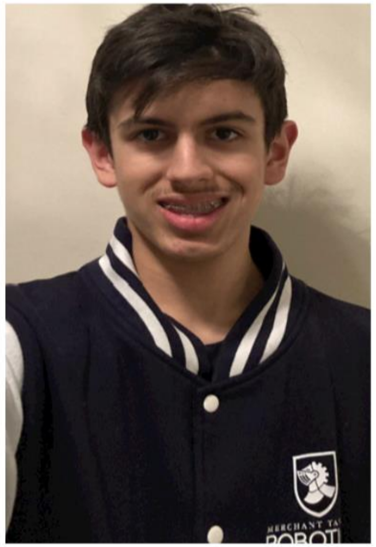
Thomas, a skilled builder, is armed with a background in engineering and a keen interest in problem-solving. He fascinates the team with the speed at which he transforms ideas into reality, offering significant potential to the team.

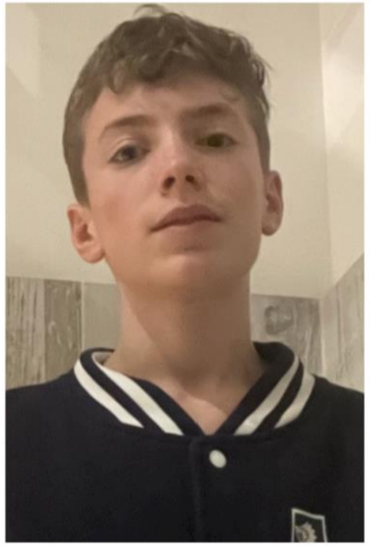
Oscar, a driver and online challenger, is a skilled and committed individual perpetually seeking avenues to enhance his capabilities and actively contribute to the team's success. His endeavours to devise the most optimal driving routes showcases a dedication to efficiency.

Ali exemplifies a devoted coder with a penchant for embracing challenges and thinking innovatively. His profound grasp of robotic principles empowers him to craft algorithms that enable robots to execute intricate tasks. He has a strong understanding of several programming languages including Python and C++.

Shay, an adept designer and builder on our team, is fuelled by a passion for engineering and an innate talent for problem-solving. His invaluable contributions make him an integral team member, always uplifting the team morale.

Pranay serves as our dedicated notebook writer/logger and online challenger, known for his attention to detail, effective communication skills, and unwavering dedication to our success. He consistently adds innovative perspectives to our endeavours – developing ideas, bringing progress to the team.





Top left: Ali
Top middle: Oscar
Top Right: Pranay
Bottom Middle: Shay
Bottom Right: Thomas

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