GNG5140 User Manual

Working Winter Accessibility

Submitted by

Group 4

Jin, Ziqi	300102995
Li, Wantong	300104456
Liu, Yupeng	300111472
Zhang, Zhijia	300127215
Zhou, Jiancong	300128021

2020.4.5

University of Ottawa

Abstract

In this report, we introduce the background of product design and analyze the importance of product existence and product competitiveness.

At the same time, we give detailed user manuals to help our customers better understand and use this product, and provide perfect design files to help future teams quickly take and improve the product to the next level.

Finally, we summarize our lessons learned and our work and suggest the most productive avenues for future work.

Keywords：snow shovel, user manuals, design files

Table of Contents

List of Figures

1 Introduction

The main problems we want to improve are that the snow shovel is too heavy, and the joints are unstable. Our customer wants to use a wheelchair to shovel snow in winter, but the snow shovel equipment is too heavy, which has high requirements on the physical strength of the installer, so it is not friendly to his family. Moreover, the connection between the snow shovel and the wheelchair is unstable. After running for a while, the whole snow shovel will shake or tilt, which not only affects the efficiency of snow shoveling but also has hidden safety risks. Therefore, how to make the snow shovel as light as possible and to improve the connection part are two critical issues.

Under the condition of satisfying security, some basic user requirements can also significantly improve the user experience. The lighter snow shovel can reduce the demand for the number of people so that the installer can operate from multiple people to only one. For example, one person lifts, and another person connects and fixes it, and after changing, it can be lifted and installed by a single person. This is very friendly to the installer, and it also increases the time that snow shovel equipment can be used. The stable connection of the snow shovel can enhance safety, and improve the snow shoveling effect and efficiency, which is a good thing for customers and people who hire customers to shovel snow.

About the improvement, we use a 3D printed model for the main weight replacement, replacing the original metal horizontal and vertical support rods with multiple horizontal support rods and V-shaped structures, which can significantly reduce the weight and the snow shovel can be picked up easily by one hand. We decided to add strapping as an additional tool to maintain the stability of the connection, maintain the original screw and nut structure unchanged, and use sufficient friction and low price as an advantage to increase the stability of the connection at a small cost.

2 User manuals

2.1 Important features

The feathers of this prototype include:

1. Lightweight: The snowplow mechanism (including the bracket) is less than 8 KG, easy to install by a single client with only a wrench.

2.Portable size: The snowplow is 32 inches wide*14 inches high. The bracket contains three parts, and the weight of each of them does not exceed 3 KG.

3.Adjustable operation height: Five sets of fixing holes on the bracket for height adjustment, good adaptability for different terrains.

4. Excellent snow-clearing efficiency: 31 inches of snow-clearing width, 12 inches of snow-clearing depth. This prototype can clean up the sidewalk in no time.

5. High battery endurance: 2 chargeable high-quality lithium-ion batteries. Takes 6 to 8 hours to recharge. Travel distance with full batteries is 15.5 miles.

6. Well-designed ergonomics: 20 inches of seat height*17 inches of seat width, 15 inches of backrest height*16 inches of backrest width. Weight capacity is up to 265 lbs.

2.2 Functions & Capabilities

2.1.1 Snow clearing ability

Dry snow:

(1). Snow clearing width: 31 inches

(2). Snow clearing depth: 12 inches

(3). The maximum operating speed is no less than 8.5 KM/Hour.

Wet snow:

(1). Snow clearing width: 31 inches

(2). Snow clearing depth: 12 inches

(3). The maximum operating speed is no less than 8 KM/Hour.

Slop surface:

(1). The prototype is stable at a gradient greater than or equal to 30 degrees.

(2). The maximum operating speed is no less than 5 KM/Hour on a 30-degree slope.

(3). Snow clearing width: 31 inches

(4). Snow clearing depth: 12 inches

2.1.2 Mobility

Bituminous street(with snowy surface):

(1). The maximum operating speed is no less than 8.5 KM/Hour.

(2). Turning radius is less than 0.9 M.

(3). Incline angle is less than 12 degrees.

Sidewalk(with snowy surface):

(1). The maximum operating speed is no less than 8 KM/Hour.

(2). Turning radius is less than 0.9 M.

(3). Incline angle is less than 8 degrees.

Obstacle crossing ability:

The prototype can cross:

(1). Stairway: 5 CM

(2). Brick: 5 CM

(3). Cavity: 10 CM*10 CM*8 CM

(4). Any other obstacles that are similar in size.

2.1.3 Installation

(1). The weight of the snowplow is less than 2.5 KG.

