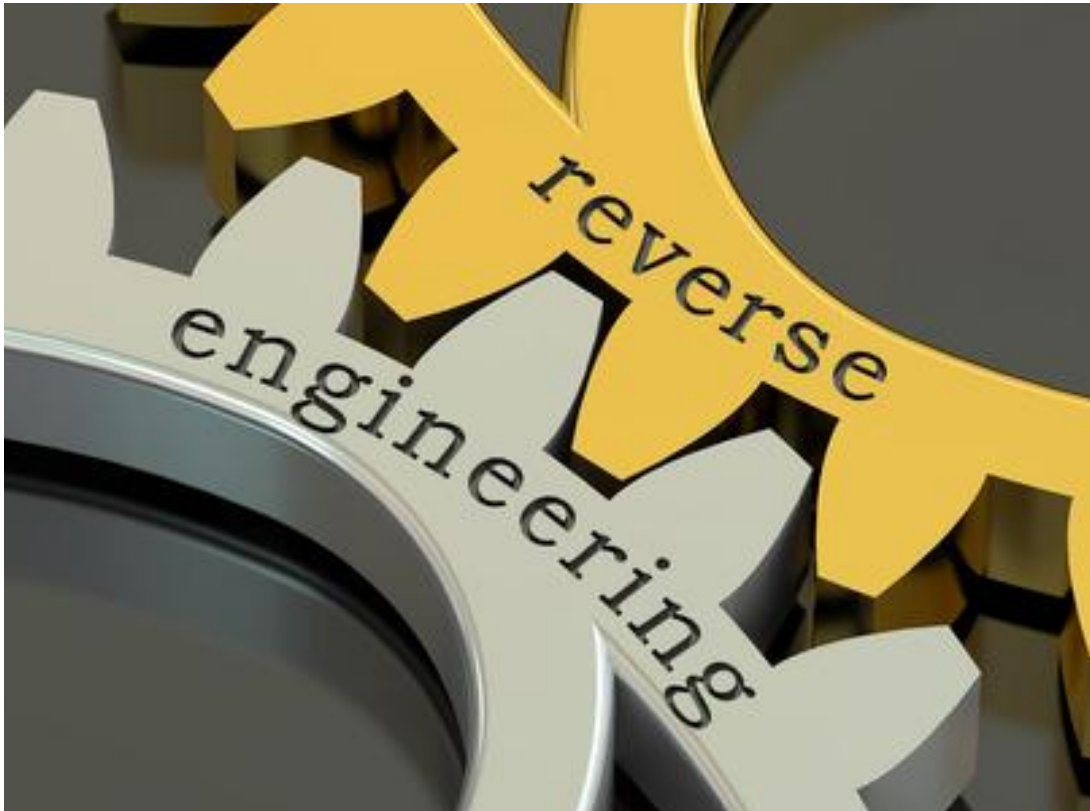


VEX VRC - 2023/2024
Reverse Engineering Online Challenge
Summary Report



Nighthawks Robotics Club
Team 569A
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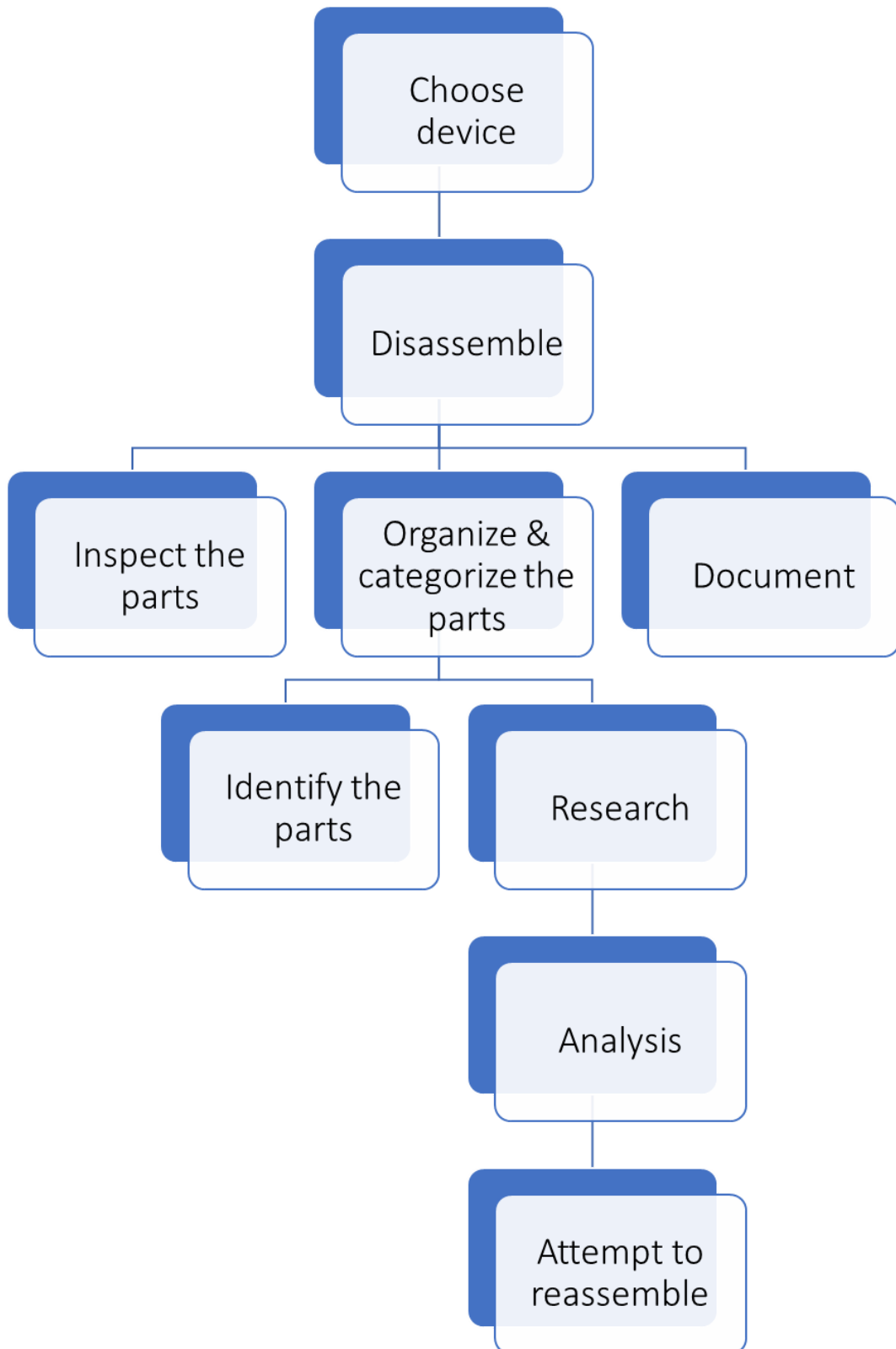
Introduction

Team 569A is made up of nine members. We chose a racing simulator wheel as our device for this challenge. We have some members on our team that enjoy car racing, so we decided to find out how the wheel works. We thought that it would be cool to see how the buttons and movements of the wheel translate to what you see on the screen.



*Fig. 1: Logitech G Driving Force G920
Feat. Nigel's leg*

The Game Plan



Disassembly

The disassembly process consisted of a lot of unscrewing and picture-taking.

Tools used:

- Safety glasses
- Allen wrench (hex)
- Philip screwdriver (different sizes)
- Ratchet
 - Flat head drill bit
 - Philip head drill bit (2 different sizes)



