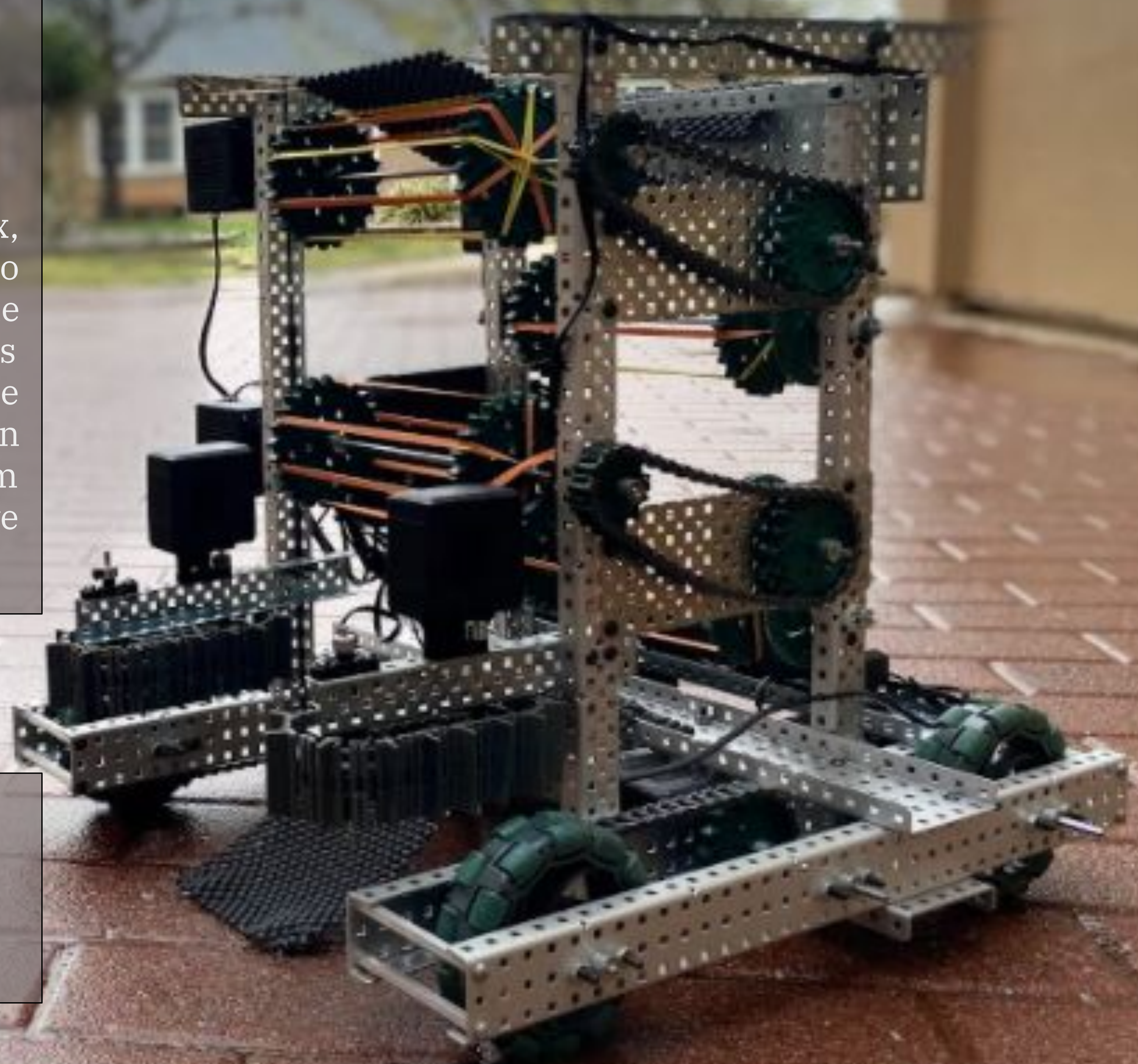
The Tyrannosaurus-Rex of Vex

As the world grows more technologically complex, the challenges we face every day will continue to escalate along with it. The situation is equally simple to understand, yet difficult to solve. The Vex Robotics Competition exists to solve this problem through the use of competitive robotics. As a part of a three-person group, Tyler Wisniewski is responsible for Subsystem One of the robot; the chassis, and the locomotive system.

