

Element C

Presentation and Justification of Solution Requirements

Name of Product: CaliCo Hand Control 3000

Designer: Silly Silly Kitty Cats La la la la la

Problem Statement

A spinal cord injury damages nerves which can cause long-term or permanent loss of function below the waist. Driving with this injury is impossible without special equipment and modifications. As of 2011, 36.5% of people with a spinal cord injury (SCI) in the US are reported to drive a modified vehicle. Studies show that this low number can be attributed to the high price of around \$20,000 to \$80,000 for modifications. Most patients feel a decrease in quality of life because of their lack of transportation and fear of driving without another person's help.

Introduction

By analyzing current products and patents used to assist drivers, a list of design specifications was noted based on the most common features and more unique features. Through an independent survey, SCI patients and caretakers ranked the importance of each component. Reliability and ease of control were ranked greatest priority, followed by durability, ease of installation, and affordability; then portability/size being the least important. Aligning with this survey, the specifications will be listed starting with reliability factors and ending with size. Despite the ranking, it is essential to note that no component should be neglected.

Target Consumer

- Patients recovering from spinal cord injuries
- Middle-aged adults and seniors

The target consumers consist of patients with spinal cord injuries who have decreased or no function of their lower body and those who have temporary injuries such as a broken bone. The majority of consumers who are interested in this device likely are employed middle-aged or seniors. With this in mind, these hand controls will be accessible to buy online and in stores and will be easily assembled.

Design Specifications

1. Performance

- **Specification:**

The hand-control driving aid shall allow customers to operate a vehicle using only their hands by having control over both braking and accelerating mechanisms.

Rationale:

All current hand-control driving aids on the market¹ allow any disabled driver without the function of their lower body to fully have access to the brake and accelerator pedals.

- **Specification:**

The hand-control driving aid should be able to be installed independently and easily by the user within three minutes.

Rationale:

The device allows for the user to have more independence if installation requires the effort of one person.²

2. Customer Needs/Ergonomics

- **Specification:**

The hand control driving aid shall have a gripped handle within arms' reach.

Rationale:

By placing the handle within arm's reach, the hand can rest comfortably on the driving aid which allows the user to be able to drive for long hours without discomfort. A gripped handle will also increase the comfortability of use.

- **Specifications:**

Users shall be able to decide where to place the hand-controlled driving aid device in relation to the OEM pedals or steering wheel/column.

¹(N.d.). Retrieved from <https://docs.google.com/spreadsheets/d/1jNNn9SnTOoFmn8VdnXaJ8JoZ5-aqWw5v3OziMGyrtQg/edit#gid=1246083777>

²Standards for Automotive Adaptive Equipment. (2021). Retrieved from <https://www.acces.nysed.gov/vr/standards-automotive-adaptive-equipment#Primary>

Rationale:

According to Hand Controls 16.5 in the Quality Assurance Program (QAP)³ Guidelines, when installing mechanical/manual hand controls in a vehicle with adjustable OEM (Original Equipment Manufacturer) parts, the pedal or steering column must be rendered non-adjustable. The mobility equipment dealer, driver rehabilitation specialist, and client shall determine the location of the OEM pedals or steering wheel/column before disconnection.

3. Size and Weight Specifications

- **Specification:**

The hand-control driving aid shall not weigh over 10 pounds.

Rationale:

Based on the current products on the market, the average range was 3-15 lbs, thus any weight less than 10 lbs is considered lightweight.

- **Specification:**

The hand control driving aid shall be expandable of a minimum of 5 additional inches and the minimum length of the shaft will be 20 inches.

Rationale:

Most of the current products on the market include an adjustable feature for user comfort and have a minimum length of 20 inches to stretch from the brake and accelerator pedals to where the hand is placed.⁴

4. Materials

- **Specification:**

The hand-control driving aid shall be made out of steel or aluminum.

Rationale:

According to the Similar Solutions Matrix⁵, all rods were made out of either steel or aluminum. This is because steel is durable and rigid, and aluminum is

³QAP Guidelines. (2023). Retrieved from <https://nmeda.org/qap/guidelines/>

⁴(N.d.). Retrieved from

<https://docs.google.com/spreadsheets/d/1jNNn9SnTOoFmn8VdnXaJ8JoZ5-aqWw5v3OziMGyrtQg/edit#gid=1246083777>

⁵(N.d.). Retrieved from

<https://docs.google.com/spreadsheets/d/1jNNn9SnTOoFmn8VdnXaJ8JoZ5-aqWw5v3OziMGyrtQg/edit#gid=1246083777>

lightweight. These two materials have different benefits depending on what properties are needed.

- **Specification:**

The hand-control driving aid will use an insulated material, such as rubber, for the handle, so it is comfortable to hold.

Rationale:

According to Scott's Fort Collins Auto⁶, the temperature inside a car is typically 48 degrees Fahrenheit greater than the outdoor temperature in the summer.

Therefore, it often reaches over 100 degrees Fahrenheit. Because of this, it is dangerous to touch conductive metals such as steel in this environment; thus an insulated handle is vital.

5. Safety and Legal Issues

- **Specification:**

There must be a clamp that is securely locked onto the pedal so that it cannot be moved with less than 500 lbs of force.

Rationale:

The average force a clamp applies is 500 lbs. This ensures that the product is secured and can not be moved unintentionally.

- **Specification:**

The hand-control driving aid shall only be installed in automatic transmission vehicles.

