I13 Shovel

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Problem Statement

The client has difficulty navigating the transitional ramps from roads to sidewalks using a wheelchair, due to the compact snow and ice that build up in this area.

Requirements

- Removes snow from path of wheelchair
- Withstands harsh winter conditions
- Withstands pressure of lifting heavy snow
- Clears snow quickly
- Efficiently removes ice
- Easy to operate while sitting in wheelchair
- Handle grips easily without slipping

Design Studies

I. Functionality

Determines whether prototypes are functional in removing snow. Shovels were able to remove 93.8% of the sand from the path of the chair.

II. Max Weight

Determines the max weight the shovel can hold without breaking. The shovel in the scooper orientation held 3.855 kg of sand without breaking.

III. Impact

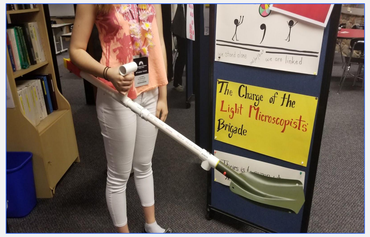
Determines whether the shovel can withstand impact of being hit against the ground. The shovels were able to withstand hits against concrete of many varying forces.

IV. Barnes Test

Determines whether the shovel can withstand being pulled when it is stuck on a slab of concrete. The shovels were able to withstand being pulled against the concrete without breaking.

Prototype 1

The first prototypes were constructed with PVC pipes. A Velcro strap was used to secure the user's arm to the shovel. The shovel head was taken off of an old shovel.



Prototype 3

This prototype had an improved attachment piece and a 3D-printed between the shovelhead and PVC pipe. An armrest that fit around the PVC pipe was also 3D-printed.

Prototype 5

This prototype had an attachment piece with a nut and bolt to hold the shovelhead to the attachment piece together. There was also a metal pin to hold the attachment piece to the shovel arm. A mesh bag was also modified to stow the shovel.

Prototype 7

This prototype had an updated armrest with curved edges, attached to the shovel with a nut and bolt. It also had a guide for the Velcro strap to ensure it was not loose. The bungee cord was inside the shovel so that the hooks did not protrude.

Functionality Testing

The shovel was used in both the scooper and puller orientations to remove sand from the path of a chair. Both orientations removed the snow.

Impact Testing

The shovels were hit against the ground while in the puller position. In this particular test, the shovel was strong enough to break concrete.

Instructions

1. Cut PVC pipe to size and print all STLs
2. Dry fit the pieces together
3. Glue all pieces together
4. Apply Grip tape for handle
5. Drill holes in PVC
6. Attach shovelhead
7. Put in the bungee cord
8. Align Shovel
9. Glue Velcro Strap Guide
10. Put shovel in bag and watch instructional video for proper usage

Conclusions

Many tests were conducted in order to determine the functionality, durability, ease of use of the wheelchair shovel

Current Prototype:

- Satisfies all Level I and Level II requirements
- Satisfies all but one Level III requirements
  - The one that is not satisfied is a future extension, not major component of device requirements
  - Passed Testing for:
    - Functionality: showed 93.8% of snow analogue (sand) was removed from ground using shovel in both configurations. Client does not need to shovel away all of the snow in real use cases → current prototype's functionality is sufficient
    - Durability (max weight, impact, and Barnes): no concern of breakage when lifting the shovel at maximum weight capacity → shovel is reliable for heavy snow lifting. The snow analogue used has a much higher mass density than any type of actual snow, which means the shovel will be able to function in almost any situation concerning the lifting of snow.
    - Ease of Use: all test subjects easily able to quickly screw in both sides of shovel pieces to the correct tightness