Tyler Wisniewski is a Senior at the Marine Academy of Science and Technology. He plans to attend **Cornell University** in the Fall, studying **Mechanical Engineering**.

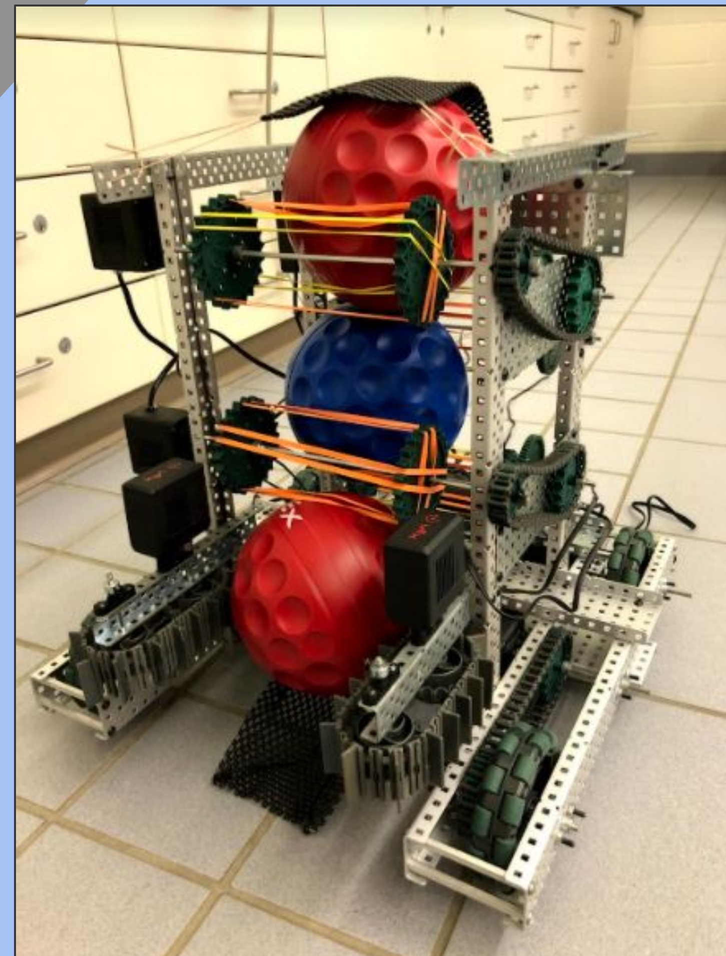


Photographer Credit: Zac Mansfield

Project Scope

As a part of a three-person group, Tyler Wisniewski is responsible for Subsystem One of the robot for the Change Up Competition. Subsystem One consists of the chassis, drive train, and locomotive system of the robot. Through the construction of the robot, shown in the image (right), the group plans to solve the following problem: to design, model, and build a robot using existing VEX parts capable of completing the desired task as per the rules and regulations of the event when released by Vex Robotics. The budget for additional parts is $250 or less. The primary goal is to score points in the NJTSA state competition at The College of New Jersey, therefore demonstrating proficiency in the design and construction of basic robots to increase knowledge of basic robotics in the participating high school students. To fulfill the duties of his project, Tyler Wisnieski must design and construct the locomotive portion of a robot, using Vex Robotics parts, for a teammate to be capable of competing and scoring points at the NJTSA state Change Up Competition at The College of New Jersey.

