Team 421H

Indian Hill Robotics Club

Indian Hill High School

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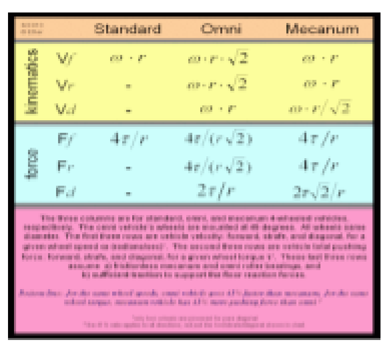
VEX "Make It Real" Challenge: VEX 4" Shark Wheel

As the VEX library of parts continues to constantly evolve from new more powerful motors to a larger variety of metal, Team 421H recognized an important problem in regards to chassis efficiency. 421H investigated the differences between an efficient and inefficient chassis, defining an efficiency chassis as one that would output the same amount of power to travel a larger distance. In other words, the main problem that the team was trying to address was the problem of overheated motors from multiple runs due to chassis design flaws. 421H's goal was to design a chassis that was more efficient and could travel more distance with less power. The team investigated the chassis efficiency from the factor of friction. After conducting the research, 421H assessed that various friction losses were occurring at contact points such as a shaft collar contacting a bearing flat and nylon spacers contacting metal. The team concluded that fixing these points of friction would be a very meticulous and tedious task which did not guarantee perfect results from every chassis.

Instead, 421H took an approach to redesign the VEX wheel lineup with the addition of the VEX 4" Shark Wheel. Before the redesign, the team researched the efficiency of the current VEX line up of wheels: Standard, Omni, and Mecanum. Based on research from Ether Welton in his research paper, *Mecanum and Omni Kinematic and Force Analysis*, specifically depicted in



		Standard	Omni	Mecanum
kinematics	V_f	$\omega \cdot r$	$\omega \cdot r \cdot \sqrt{2}$	$\omega \cdot r$
	V_r	-	$\omega \cdot r \cdot \sqrt{2}$	$\omega \cdot r$
	V_d	-	$\omega \cdot r$	$\omega \cdot r / \sqrt{2}$
force	F_f	$4\tau / r$	$4\tau / (r\sqrt{2})$	$4\tau / r$
	F_r	-	$4\tau / (r\sqrt{2})$	$4\tau / r$
	F_d	-	$2\tau / r$	$2\tau\sqrt{2} / r$

Diagram 1 (Kinematics and Force)

Diagram 1, 421H concluded that the standard wheel is inefficient, while the Omni wheel and Mecanum wheel only serve as a purpose of increased maximum speed or increased pulling force. Neither of the three wheels was able to find the balance between power and speed efficiency. Hence, the team researched a new type of wheel, the shark wheel. A shark wheel utilizes a helical design, which is essentially a hybrid between a spherical design and a cubic design. One benefit is the adjusted distribution of friction points on the ground allows the wheel to roll faster than a traditional wheel. The sine wave pattern, as demonstrated in Diagram 2, was implemented to support better lateral grip. The alternating pattern of grooves reduces hydroplaning by channeling liquid and solid debris out and away from the surface of the wheel. Rounded edges allow debris and small objects to pass around the wheel. Another advantage is its self-centering design, where at high speeds the Shark Wheel does not suffer from "Speed Wobble.", a common fatigue of the Omni-wheel, which reduces maneuverability at high speeds. All in all, the Shark Wheel theoretically should be able to handle 25% longer continuous runs before overheating. As a bonus to implementing the shark wheel, the design uses 15% less material than a traditional design, making it more efficient from a substance perspective and lighter in weight.

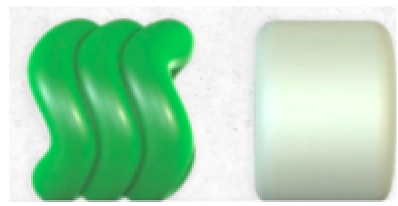


Diagram 2 (Shark Wheel Tread)

The entire development of the VEX 4” Shark Wheel was in Fusion 360 version 2.0.9313, as depicted in Diagram 3. Throughout the process of designing this model many features of Fusion 360 were used, and the multiple steps of the design process were incorporated. To begin, a rough sketch of a side view of the wheel was created. During this step, multiple sketches were created to accurately depict the sine wave curvature. A special

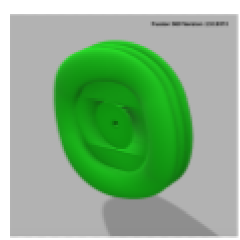


Diagram 3 (Shark Wheel Fusion 360)

feature of Fusion 360 is the ability to incorporate images into a design. With the sketch imported to Fusion 360, the "Form" workspace to shape the wheel relative to the sketch. This step took multiple tries to get an accurate curvature and to develop the main structure of the wheel. Next, the model was moved to the "Solid" workspace where the design could be adapted to be used along with VEX products. The size was adapted to make it similar to a standard 4" Omni wheel, as seen in Diagram 4. The center shaft insert was modeled to fit a standard vex drive shaft.

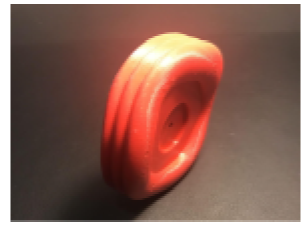


Diagram 4 (Shark Wheel 3D Print)

After the 3D modeling of the design, team 421H printed four wheels to implement into one of our robots, as seen in Diagram 5. While testing out the speed of the robot with Shark Wheels, the team did not see a difference in speed, but there was a significant increase in motor runtime before overheating. This test had confirmed our research that the Shark Wheel was in fact, more efficient than a standard Omni wheel. The wheels were able to maintain a high velocity while keeping motors from overheating. As mentioned before, the use of 3D printing our design can allow the design to be printed at a lighter weight than other VEX wheels, for the low cost of $8.49 per 60% infill wheel. This can allow for a highly efficient wheel while not sacrificing energy or weight.

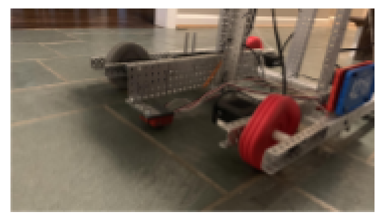


Diagram 5 (3D Print On Sample Chassis)

Throughout the entire process of designing, modeling, and testing the Shark Wheel, our team learned about the importance of CAD. Learning how to use Fusion 360 truly changed how our team perceived and followed the engineering design process for creating our robot. In future seasons, we plan to implement CAD to visualize complex parts of robots before creating them in real life. Designing parts with Fusion 360 allows us to test and revise our design multiple times without any cost to us. Learning how to use softwares like Fusion 360 can help with potential careers in any field, especially large scale manufacturing and production. The ability to simulate and visualize an idea without any risks is greatly needed in many industries. Our design was meant to represent all that we have learned about the use of CAD and how we can implement it in a transformative approach.

Works Cited

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