VRC Reverse Engineering Challenge

DECONSTRUCTION OF DEXCOM G6 GLUCOSE MONITOR

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Summary Report

As society expeditiously advances, many challenging problems result in beneficial solutions. This is especially true for diabetic appliances, which have significantly progressed through time. In 1962, the first enzymatic amperometric glucose biosensors were invented. This cataclysmic step signaled the beginning of multiple developments, as seen with fingersticks in the early 1980s. However, these outdated practices carry no benefit or convenience, and breakthroughs in modern technology have allowed the monitoring of diabetic conditions to become significantly effortless and painless, all thanks to CGM.

For the VRC Middle School Reverse Engineering Online Challenge, we have decided to deconstruct the DEXCOM G6 Continuous Glucose Monitoring (CGM) Sensor due to its groundbreaking technology and crucial significance to the *convenience*, *consistency*, and *safety* of diabetic tracking. This device contains a sensor, which transmits data to an application using a circuit board.

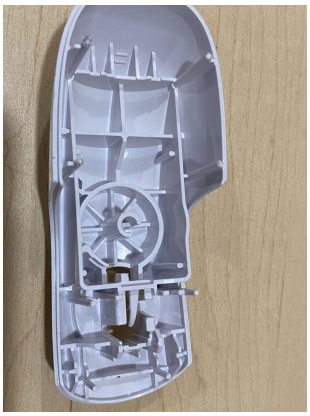
Although the device looks simple, multiple complex components concurrently function to painlessly apply the sensor. To begin, the screw locks need to be removed, which reveals two sections.

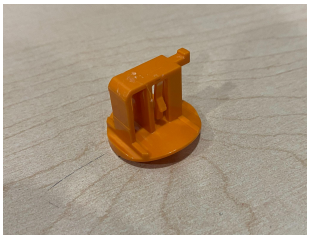
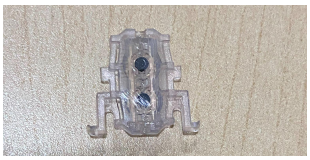
The white section contains the button interface, but has more than apparent functions. It's secured with two vertical locks, connected to a groove. Nearby, a kicker spring, a piece of metal that encircles itself, creates a spring through its attachment with its case. The spring expands due to circular motion, and creates a natural rebounding tendency, but is prevented by the catching of the button and casing's groove. This contraption *converts linear motion to circular motion,* which allows the spring to oscillate when the button's ledge is lifted. Adjacent is a metal plate, which *passively* supports the sensor.

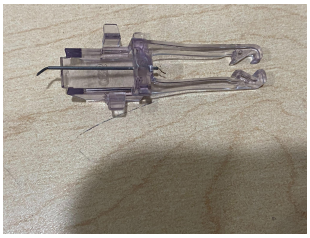
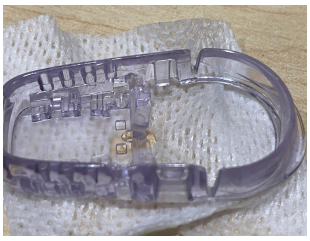
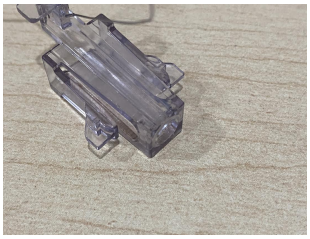
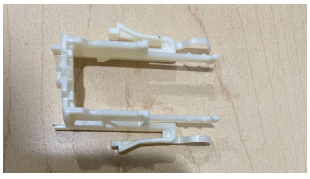
On the other half, the needle and spring mechanism is stored, which encompasses the transmitter cartridge. To release it, a small plate, threaded with a needle, is extended to a second plastic component, which is *attached* to a spring. As the spring expands or contracts, the needle moves backward or forward, respectively. Although the spring is isolated (custom designed chamber), the other components still interact with it. Once the button releases, the kicker spring's case contracts the spring, causing the plate to release the sensor while meticulously releasing the needle. This releases the sensor, which communicates sugar levels via the transmitter. This ***electrical component*** contains a battery and *circuit board* to monitor trends.