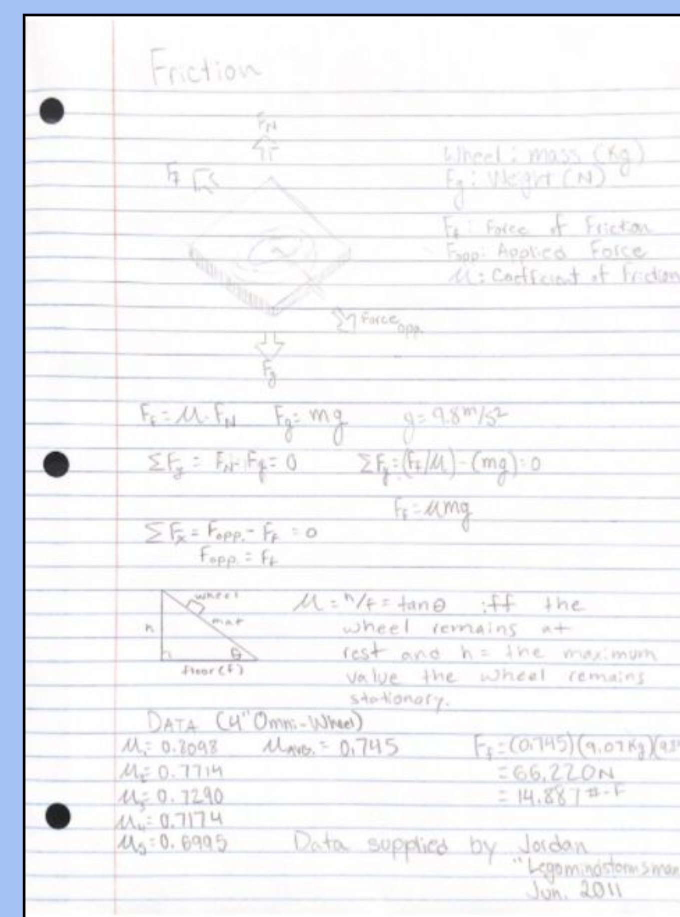
The robot must also serve as a mobile base for the other robot mechanisms to score goals. As such, the chassis must be extremely sturdy while also maintaining a high speed and acceleration. The robot is further limited to Four V5 Smart Motors and a size of 18" cubed.



Final Product. The culmination of Subsystem One, Subsystem Two, and Subsystem Three. In the image, the robot is testing all game aspects, holding three balls at once.

Photographer Credit: Tyler Wisniewski

The core components of Subsystem One are the chassis and the locomotive system. The goal of the chassis is to serve as the foundation of the robot. All other components of the robot are either built within or on top of the chassis. As a result, the structural integrity of the chassis is of the utmost importance. The chassis is built using a six-wheel tank drive as the foundation of the design. This serves to establish a wide foundation for the rest of the robot to be built upon. The Drive system used in the design is a four wheel tank drive system. By implementing these two, distinct forms into a single design, the versatility and effectiveness of the design increases by leaps and bounds. By using sprockets and chains to apply a torque on the wheels from a distance, the motos are able to tuck themselves back, beneath the support of the chassis. Not only does this design choice make the total robot sturdier, but the design also frees up more room in the front of the robot, allowing for more design possibilities regarding the intake system. The intake system is the system which uses treads and paddles to intake balls or other game elements into the robot.



Science and Math

Throughout the research, design process, modeling, and construction process, the aspect of science most relevant to the project is Physics. There are many laws of physics that affect the robot, especially during an event as dynamic as a competition. However, there are many laws and equations relevant to kinetic activity which are irrelevant to the design process. These include laws of momentum and laws of inertia. There are laws that pertain to the development of the robot. By using Charles Coulomb's Equation of Frictional forces, I can calculate the coefficient of friction between the Omni-Directional Wheels and the foam arena tiles. The calculation can be done using the equation =h/w(f)=tan(). The image (left) shows the process and application of the equation. The value for the friction between the wheels may initially seem insignificant or even detrimental in the case of a high coefficient. However, a high coefficient of friction is actually good because the value signifies the ability for the robot to gain traction and, as a result, accelerate and decelerate faster. Also, the high traction paired with the horizontal roller allowing for less energy loss to friction when turning or pushing other robots.

Calculations: The applications of Physics equations regarding the robot. To find force of friction, amount of traction, and μ value (left)