Fig. 2: Wheel Front View



Fig. 3: Wheel Bottom View



Fig. 4: Wheel Top View



Fig. 5: Wheel Itself Detached from Body


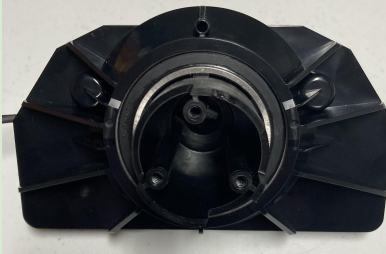





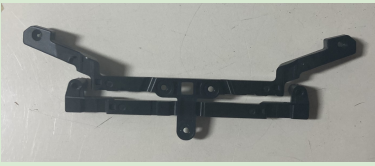



Fig. 6: Wheel Base with Top Off

Parts/Components: Non-Electronic

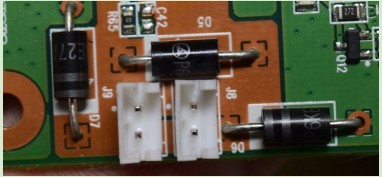
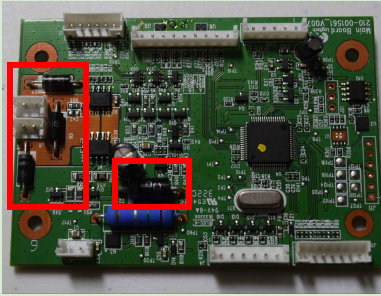
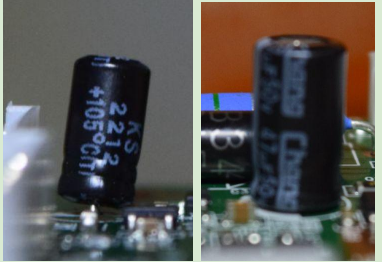
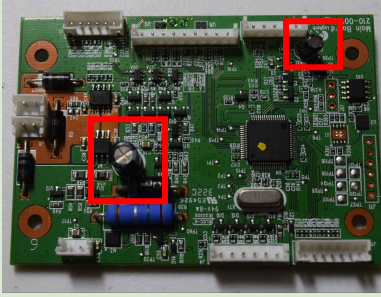

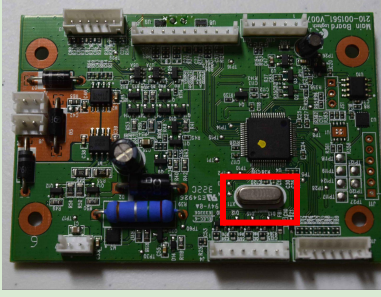
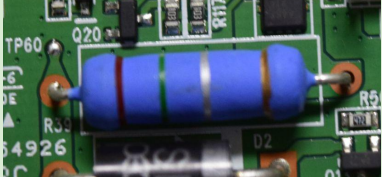
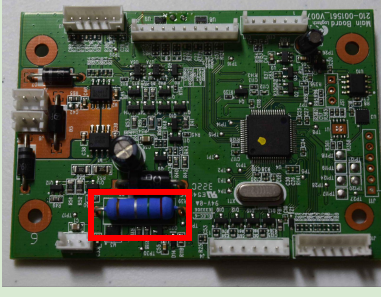
All parts are non-proprietary. Made by Logitech

Part Name	Description	Photo
Steering Wheel	The steering component of the Logitech racing wheel	
Mounting Clamps	Clamps used to mount the racing wheel onto something (ex: a table)	
Clamp Extenders	Extends the Clamps for thinner surfaces	

<p>Clamp Knobs</p>	<p>Used to adjust the Mounting Clamps</p>	
<p>Shaft</p>	<p>Rotation point</p>	
<p>Hood</p>	<p>Front cover; protects the electronics</p>	
<p>Shaft Coupler</p>	<p>Connection point between Shaft and Wheel</p>	

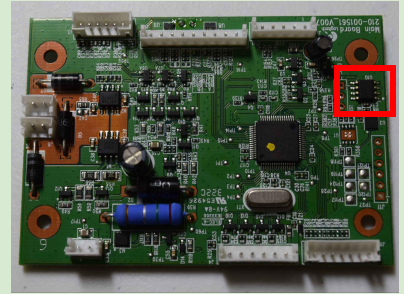
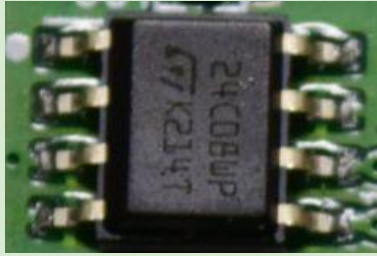
<p>“Radiator”</p>	<p>The Hood is meant to look like the actual Hood of a car, and this is the part that looks like the radiator of the car.</p>	
<p>Button Frame</p>	<p>Holds the LSB, RSB, Home, and Share buttons. Connects to the wheel.</p>	
<p>“Cable Management”</p>	<p>It is essentially cable management, but for inside the wheel.</p>	
<p>Paddle Shifters</p>	<p>If you are driving a manual car in the simulator, it will make the car go faster.</p>	
<p>Wires</p>	<p>The wiring of the main board.</p>	

Parts/Components: Electronic

Component Name/Description	Photo	Location
<p>Diodes They protect the electronic components from burning Datasheet</p>		
<p>Capacitor Act as extra batteries to charge the circuit board</p>		
<p>Quartz Oscillator It acts as the “crossing guard” inside of the microchip</p>		
<p>Resistor Lessens the strength of the currents so that they do not ruin the inside components</p>		

