

ComfyCane

Prepared for:

Ms. Cindy Lafond

Ms. Kathleen Wood

Shirley Ryan Ability Lab, Burr Ridge, IL

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Executive Summary

The Cane on Wheels device is vital to our client, Ms Lafond's, ability to remain mobile and active in her day to day life. Without it, due to physical impairments, Ms Lafond would not be able to walk while maintaining balance, stability, and comfort. However, the current prototype does not adjust for Ms Lafond's decrease in height over the period of two years. Since the prototype no longer meets Ms Lafond's physical needs, it causes discomfort for her when used. Given that her prototype is custom made, there are no available devices to accommodate her needs. Team 12.2's goal is to provide Ms Lafond with a new, durable prototype that improves the user's balance while increasing comfort when walking in indoor and outdoor environments. Our project involved a partnership with Kathleen Wood, a Clinical Manager at the Shirley Ryan Ability Lab, Burr Ridge, IL. We, Team 12.2, have worked on this project from the last week of March to the first week of June, 2024.



The ComfyCane

In response to these issues, Team 12.2 developed the ComfyCane: an adjustable, lightweight cane with two front wheels and back stoppers, a hand grip, and an arm resting platform. When in use, Ms Lafond's left arm will rest on the arm platform, and her left hand will wrap around the hand grip. The arm platform itself can be loosened, and adjusted to a position the user feels most comfortable with. The shaft can be adjusted vertically through a hole and peg system. The base of the cane is composed of a lightweight frame with four individual legs. The front legs each have a wheel screwed in, secured with a nut and bolt, and the back legs have rubber stoppers attached.

The cane's design is focused on improving balance, stability and comfort for Ms Lafond. The cane's lightweight frame reduces the overall weight of the device, while also providing a more stable foundation for the cane. The adjustable features – the arm platform and shaft – allow the user to customize the prototype to a set up that makes them feel comfortable. The hand grip provides an additional method for the user to maintain their balance. The reason our team chose this design was because after performing user testing with Ms Lafond and our initial mockups, we realized our prototype shouldn't require the user to bear excessive weight on the device, and prioritize helping her maintain balance and stability.

Components and Benefits

- Arm Platform: Provides the user with an additional source of stability and comfort.
- Aluminum Lightweight Frame: Material is strong and lightweight, allowing for a lighter base and improved stability
- Adjustable Shaft: This component allows the user to adjust the height of the device

Introduction

Walking canes are one of the most commonly used assistive devices for people 65 or older [1]. They are usually used to increase balance and mobility. Our user, Ms. Lafond, experiences two health challenges that require her to use a modified quad-base cane with wheels so that she can continue to maintain her balance, mobility, and ability to ambulate. The first challenge is hypertonicity in her left extremities as a consequence of a stroke. The second is severe osteoarthritis in her right knee and shoulder (See [Appendix A: Secondary Research Summary](#)). The modified Cane on Wheels was previously sufficient for Ms. Lafond to ambulate independently and comfortably without putting excessive stress on her affected knee and shoulder (See Figure 1). However, due to her height having decreased by 2 inches, the device no longer supports her needs, as it no longer fits the user comfortably. Our team has designed and developed the ComfyCane to allow Ms. Lafond to continue to comfortably, safely, and independently ambulate in indoor and outdoor environments. Our design incorporates a similar design to the Cane on Wheels, as it has been proven to be effective. In addition, we incorporate an armrest to increase comfort while walking. Our design prioritizes safety, durability, comfort, and the storability of personal belongings for the user. This report details the specifications of our team's design and our processes, including our major users and requirements, design concepts and rationales, limits, and future development.

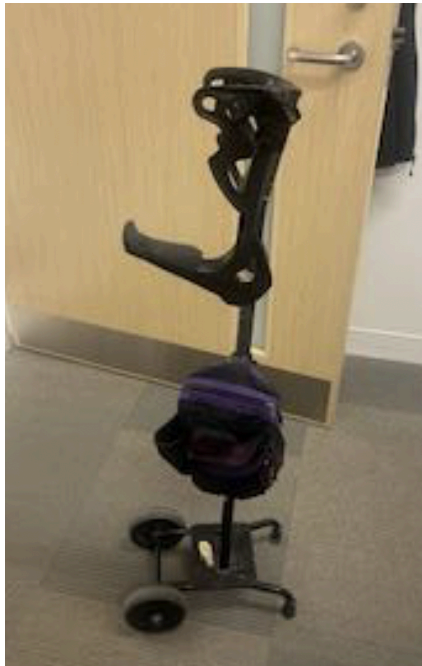


Fig 1. The Cane on Wheels, which was previously used by Ms. Lafond.