Credit: Tyler Wisniewski

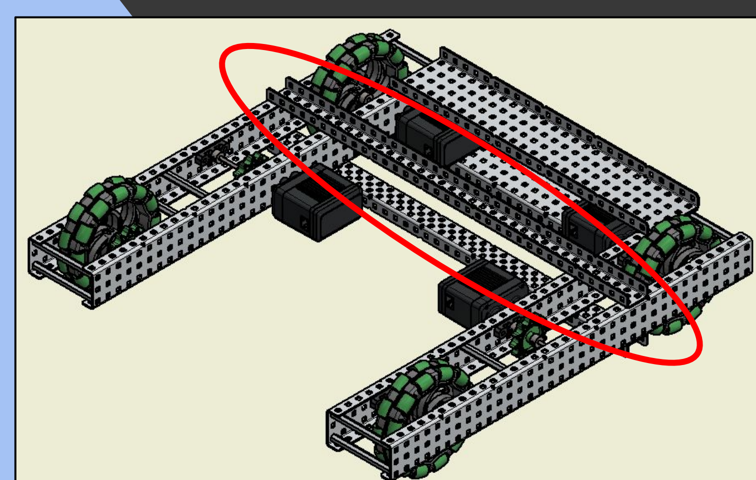
Design Changes

Throughout the building and design process, many changes were made regarding the design of Subsystem One of the robot used for the VRC Change Up Competition. The majority of these changes occurred before the group began building. This happened for two major reasons. The first is that the period of time before building was abnormally long. The causes were the general delays surrounding the acquisition of parts due to the Covid 19 Pandemic as well as the virtual nature of the teaching environment. Many processes were delayed as a result.

For the design of the chassis, the initial plan was to use a Four Wheel Tank Drive Chassis and a Four Wheel Tank Drive System. However, the plan changed after considering the other aspects of the robot. The Computer Aided Design Model, shown below, illustrates the design of Subsystem One using a Four Wheel Tank Drive System with a Six Wheel Tank Drive Chassis. In the design, one can note the 1x2x1x35 piece od C-Channel supporting the opposite drive pairs. The smaller piece of C-Channel was later changed for a larger piece of 1x5x1x35 C-Channel. The change in design has multiple benefits. First, the chassis was strengthened and became sturdier. Second, the larger piece of C-Channel created a better connection for the integration of the other necessary Subsystems and components with the Chassis of the robot. Lastly, the design change created a place for the battery to stay. This was an issue neither party had initially planned for so the design change solved this issue. The design change was extremely worthwhile, killing three birds with one stone.

Additional Skills

During the arduous building and design process, many skills were gained either unintentionally or they were skills one would not normally think of when concerning the topic at hand. The majority of these additional skills gained were primarily skills adjacent to the project, as opposed to the obvious technical skills gained when creating a robot. Many of these skills arose from the various types of projects students were required to do in their Systems Engineering II Senior Capstone class. The following additional skills were gained: presentation abilities, researching skills, communication skills, networking skills, general writing skills, technical writing skills, proper utilization of elements and figures, and the skills to organize and develop a journal article.



Detailed Computer Aided Design Model of Subsystem One; Chassis and Drive System. Created Using Autodesk Fusion 360. The changed piece of C-Channel is highlighted.

Credit: Tyler Wisniewski

These many additional skills were picked up over the course of the year by the students. Presentation skills are seemingly unrelated to the field of robotics. However, this skill, like many others, was gained through the Systems Engineering II class, rather than the direct applications of the Capstone project. In the Systems Engineering II class, the students must prepare many presentations throughout the year, with particularly important presentations marking every marking period. The preparation, notes, outlines, and reflections of each presentation also accompanied these elements, requiring proficiency. Researching abilities were integral to the course of the Vex Robotics Project. Tyler Wisniewski scoured various mediums and sites for relevant and helpful information. The following sources were used for research: The Vex Robotics Change Up Game Manual, the game manuals of previous games, early season designs, world record holding robotics professionals, competition videos and records, mentor contacts, and working robot prototypes of previous projects, years, and competitions.

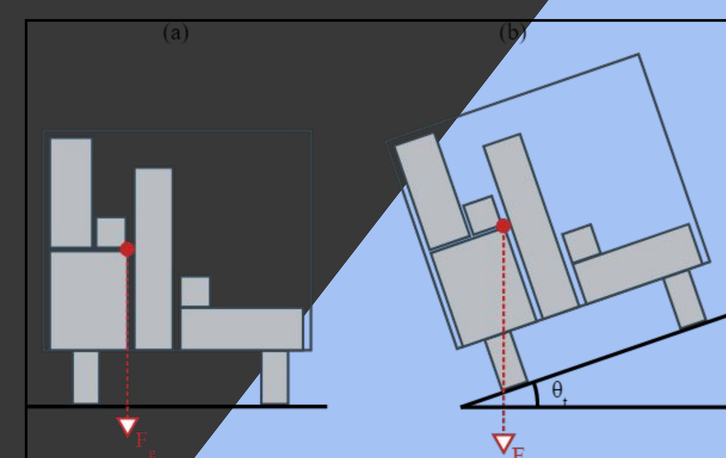


Diagram: The topple limit of a poorly loaded truck; Center of Mass. (above)

Credit: Khan Academy

Communication skills are supremely important in team settings and situations. As part of a three-man team, communication is necessary to maximize efficiency in aspects, from researching to construction. This is especially true in this case as each individual focused on a different aspect of the robot. Networking skills are also crucial during the interactions between student and mentor as well as the time during the students' initial period when they are trying to find a mentor at all.