Throughout the deconstruction process, our discoveries conveyed multiple lessons. The harmonious collaboration of the components truly illuminates the revolutionary technology of CGM diabetic monitoring. It allows those burdened with a medical condition to experience the joys of life by eliminating the impracticality of blood glucose monitors. Practices such as diabetic calibration and reading limitations such as deliberate action requirements reduce the patient's well-being. CGM systems allow **hundreds** of *real-time* readings by monitoring interstitial fluid. This can not only prevent hyperglycemia and hypoglycemia but can create a sense of self-regulation, even mitigating Type 2 diabetes through the reflection of different habits on glucose. Even with multiple parts, the G6 is a flawlessly assembled device with one goal in mind: the well-being of the patient.

Appendix/Part List of DEXCOM G6 Continuous Glucose Monitor

Name	Quantity	Image	Function
Screw Locks	4		Holds casing together
Plastic Casing (Gray)	1		Houses spring and needle extensions
Plastic Casing (White)	1		Houses button interface

Kicker Spring	I		Allows button interface to create rotational motion to release the spring
Kicker Spring Case	I		Creates attachment, creates kicker spring rebounding, and attaches groove to button interface
Button (Orange)	I		Application button, groove to hold kicker spring case
Button Safety Lock	I		Prevents accidental applications
Plastic Sensor Plate	I		Pushes sensor out

Plastic Plate (Spring Attachment)	I		Provides connection between spring and external plate
Diabetic Sensor	I		Attaches onto skin, space for cartridge
Spring Plastic Casing (Internal)	I		Provides housing to spring, creates a barrier to prevent
Spring Plastic Casing (External)	I	 	Provides extra support to the spring mechanism, locks spring casing to gray case

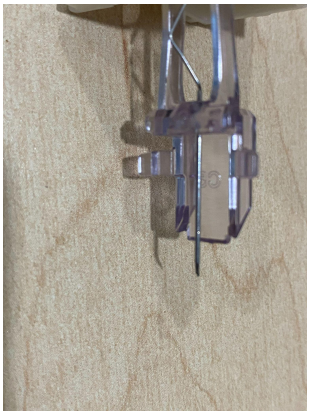
Spring	I		Allows needle to move and plate to release sensor
Transmitter	I		**Uses circuit board, battery, and sensor data to communicate information**
Needle	I		Prickles skin to allow the transmitter to detect glucose holds components together

Figure 1 (Right):

Top view of the applicator. The button interface can be seen, as well as the safety tab that prevents accidental insertions.

