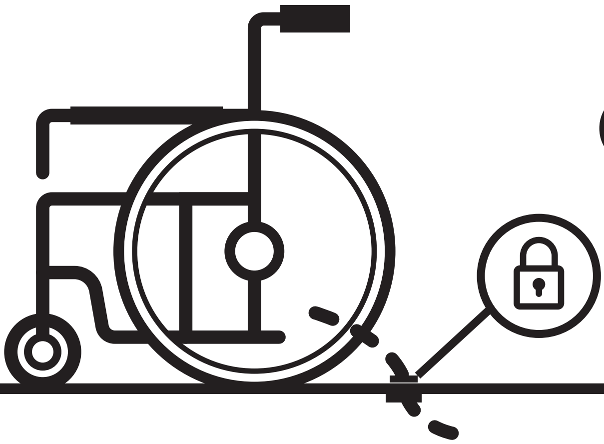

over braked

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DESIGN BRIEF

problem statement

The need being addressed by product has to do with the deficiencies of current standard braking systems on wheelchairs. Standard brakes for solid rubber wheels work well enough when the wheels are new, but as the wheel wears down in use, the brakes cease to work at all, allowing the wheels to roll. Even worse, these standard brakes can actually wear down the wheels themselves, due to their rough metal surface. Standard brakes for pneumatic wheels have their own issues when the wheels go flat. These deficiencies can be addressed by purchasing and installing other systems, but said systems are more expensive and complicated than the standard brakes

solution

Our solution is to standard brakes as a bike’s kickstand is to its normal brakes. Essentially, we have designed a brake that engages with the floor instead of the wheels. This ensures that the braking system does not damage the wheels at all. More importantly, by transferring the load from the wheels to this system, we ensure that the wheelchair has minimal ability to slip or roll, no matter the condition of the wheels.

primary research

We conducted primary and secondary research during the prototyping process. Our primary research consisted of interviewing current wheelchair users, many of whom we met at Rancho. We were particularly interested in understanding the effectiveness of existing braking/locking mechanisms on wheelchairs as well as the complexities of the interaction between the user and the wheelchair

+ do you prefer a manual locking mechanism or something more easily accessible such as an automatic braking system, why?
+ do you experience any strain or fatigue in your arms and upper body from using the current braking system?
+do you prefer to make your transfers in and out of the wheelchair independently or with the help of someone
+do you find your whelechair shifting or making small movements while you are trying to get in/out of the whelechiar, does that make you afraid of attempting to transfer independently?

marketplace & secondary research

We looked into pre-existing wheelchair locking and braking systems and evaluated which elements in each design were successful and unsuccessful. Through market research, we gained a better understanding of the current technology, price points, and structures that are consistently effective.

wheel locks:

Push/Pull to Lock: industry standard, push/pull a lever to lock in place, located on the top side frame rail in front of each rear wheel

Hub Brakes: located on the hub, not easy to reach for some users, weighs more than a knee lever brake. D’s Locks, locks wheels through the wheel hub and not the tire, uses a small concealed lever that is mounted flush to the wheelchair frame. When you flip the lever, the locking pins spring out to locate one of the 27 holes on each hub disc.

EZ Lock: automatic docking base to lock the wheelchair into place, securing the wheelchair to the vehicle floor

design approach

we worked through a few initial concepts

prototype #1: deployable wedge

A wedge that sits behind both wheels. It is attached to a two-bar linkage mechanism that extends along the inside sides of the wheels. The method of user activation has not been determined yet. From preliminary tests, we notice that this is already fairly effective with our foam core prototypes. Later prototypes would be manufactured with rubber or some other material of high friction.

prototype #2: vertical jack

We improved on our previous design for the vertical jack with a two-pronged approach.

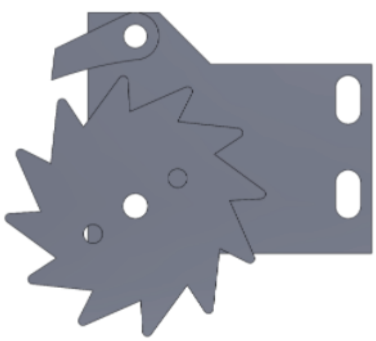
First we created a PVC pipe model that attaches into the wheelchair to show a more functional design of what was possible with the mechanism.
Second, we created an oversized model to gain a better understanding of the different functional components within the mechanism.

Our next iteration will include a linear motion with user controllability to start testing the validity of the idea, having two points of contact to the floor rather than one.

next iteration: rotary jack

We changed our direction and worked out a rotary jack system to lift and adjust the brake rather than a vertical jack.

We decided that the rotary jack would be the most suitable to design, manufacture, and assemble in a short period of time while also being fully functional as a viable prototype. We worked on building something that could support the weight of someone sitting on the wheelchair and hinder any unwanted movements.
To start with, we designed a ratchet mechanism able to be quickly manufactured. While wondering how to mount the ratchet into the wheelchair, we found screw holes which were, at the time, used for the anti-rollback features. We decided that these holes would be ideal for mounting the entire system to, and designed the system with slots of the correct size to allow for easy attachment.



The main structure of the prototype is aluminum. The ratchet mechanism and corresponding plates were cut out of aluminum sheet, the axle is an aluminum rod with mounting holes for the ratchet's hub and extendable legs, and the legs themselves are U-channel aluminum beams with adjustability holes drilled through. The "foot" is a slightly bent aluminum plate with polyurethane foam to better distribute the normal force and increase friction with the floor.

While it ended being a successful demonstration of the idea, this prototype is far from a complete product. For starters, it lacks any user interface and is nearly impossible to move into position while attached to an occupied wheelchair. Secondly, many of the dimensions were not toleranced correctly around the attachment points, leading to some screws which come loose from the smallest amount of use, and one screw in particular which has bent from the prolonged force it supports.

next step

From this point, we need to look towards the future. Our current design has multiple problems, but that is always expected out of every prototype. For our next prototype, we aim to make a more complete product in terms of both functionality and aesthetics.

Our plan is to build a fully functioning prototype, and calibrate it for both end-user and practical functionality. The key goals of the design are 1) make it work 2) make it easy to use, 3) make it desirable aesthetically 4) make it retract while not in use.

cost & manufacturing

One of our goals with the design is to lower costs as much as possible in order to maximize the number of people it can benefit. The idea of “cost” has multiple meanings for this design, namely monetary, mass, time, and social.

The primary meaning is monetary cost, for which a prohibitively high purchase price would lower the number of people who could afford to buy our product. Slightly related to monetary is mass cost, since the market we are targeting may have muscle weakness, and a prohibitively heavy add-on would prevent people from using our product everyday, or even at all. Our decision to use hollow extruded aluminum for the structure of our final product optimizes the monetary and mass costs to allow the widest range of people to afford and use our product.

The time cost is how much time a user must spend on our product, including installation, activation, repair, and removal. Minimizing time cost is crucial for enabling our users to more easily use our product and successfully deploy it when needed. Our clamp-based attachment method for the final product will reduce the amount of time and skill required to attach our product.

Finally, the social cost is any stigma associated with using our product. We have heard from many wheelchair users that they prefer their equipment to be unobtrusive, and to that end our final product is designed to blend in with the existing aesthetics of wheelchairs and not

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