Writing is a large part of the Systems Engineering II class as there are many reports, outlines, and other written projects. These assignments include a wide variety of typical writing as well as a plethora of technical writing projects.

The utilization of figures and elements is important in any sort of exposaic project in the class. These include, but are not limited to reports, presentations, posters, and journal articles. The figure below can be seen as an example of this. Out of context, the weight distribution of a fictional truck has seemingly nothing to with a robot. However, this figure can be used to show a core principle of center of mass and then relate shared potential issues. By using this figure when speaking about the issue of a robot toppling over due to a high center of mass, the audience can gain a high-level insight be using a detached, foreign figure.

Lastly, the ability to design, develop, and produce a journal article seems far-fetched when concerning a robot. However, during the production of this very issue, the students gained an understanding of journal design by creating their own articles.

Project Experience Benefits

Much of the benefits gained through this experience are unconventional or not immediately known. As previously mentioned, a multitude of skills and experiences were gained through the researching, designing, drafting, building, and testing process- Including many seemingly irrelevant skills. However, the greatest gain was the experience of the project. Not only will this project start the resume of the young engineers building this robot, but they are also begging their journey into the world of practical engineering. By developing a relationship with their mentors, the students were indoctrinated in the greater world of engineering and officially began their journey with their first connection. Additionally, Tyler Wisnieski began cultivating relationships with other sub-groups throughout the course of the project, with the largest being the Vex Robotics Community.

The Journey- In Short

Of the many Senior Capstone projects at the Marine Academy of Science and Technology, those focusing on Engineering come from the Systems Engineering II course. The Vex Robotics project utilizes all the aspects of STEMM to the fullest extent. As the world grows more technologically complex, the challenges we face every day will continue to escalate along with it. The situation is equally simple to understand, yet difficult to solve. In many cases, the traditional methods of teaching science, technology, engineering, and math will not be enough to adequately prepare students for our complex world. The Vex Robotics Competition exists to solve the previously mentioned problem. Through its uniquely engaging combination of teamwork, problem solving, and scientific discovery, the study of competitive robotics encompasses aspects of STEMM. As per the Vex Robotics Competition website, "VEX Robotics is educational robotics for everyone. VEX solutions span all levels of both formal and informal education with accessible, scalable, and affordable solutions. Beyond science and engineering principles, VEX encourages creativity, teamwork, leadership, and problem solving among groups. VEX allows educators of all types to engage and inspire the STEM problem solvers of tomorrow!"(Vexrobotics) The Vex Robotics Competition is an excellent event for students to learn the fundamentals of robotics and the Engineering Design Process.