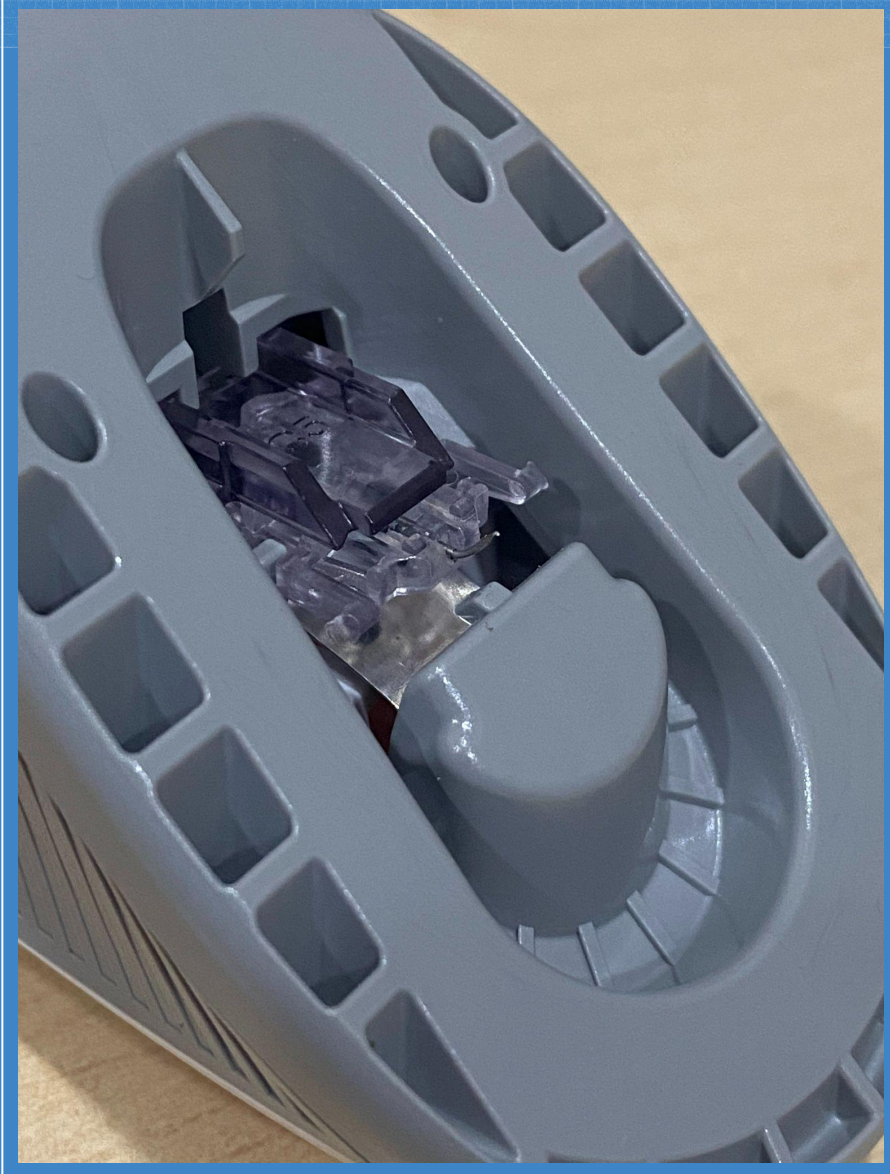


Figure 2 (Left):

Bottom view. The ridge is where the sensor sits, and the plate’s job is to release the sensor and prick the skin.

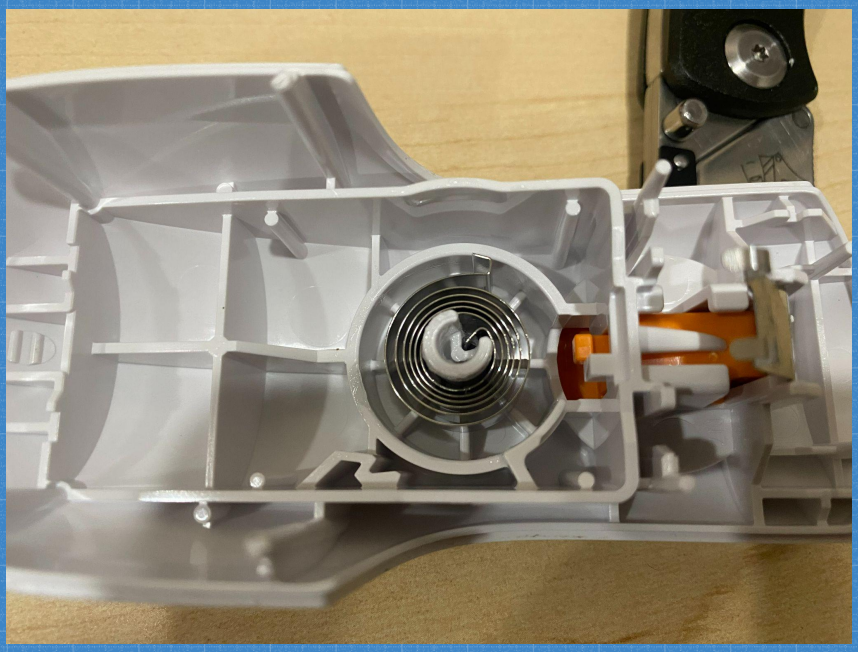


Figure 3 (Left):

Inside view of the button interface. The screw locks can be seen, as well as the small groove and metal plate.

Figure 4 (Right):

Second view of the white assembly, but with the kicker spring case present, which locks onto the button’s groove.

Figure 5:

Highlighted view of the button interface. When the button is pushed, the groove moves up, releasing the kicker spring.

