Team Number: 3759x

Team Name: Virtuoso

Location: Irvine, California

2023 Reverse Engineering Online Challenge

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Reverse Engineering Process

Select Device → Deconstruct → Isolate parts → Research → Identify and record / What is the function? → Reconstruct

We utilized a flowchart to organize our reverse engineering process, similar to the way in which the engineering design process is used to organize a design solution.

1. Select a Device
Xbox One X Controller

We decided to choose an Xbox One controller for our reverse engineering challenge because of the widespread use and importance of remote control devices in the real world. From TVs to gaming consoles to VEX robots, remote control devices, such as an Xbox One X Controller, hold crucial value for numerous systems to function. The controller features a variety of advanced features such as motion sensing, vibration motors, and a built-in microphone, which adds to the complexity and makes it a challenging subject to reverse engineer. Overall, the complexity of its internal hardware makes it an ideal subject for exploring and understanding the inner workings of a modern gaming controller.
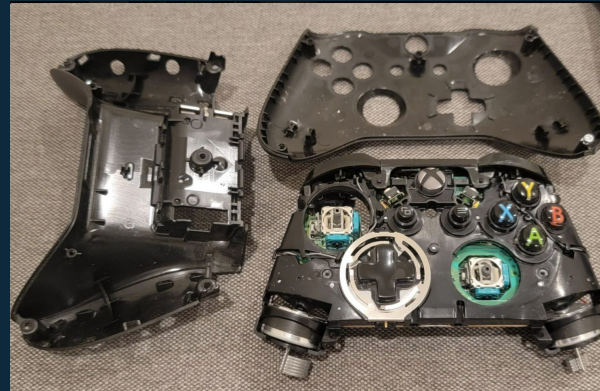

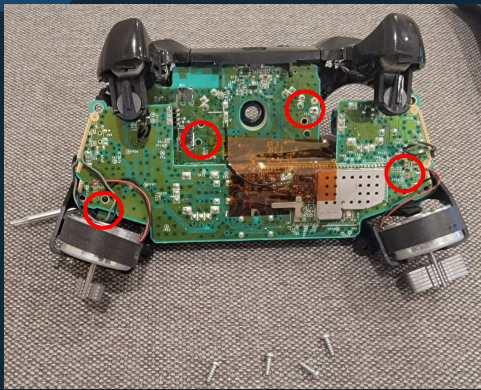Figure 1: Xbox One X Controller
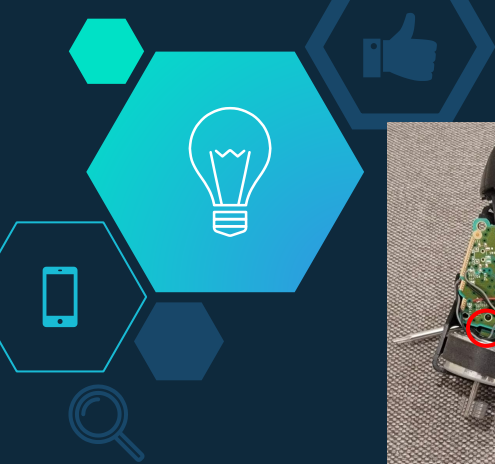
Deconstruction Process

2

Removed handle and battery covers

Unscrewed four T8 torx screws

Took front and back cover off of mid frame assembly

Unscrewed four T6 torx screws from daughterboard

Removed daughter board and rumble motors

Unscrewed four T6 torx screws from motherboard

Removed motherboard from mid frame assembly

Removed action button covers, joystick and bumper covers and small rumble motors

Research, Identify, Analyze

Non Electronic Parts

ID	Image	Identify	What is it used for?
1		Action button covers	- Provide additional tactile feedback - Placed over button on motherboard - Lets user identify buttons on the controller easier
2		Front controller panel	- Area where most of the buttons, triggers and joystick are located - Main structural interface for user interaction
3		Controller Midframe	- Responsible for holding the various internal components of the controller in place - Serves to protect the internal components from physical damage and provide structural integrity to the controller. - Made of a durable plastic material and is designed to be lightweight yet sturdy

4		Rear controller panel	- A cover for the internal components of the controller - Provides additional grip for the user - Includes the battery compartment and other connectors
5		Battery Enclosure	Houses AA or rechargeable batteries
6		Left and Right hand cover	- Provides extra grip to users - Act as handles for user