(2). The weight of the attachment bracket is less than 5 KG.

(3). The installation time is within 5 minutes.

(4). The snow-clearing mechanism contains:

- Snowplow*1 piece
- Supporting bracket*1 piece
- Connecting bracket*2 pieces
- Screw&Nut*10 pairs
- Banding belt*2 pieces

(5). The client can easily install or disassemble the snow-clearing mechanism within 5 minutes, using only a wrench.

2.3 How the prototype was made

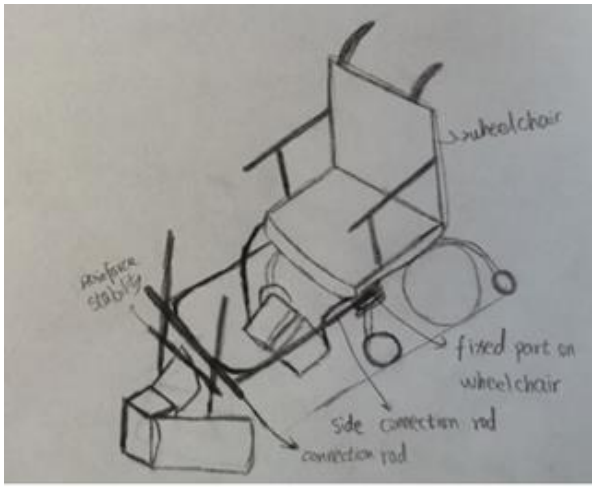

Figure 1 Overall diagram of prototype

This is the overall diagram of our prototype (Figure 1).

This is the front view of the snow shovel prototype (Figure 2). The aluminum poles(vertical) on the snow shovel are 30cm high. There are two rows of parallel holes on each of the two aluminum rods, each hole is 4 cm apart, 2 cm in diameter and 5 holes in each rod. An iron rod (50cm) is connected to the lower hole of the two aluminum rods. All connection holes are fixed with screws and nuts.

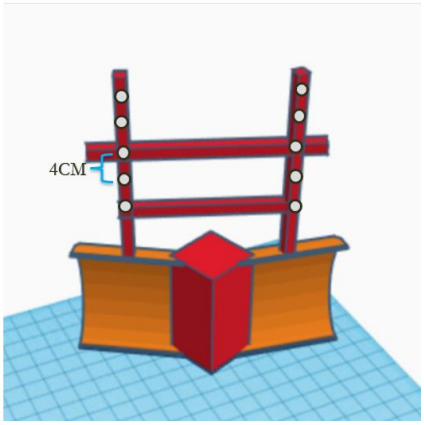

Figure 2 Front view of prototype

The PLC connector in the middle is a cuboid with a filling density of 80%. The angle of the PLC connector is 90 degrees, the side length is 25cm, and the height is 35cm. Grooves are designed on both sides of the diagonal of the connector to match the side of the snow shovel. The groove

is 5 cm deep and 30.5 cm high. The snow shovel is inserted into the groove along the diagonal of the connecting body and tightly joined. The angle formed by the two snow shovels is 120 degrees.

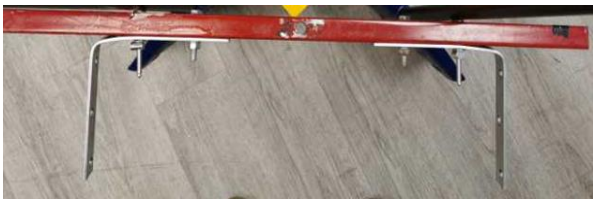

Figure 3 Aluminum alloy sheet

Of the two metal connecting rods, the upper one (55cm) has 5 available holes at each side. The distance between each hole is 4cm. Besides, it uses an aluminum alloy sheet (Figure 3) to connect the rod to the two side connection rods. Three holes are drilled at each end of each side connection rod, and the distance between each hole is 4cm, which can adjust the distance between the wheelchair and the snow shovel.

Figure 4 Fixed end

At the fixed end of the wheelchair, a 15cm iron rod and a 12cm aluminum alloy piece with nuts at both ends are used (Figure 4), and a hole is drilled in the center of the side of the 15cm iron rod, and it is fixed to the side with a screw nut on the connecting rod. The screws and nuts used are removable and replaceable. The total width of the snow shovel is 80 cm, the height is 60 cm, and the weight is 5 kg.

2.4 How it works

When the prototype is working, the wheelchair moves forward, giving the snow shovel thrust. The V-shaped tip of the snow shovel is subject to the resistance of snow. But due to its small bearing area, when the snow shovel is pushed, it will form a large pressure on the contact surface, which can easily break the snow. When the wheelchair continues to move forward, the squeezing motion between the snow molecules will gradually flow the broken snow along the double snow shovel to both sides of the road, thereby realizing the function of clearing the road.