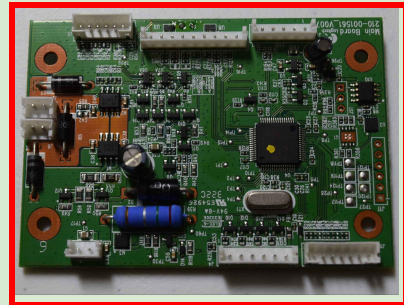
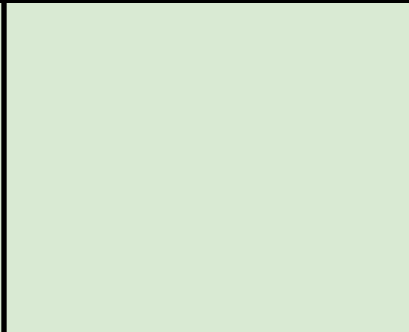
EEPROM

(Electrically Erasable Programmable Read Only Memory)
Act as a form of accessible storage that keeps user data
[Datasheet](#)



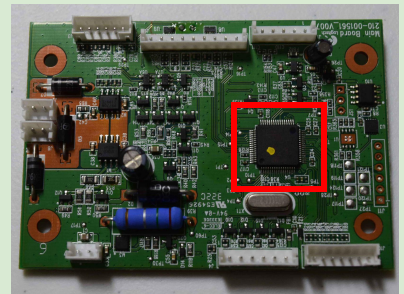
Transistor

a system of gates that lets certain currents through



Microcontroller

Used to control sensors and output different forms of data

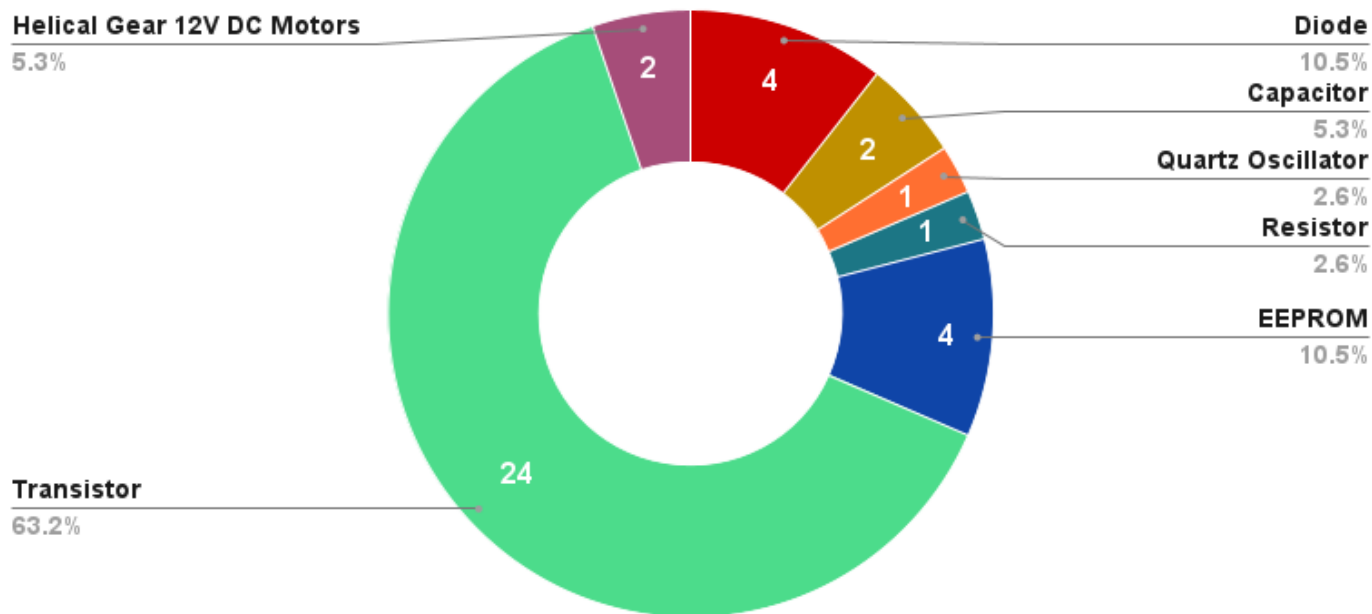


Component Analysis

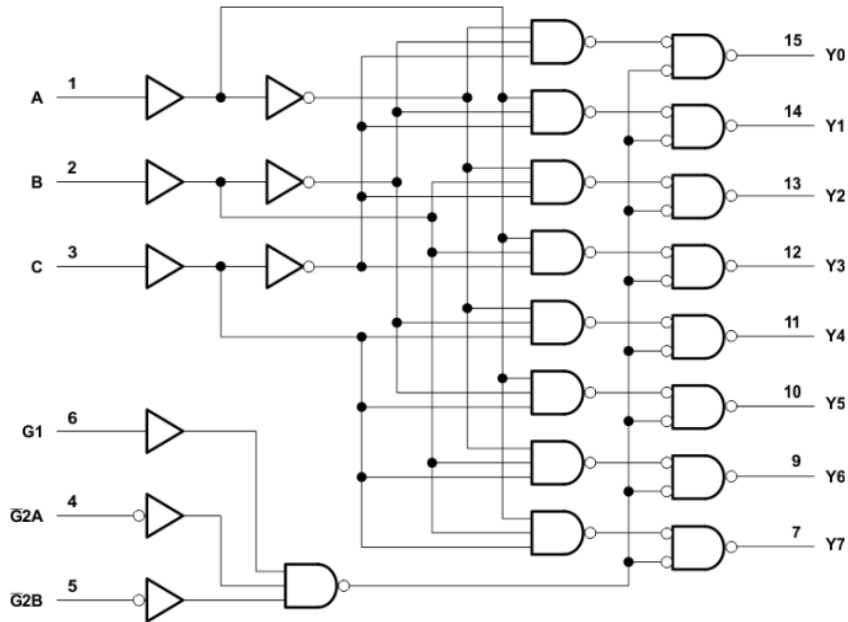
We put together a table showing all of the electric components we found and researched.

Electronic Component	Quantity
Diode	4
Capacitor	2
Quartz Oscillator	1
Resistor	1
EEPROM	4
Transistor	24
Helical Gear 12V DC Motors	2

Microchip Makeup



Findings



We found that the transistor for this mechanism has four different gates: the Inverter (NOT), Alternate OR, NAND, and Buffer. There is a “fifth” gate, the DeMorgan Inverter, which is no different to Inverter gates.

Input	Output
0	1
1	0

Fig. 7: Inverter Gate Truth Table

A	B	Output
0	0	0
1	0	1
0	1	1
1	1	1

Fig. 8: Alternate OR Gate Truth Table

A	B	Output
0	0	1
1	0	1
0	1	1
1	1	0

Fig. 9: NAND Gate Truth Table

Input	Output
0	0
1	1

Fig.10 Buffer Truth Table

We also found out that the resistor used in this device is served to limit any variance in the voltage to keep the EEPROM, and other logic gates safe.

Conclusion