User and Requirements

Users

The main user of our device is Ms. Lafond. She is a 65-year-old woman with hypertonicity in her left extremities and severe osteoarthritis in her right shoulder and knee (See Appendix A: Secondary Research Summary). As a result, she requires a modified assistive device named the “Cane on Wheels” to ambulate. The device no longer fits her, and she would like a replacement so that she can comfortably ambulate again.

Mr. Lafond will also need to assist Ms. Lafond in carrying and holding the cane for her when the cane is unable or impractical to be used. For example, the cane is not necessary when Ms. Lafond is using stairs or when using a car.

Requirements

There are four requirements that must be met with our design:

1. The device must be able to be used so that the user can independently ambulate.
 - The user would like to walk comfortably in both indoor and outdoor environments (See [Appendix B: Observation Summary](#), [Appendix C: Interview Summary](#))
 - Our device must be able to be independently used so that the user can once again comfortably ambulate on her own.
2. The device must also maximize safety, decreasing the risk of failure and mitigating the effects of any emergency situation.
 - Because the user already has hypertonicity and severe osteoarthritis, our design must maximize the safety of the user to avoid potential injury.
 - Since walking is also something that our user does daily, we must make sure that the device is safe to avoid potential injury.
3. The device must be durable.
 - Because the user would like to use the device in both indoor and outdoor environments, it will be subject to variable weather conditions such as rain, snow, high winds, or extreme heat.
 - For the device to continue to serve as a walking aid for Ms. Lafond, the device must be built to withstand these conditions.
4. The device must be accessible and easy to use.
 - Since Ms. Lafond will need the cane almost all day on a daily basis, the device must be able to be easily cleaned, stored, and adjusted according to the needs of the user at a given time.
 - Additionally, Ms. Lafond will need a way to store and carry her personal belongings, thus requiring the design to accommodate these needs.

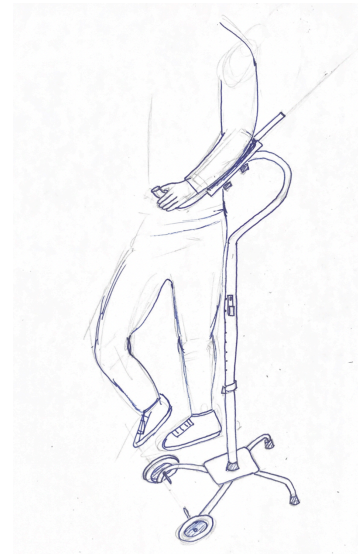
Find a full list of stakeholders, requirements, and specifications in [Appendix D: Project Definition](#)

Design Concept and Rationale

The ComfyCane is a lightweight frame cane with adjustable height and a rotating arm rest, along with two front wheels and two back stoppers. When being used by Ms Lafond, her arm may rest comfortably on the arm platform, which can be adjusted to the angle she deems comfortable, and her hand gripping the hand grip at the end of the platform. The cane's wheels and stoppers only allow the device to move forward (See [Appendix E: Instructions for Use](#)).
(insert photo)

Design Subsystems, Important Features, or Key Decisions

Arm Platform and Hand Grip



This section shows the top of the cane, which consists of the arm platform and hand grip.

Rationale

The arm platform provides a method of improving the user's balance while also providing comfort. In addition, by allowing the platform to rotate, we allow the user to adjust the platform to their preferred angle. The hand grip provides an additional method for the user to maintain their balance. By being able to grip the handle firmly, this can increase the balance and stability of the user and prevents the user from applying unnecessary weight to the cane itself.

Cane Bottom/Lightweight Frame Base/Wheels and Stoppers



This section shows the bottom of the cane, which consists of the Lightweight Frame, wheels, and stoppers.

Rationale

By reducing the size and weight of the bottom frame, we can make the device easier to use.

Utilizing a lightweight frame can provide more stability to the design, and therefore more balance for the user when compared to a large metal frame in the previous design. The specific mold of the

frame was chosen to accommodate the user's requirement, that the cane must be used by her left arm, and remain on her side, rather than in front of her. Additionally, by securing wheels to the two front legs and leaving only stoppers on the back legs, we fulfill Ms. Lafond's specification that the device should not be able to move backward, which is accomplished through the back stoppers, which will prevent any backward movement.