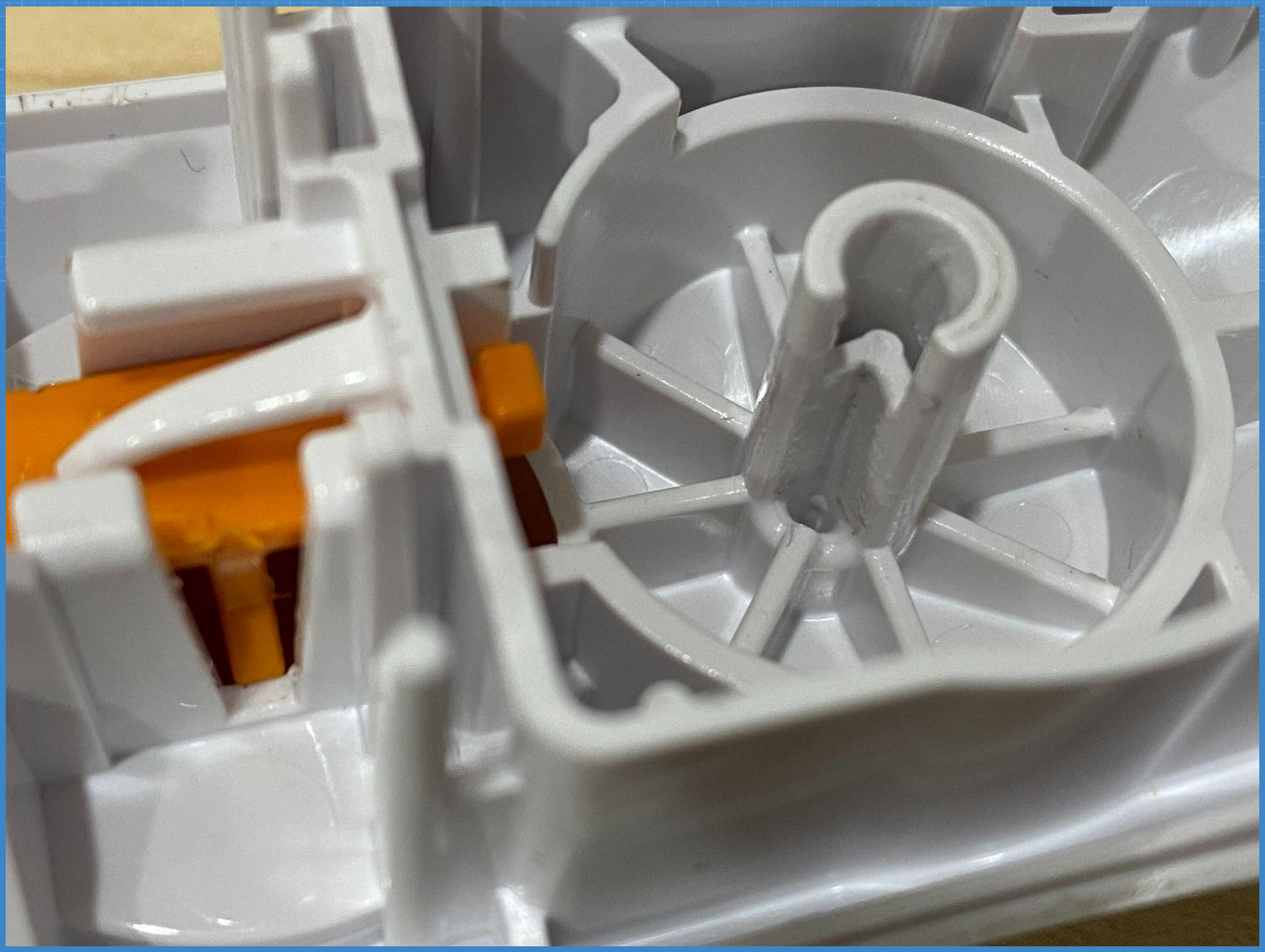


Figure 6 (Right):

The expanded version of the spring. Once the kicker spring is released, it forces the groove back, extending the plate.

Figure 7 (Left):

View of the contracted spring. This spring locks in place once the kicker spring’s groove moves it back.

Figure 8:

Picture of the DEXCOM G6 applicator's components. Even though it isn't environmentally friendly, the usage allows it to be vital to diabetic monitoring.

Appended Citations

Dexcom G6 Continuous Glucose Monitoring (CGM) System. Dexcom. (2021, August 29). Retrieved January 14, 2022, from https://www.dexcom.com/g6-cgm-system

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Hoskins, M. (2021, June 7). All about the Dexcom G6 continuous glucose monitor. Healthline. Retrieved January 14, 2022, from https://www.healthline.com/diabetesmine/dexcom-g6-cgm-product-review

Non-insured health benefits program now covers Dexcom G6 Continuous Glucose Monitoring System for children and adolescents on intensive insulin therapy. Business Wire. (2021, September 13). Retrieved January 14, 2022, from https://www.businesswire.com/news/home/20210913005728/en/Non-insured-Health-Benefits-Program-Now-Covers-Dexcom-G6-Continuous-Glucose-Monitoring-System-for-Children-and-Adolescents-on-Intensive-Insulin-Therapy