Rationale:

To ensure safety, the device should not be able to detach from the pedals without a significant amount of force added. According to Hand Controls 16.1 in the Quality Assurance Program (QAP) Guidelines, "Hand controls for accelerator and brake operations shall only be installed in vehicles with power brakes, power steering, and automatic transmission."⁷

⁶How Hot Do Cars Get in the Summer?: Scott's Fort Collins Auto. (2019). Retrieved from <https://www.scottsfortcollinsauto.com/how-hot-do-cars-get-in-the-summer/#:~:text=After%20an%20hour%2C%20the%20average,temperature%20ever%20recorded%20on%20earth>

⁷ QAP Guidelines. (2023). Retrieved from https://nmeda.org/qap/guidelines/#_Toc72740541

6. Target Cost

- **Specification:**

The manufacturing cost for this product will not exceed \$200. The market price will be on the lower end ranging from \$200-250. The profit margin shall range from 10-20%, thus the selling product shall be 10-20% greater than the production cost.

- **Rationale:**

The average cost of a product in the market is \$500. This product aims to be below the average cost to be more accessible to users. According to a survey conducted on patients, their family members, and their nurses, the majority would pay more than \$200 for this product. Therefore, it's most appropriate to cap the production price at \$200 and have the selling price be 10-20% higher.

What is the value of a solution (how much would you pay for a portable hand-controlled driving aid)?

35 responses

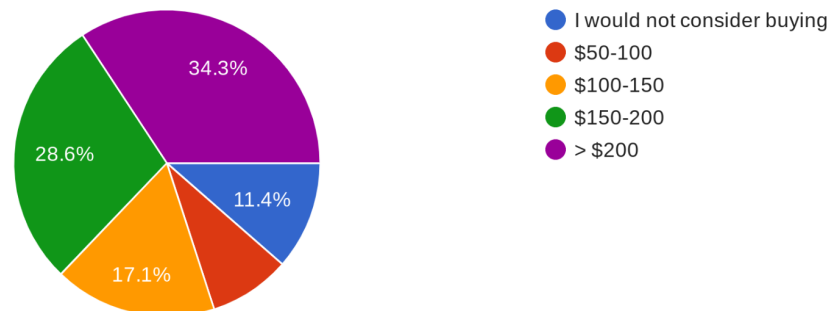


Figure 1: Value of a Solution - Survey Responses

34.3% of 35 survey takers would be willing to pay over \$200 for a portable hand-controlled driving aid.

7. Service life/Durability

- **Specification:**

The hand control driving aid will be functional for around 50 years.

Rationale:

According to Metals Warehouse, an ISO-certified company, aluminum has a lifespan of over 40 years. Stainless steel can last over 50 years.⁸

8. Operating Environment

○ **Specification:**

The hand control driving aid will be able to withstand a temperature of 110° Fahrenheit.

Rationale:

According to a study conducted by scholars from Stanford School of Medicine, the interior of a parked vehicle during a summer day can reach temperatures of 72 to 96 degrees Fahrenheit.⁹

Table 1: Estimated Vehicle Interior Air Temperature vs. Elapsed Time

| Estimated Vehicle Interior Air Temperature vs. Elapsed Time | | | | | | |
|---|------------------------------|-----|-----|-----|-----|-----|
| Elapsed Time (minutes) | Outside Air Temperature (°F) | | | | | |
| | 70 | 75 | 80 | 85 | 90 | 95 |
| 0 | 70 | 75 | 80 | 85 | 90 | 95 |
| 10 | 89 | 94 | 99 | 104 | 109 | 114 |
| 20 | 99 | 104 | 109 | 114 | 119 | 124 |
| 30 | 104 | 109 | 114 | 119 | 124 | 129 |
| 40 | 108 | 113 | 118 | 123 | 128 | 133 |
| 50 | 111 | 116 | 121 | 126 | 131 | 136 |
| 60 | 113 | 118 | 123 | 128 | 133 | 138 |
| >60 | 115 | 120 | 125 | 130 | 135 | 140 |

Table 1 displays various estimated interior air temperatures as time progresses in specific external air temperatures.

9. Maintenance

○ **Specification:**

Aluminum parts of the hand control driving aid will require no maintenance. Stainless steel is used, and maintenance will be required every once a month.

⁸Asdf, A. (2021). The Lifespan & Recyclability Of Aluminium And Steel. Retrieved from <https://www.metalswarehouse.co.uk/lifespan-recyclability-aluminium-steel/#:~:text=Stainless%20steel%20refers%20to%20any,corrosion%20due%20to%20water%20exposure>

⁹Inside Car Temperature Calculator. (n.d.). Retrieved from <https://goodcalculators.com/inside-car-temperature-calculator/>

Rationale:

Aluminum requires no maintenance. Stainless steel is highly resistant to scratches, dents, and warping, and it will be able to function well without much maintenance. However, it must be cleaned once a month to prevent the material from rusting.

10. Aesthetics**○ Specification:**

The hand-control driving aid will come in the colors baby pink and white to create a distinguishable design and appeal to target consumers.

Rationale:

To create a design that is unique and stands out from other products which are usually black or gray, the CaliCo's hand controls will have an iconic pink tint.

○ Specification:

The hand-control driving aid will be finished with sealant.

Rationale:

To avoid scratches and maintain a clean appearance, a finish will be added. This will also keep the paint from peeling.

Conclusion

The specifications and rationales presented in this document are reasonable requirements to ensure the success of this product in the market and with the users. The product will be marketed to patients with spinal cord injury or other temporary injuries that cause them to lose the function of their legs and lower body. The primary goal of this device is to allow patients to operate a car independently while including the specifications outlined in this document. There will also be aspects unique to the design of the CaliCo Hand Control 3000, increasing its marketability.