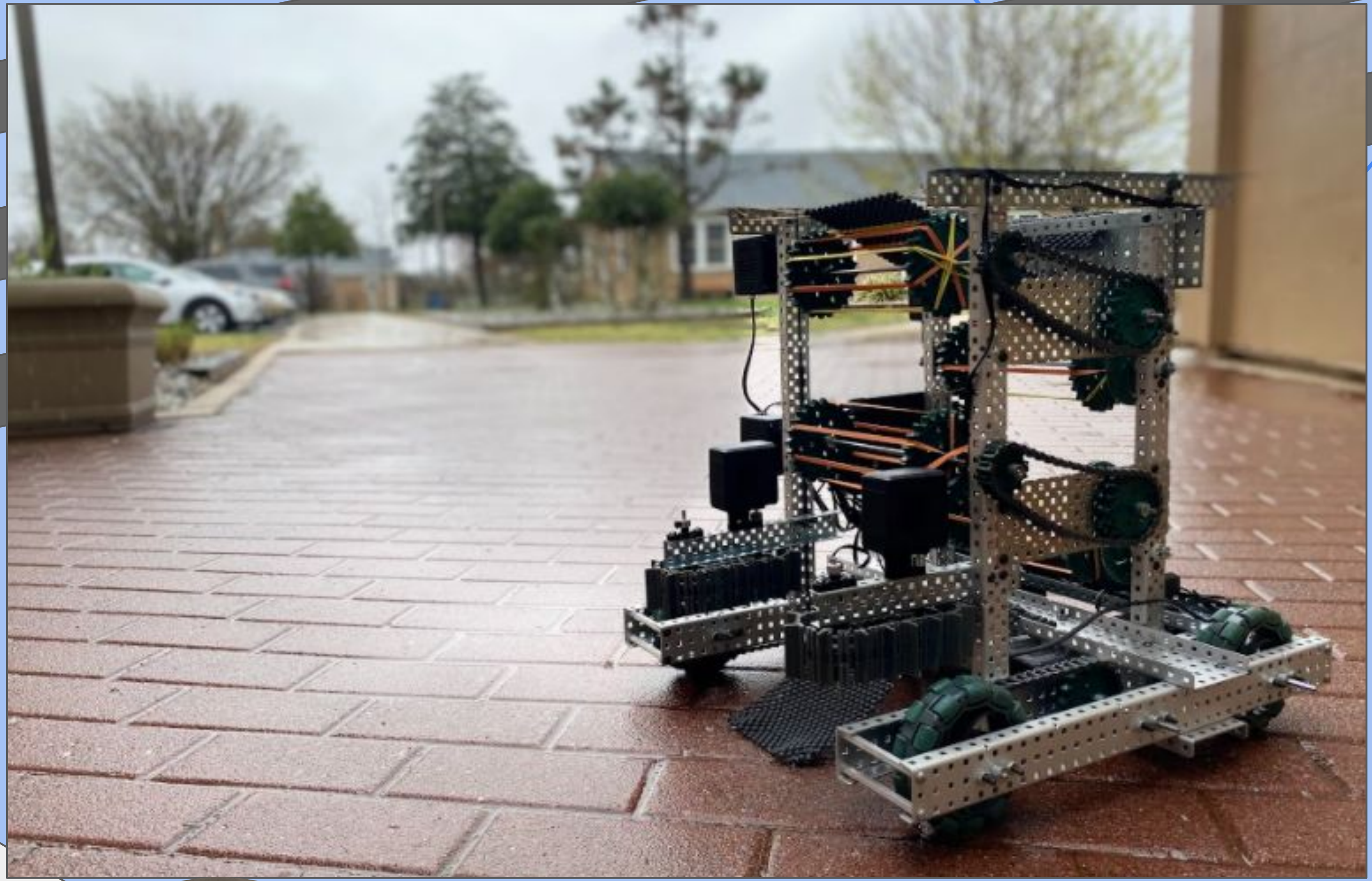
The competition is played on a 12'x12' square field. Two Alliances –one red and one blue– composed of two teams each, compete in matches consisting of a fifteen second Autonomous Period, followed by a one minute and forty-five second Driver Controlled Period. During the Driver Controlled Period the primary objective is to capture balls and score them into goals. The teams must design, construct, and program a robot to compete in the competition.

Throughout the arduous process of researching, designing, drafting, building, and testing a robot for the Vex Robotics Change Up Competition resulted in a great deal of growth for the students involved, in addition to their final, completed product.

All aspects of STEMM were utilized throughout this process and many inadvertent skills were gained as well. Overall, the students gained a valuable experience and truly learned through the trials and tribulations of robotics.

Portrait Photograph of the Final Product of the Vex Robotics Team from The Marine Academy of Science and Technology.

Photographer Credit: Zac Mansfield



Editor's Note: Hello All! Thank you for reading this article and I hope you all enjoyed it! For those that were curious about the title of this article, the name of "T-Rex" was chosen due to the similarities the robot held with the prehistoric creature. While not carnivorous, the robot has small arms protruding forward in comparison to the large, overall body. In addition, the base is divided into two leg-like drive systems with a large torso and body. If one uses their imagination, you can imagine the "T-Rex" sitting down while looking at the sky in this picture. Anyhow, I hope you enjoyed and I look forward for future issues!

-Tyler Wisniewski