7		Bumper Assembly	- House small rumble motors for controller vibration - Typically made of plastic - Has spring-like action to act as extra buttons on the controller
8		Joystick Cover	- Provides a controllable cover for the internal joysticks - Provides comfort for user
9		D-pad button	- Four way directional pad - Connected to multiple buttons on motherboard

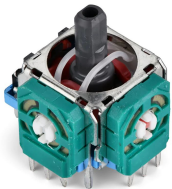| 10		Big Rumble Motors	● Big vibrating motors located in the controller handles ● Provide haptic feedback response to user ● Vibrates controller based on user interaction
11		Small Rumble Motors	● Small vibrating motors located in bumper assembly ● Provides tactical feedback and increased immersion ● Vibrates controller based on user interaction
12		Controller Joystick	● Concave shape that allows the user to comfortably rest their thumbs on them ● Designed to be sensitive to small movements, allowing for precise control ● Two small, circular sticks located on the front panel of the controller.

| 13		3.5mm headphone jack port socket	- Allows user to connect headphones or other audio devices to controller - Allows for user to communicate - Increases audio immersion for user
14		Daughter board	- Directly connected to motherboard - Adds additional functionality by adding additional buttons and paddles - Wireless connectivity - Used to upgrade controller firmware for internal components - Allows for more customization and versatility
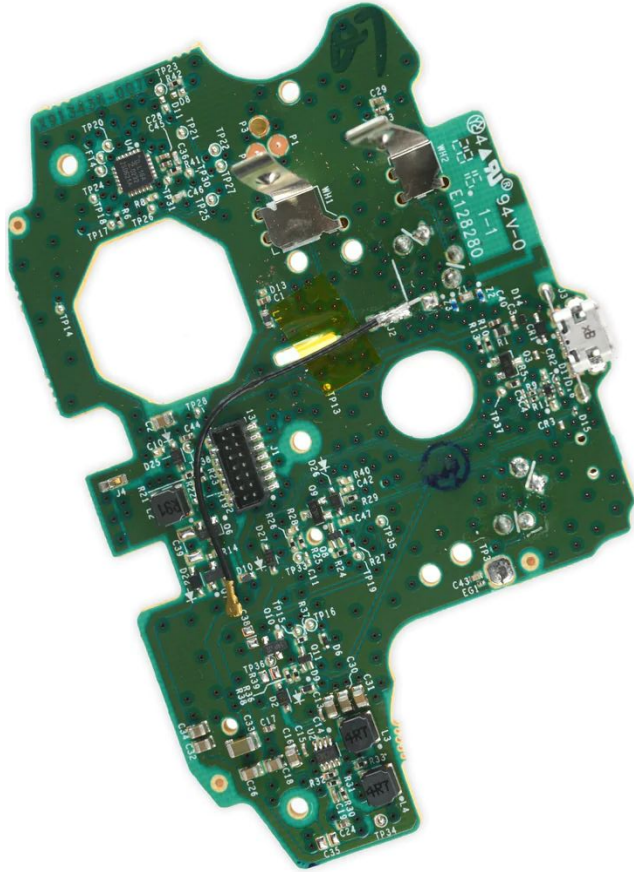
Motherboard

Motherboard functions:
- The main circuit board that houses the microcontroller, memory, and other electronic components that make the controller function
- Responsible for processing the input from the buttons, triggers, thumbsticks, and other controls, and sending that information to the console.
- Controls vibration, audio, and manages power supply
- Redirects current, power, and other vital components to keep a system running to the appropriate parts that need it.

Button Control On Motherboard:
- When buttons are pressed, the small, sealed mechanism completes an electrical circuit. Inside, a metal spring makes contact with two wires, enabling the flow of electricity and turning the circuit on.
- When power button is pressed, 2 pins on the motherboard come into contact, allowing for redirection of power

Lessons Learned

Through this process of reverse engineering an xbox one controller, we learned a variety of valuable lessons. We gained an understanding of how different parts and components work together to form the final product. When we ran into problems, we were able to developed problem-solving skills by identifying and troubleshooting issues within the product. We gained real-world knowledge of the materials and manufacturing processes used to create different aspects of a product through our research of the individual parts and functions. We were able to understand the fundamental design principles and trade-offs that were made during the development of the controller as we looked at alternate designs and ease of assembly. Disassembling the xbox one controller also enhanced our creativity and innovation by letting us think of new ways to use or improve the product. Overall, reverse engineering can be a great way to learn about the technology behind a product and develop a deeper understanding of how it works. It can also be a valuable tool for innovation and design as it allows you to explore new possibilities and identify areas for improvement or efficiency.

Works Cited

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