We learned how to read resistor stripes, about different transistor gates, and how capacitors store energy. We realized that having an order of operations was extremely important. It was very helpful having someone on the team that already has prior knowledge about circuit boards and its components.

Resources

Other sources like datasheets are linked in the description of each component. Below are the sources in which we gathered information from.

1. *How to read capacitor code – BuildCircuit.COM.* Buildcircuit.com.
<https://www.buildcircuit.com/capacitors/>.
2. *Helical Gears - an overview | ScienceDirect Topics.* www.sciencedirect.com.
<https://www.sciencedirect.com/topics/engineering/helical-gears#:~:text=Helical%20gears%20are%20used%20increasingly> (accessed 2023-12-03).
3. Chonowski, K. *Cracking the Resistor Color Code.* Arrow.com.
<https://www.arrow.com/en/research-and-events/articles/resistor-color-code>.
4. *What is a gate-all-around transistor?* www.asml.com.
<https://www.asml.com/en/news/stories/2022/what-is-a-gate-all-around-transistor#:~:text=Transistors%20make%20up%20the%20basic> (accessed 2023-12-03).
5. *How does a Crystal work?* Electrical Engineering Stack Exchange.
<https://electronics.stackexchange.com/questions/117624/how-does-a-crystal-work> (accessed 2023-12-03).
6. Khutoryansky, E. *Capacitors and Capacitance: Capacitor Physics and Circuit Operation.* YouTube, 2016. https://www.youtube.com/watch?v=f_MZNsEqyQw.