2.5 How to install

For installation, a variable-size wrench is needed.

Steps for installation:

1. Mount the two small pivot attachments to the left and right hook rings of your wheelchair, as shown in the following figure. Tighten bolts with wrench.

Figure 5 Pivot attachment

2. Grab frame and place in front of pivot attachments. If size is not adequate, use wrench to remove bolts and readjust side and front square tubing until frame fits on wheelchair properly.
3. Insert long bolts onto each side, making sure that they cross both the side tubing and the pivot attachments. Tighten nuts with wrench.

Figure 6 Insert long bolts onto each side

4. Use the right amount of cable ties to bind the three parts separately to increase the stability.

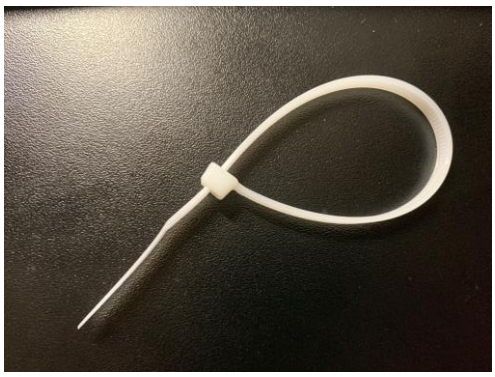

Figure 7 Cable ties

2.6 Operation

5. Once installed, user does not need to do any further action. The plow can operate just by moving the wheelchair forward.

2.7 Maintenance instructions：

6. Many roads are covered with snowmelt and will corrode the shovel. It is recommended to rinse and store the shovel after use.
7. Our metal rods have been coated with anti-rust coating, but the screws and nuts are not, so they need to be cleaned of water stains after rinse.

2.8 Health and safety guidelines and precautions

2.8.1 Frostbite Risk

Prolonged outdoor low-temperature work may cause discomfort and frostbite. Therefore, it is necessary to pay attention to the sufficient number of breaks and rest time. At the same time, users should try to wear materials with low thermal conductivity and low hygroscopicity to make cold-proof clothing, and wear warm gloves and hats. Avoid binding hands and feet to affect blood circulation.

2.8.2 Cold metal sticky skin damage

In winter, outdoor metal is already extremely cold, and human hands are at high temperatures. When people touch the metal, cold and heat exchange occurs. The temperature on the hand suddenly drops, and the skin and the metal stick together. User needs to remember to wear the gloves.

2.8.3 Security risk

There is a danger of overturning when there is too much snow on the snow shovel or problems with the operation of the wheelchair, such as skidding. So user should tighten the straps on the wheelchair before using so that they can sit still. Don't drive in front of ice. Avoid bumpy roads and do not hit tough objects at high speed.

2.8.4 Scratch hazard

Due to the shape chosen, the user is at risk of being scratched by sharp edges. User remember not to let the shovel contact their body. But purchased snow shovel material is edge passivated so we don’t need to worry too much.

2.9 A troubleshooting section with technical instructions

2.9.1 Exhausted battery

The battery should be fully charged and avoid deep discharge. For charging instructions, see the manual provided with the battery charger. We recommend that charge the battery at least 48 consecutive hours every month to improve battery performance and battery life. When the wheelchair is exhausted, the battery will be damaged and cannot be turned on. At this time, please contact the wheelchair manufacturer for repair.

2.9.2 Damaged or loose components

Regularly check the controller system for corrosion and tire wear. If necessary, contact the manufacturer for replacement. The loose parts can be tightened with a screwdriver. If there is any problem with the strap, you can repurchase it for replacement.

3 Design files

Project available at makerepo at https://makerepo.com/YPL/working-winter-accessibility

4 Conclusions and Recommendations for Future Work

The process of starting and delivering the project was a complex learning process for members of the design team. Teamwork, time management, problem-solving, and budgeting skills must be developed in order to achieve design solutions for design days. Time management was a particularly difficult skill to master for a design team because team members seem to have opposite schedules.

It was also complex to solve problems, because there were many hidden flaws in the design that were initially overlooked, and it took a lot of innovation and creativity to fix those weaknesses later on in the road. The difficulties of dealing with constraints such as a very limited $100 budget cannot be underestimated but can be solved by using free waste material in the lab. Overall, we learned a lot of technical and project-oriented skills this semester. Next, we want our customers to test our prototypes and get feedback, continue to improve our design, and possibly turn the concept into a small business.