Adjustable Cane Shaft



This section shows the middle of the cane, which consists of the adjustable shaft of the cane.

Rationale

Part of Ms. Lafond's original issue was the fact that her previous model's height could not be properly adjusted to accommodate her height change of 2 inches. Therefore, our team decided to use a cane that could easily adjust heights and offer a range of adjustability. For this, our team decided to use an adjustable cane shaft with a screw to tighten. Through this, our design can improve on the previous Cane on Wheels model by providing a range of adjustability, but also allowing for the user to change the height at their leisure.

Benefits

Given the problem was to provide Ms. Lafond with a new device with increased durability and improves the user's balance when in use outdoors and indoors, the benefits of our design are the following:

- Allows the user to change the height of the device to accommodate her
- Reduces size and improves the stability of the device, allowing for easier use in indoor and outdoor environments
- Adjustable platform for arm and hand grip allows for improved balance and prevents the application of unnecessary body weight

Limitations and Next Steps

Our team's mission statement is: Design a durable device that improves the user's balance while increasing comfort when walking in indoor and outdoor environments (See [Appendix D: Project Definition](#)). The final design for our cane is focused on allowing Ms. Lafond to maintain her balance while using the cane. Teams that further develop this device should devote more resources and time to user testing and cost-effectiveness.

1. Cost Effectiveness

All the materials used for our final prototype were obtained through Amazon (See [Appendix F: Bill of Materials](#)). However, there are potential alternative materials (e.g. plastic) that are more cost-effective than the ones we used in our project. It is important for future teams to spend time researching and analyzing any new materials that may improve the final prototype, but also contribute in a cost-effective and economical way.

2. Height Adjustment

While we are content with the current pin and hole-based height adjustment mechanism, one of its shortcomings is its imprecision. Given that our user may encounter additional height loss, a slow and gradual process, the ComfyCane should be able to adjust similarly, with much smaller increments than the 1” gaps between pin holes currently available on the device (See [Appendix G: Instructions for Construction](#)). One promising mechanism would be knob-based gradual adjustment, similar to many adjustable tables, allowing infinitesimally small increments of adjustment.

3. Weight Reduction

While the ComfyCane is not uncomfortably heavy in its current form, it can always be lighter. Aluminum excess at the base of the cane and the armrest should be removed, and as with cost effectiveness, alternative lighter materials should be considered.

4. Storage

Safe but functional storage was another goal for our final design, and we believe both of those aspects can continue to be improved. Hook geometries that evenly distribute loads to prevent bending/snapping should be tested.

5. Armrest

While the armrest currently allows for any angle and any adjustment within its given range, it does not allow the user to lock a preferred angle in place to use. Future development should aim to find a way to allow a gradual adjustment while allowing the armrest to lock into a preferred angle.

Conclusion

Our design meets the essential requirements and needs of our user who will utilize the walking aid. It successfully allows the user to easily ambulate safely and comfortably. Our design utilizes:

- an aluminum base and shaft capable of withstanding 50 lbs of body weight without bending or deforming
- a lightweight, off-center base that facilitates balance and stability through optimal force placements
- a 2-wheel and 2-stopper base system that minimizes unwanted movement and allows for clockwise rotations
- a height adjustable shaft from 29" - 38" that allows the user to comfortably use the walking aid and considers future potential height loss
- an angled, cushioned armrest with 180 degrees of rotation that adapts to the user's preference

Our user needs a walking aid that is comfortable and convenient for everyday use, but also safe and durable for long-term viability. The cushioned armrest provides full arm support for stability and the wheel-stopper base allows for ease of maneuverability in walking and rotating. The metallic aluminum prevents potential deformation of long-term weathering.

Furthermore, the user has to be able to use the walking aid in the long term considering further height loss or arm restrictions. The shaft height adjustment allows for the user to adapt the height of the shaft continuously if their height continues to decrease. The angle of the armrest can be easily modified to fit the user's current conditions or arm restrictions to provide maximum ease of use.

References

- [1] N. M. Gell, R. B. Wallace, A. Z. LaCroix, T. M. Mroz, and K. V. Patel, “Mobility Device Use in Older Adults and Incidence of Falls and Worry About Falling: Findings from the 2011-2012 National Health and Aging Trends Study,” *Journal of the American Geriatrics Society*, vol. 63, no. 5, pp. 853–859, May 2015, doi: <https://doi.org/10.1111/jgs.13393>.
- [2] CDC, “About Stroke | cdc.gov,” Centers for Disease Control and Prevention. Accessed: Apr. 02, 2024. [Online]. Available: <https://www.cdc.gov/stroke/about.htm>
- [3] “Stroke - What Is a Stroke? | NHLBI, NIH.” Accessed: Apr. 02, 2024. [Online]. Available: <https://www.nhlbi.nih.gov/health/stroke>
- [4] “Hemiparesis,” www.stroke.org. Accessed: Apr. 02, 2024. [Online]. Available: <https://www.stroke.org/en/about-stroke/effects-of-stroke/physical-effects-of-stroke/physical-impact/hemiparesis>
- [5] “Muscle Function Changes After Stroke,” NEOFECT Blog. Accessed: Apr. 02, 2024. [Online]. Available: <https://www.neofect.com/us/blog/muscle-changes-after-stroke>
- [6] “Osteoarthritis | CDC.” Accessed: Apr. 02, 2024. [Online]. Available: <https://www.cdc.gov/arthritis/types/osteoarthritis.htm>
- [7] “What Are the 4 Types of Canes? How To Use, Walking Aids,” MedicineNet. Accessed: Apr. 03, 2024. [Online]. Available: https://www.medicinenet.com/what_are_the_4_types_of_canes/article.htm
- [8] “Rolling Cane.” Accessed: Apr. 03, 2024. [Online]. Available: <https://www.assistivetechservices.com/rollingcane.html>
- [9] C. Zhu, “What is the Best Mobility Aid?,” OasisSpace. Accessed: Apr. 07, 2024. [Online]. Available: <https://www.oasisspace.com/blogs/healthcare/best-mobility-aid>

- [10] “Amazon.com.” Accessed: Apr. 03, 2024. [Online]. Available: <https://www.amazon.com/LZYLZF-Hemiplegia-Rehabilitation-Three-Speed-Adjustment/dp/B09F9DLMDS?th=1>
- [11] W. M. Warees, L. Clayton, and M. Slane, “Crutches,” in *StatPearls*, Treasure Island (FL): StatPearls Publishing, 2024. Accessed: Apr. 03, 2024. [Online]. Available: <http://www.ncbi.nlm.nih.gov/books/NBK539724/>
- [12] D. Dujali, “Wheelchairs vs Canes: Which Is the Better Choice for Seniors? | Eden Senior Care.” Accessed: Apr. 03, 2024. [Online]. Available: <https://www.edenseniorhc.com/wheelchairs-vs-canes-which-is-the-better-choice-for-seniors/>
- [13] E. Cassidy, “Report of the Ombudsman,” World Health Organization, EB146/INF./3, Dec. 2019. [Online]. Available: https://apps.who.int/gb/ebwha/pdf_files/EB146/B146_INF3-en.pdf
- [14] C. Khasnabis *et al.*, “Assistive devices,” in *Community-Based Rehabilitation: CBR Guidelines*, World Health Organization, 2010. Accessed: Apr. 03, 2024. [Online]. Available: <https://www.ncbi.nlm.nih.gov/books/NBK310951/>
- [15] “7 Common Reasons Why a Person May Need a Cane,” Giraffe Rolling Cane. Accessed: Apr. 03, 2024. [Online]. Available: <https://girafferollingcane.com/blogs/news/7-common-reasons-to-need-a-cane>
- [16] “Data from the NATIONAL HEALTH SURVEY Use of SpecialAids United States -1977 Statistics on the distribution and use of artificial limbs, braces, crutches, canes or walking sticks, special shoes, wheelchairs, walkers, and other special aids for getting around. Based on data collected in the National Health Interview Survey in 1977,” 1980. Accessed: May 25, 2023. [Online]. Available: https://www.cdc.gov/nchs/data/series/sr_10/sr10_135.pdf
- [17] A. Anderson, “What to Know About Using a Cane,” WebMD. Accessed: Apr. 03, 2024. [Online]. Available: <https://www.webmd.com/a-to-z-guides/what-to-know-about-using-cane>

[18] “How To Use Crutches, Canes, and Walkers - OrthoInfo - AAOS.” Accessed: Apr. 03, 2024. [Online]. Available:

<https://www.orthoinfo.org/en/recovery/how-to-use-crutches-canes-and-walkers/>

Appendix A: Secondary Research

Introduction

Over March 29-31, initial research was gathered from a variety of online sources to begin to contextualize the design problem. Research began with the conditions/physical ailments of the user, existing solutions to similar problems, constraints, and challenges of the design problem, and the greater context/environment that the final product might be used in.

User Physiology

The user, Ms. Lafond, experiences two relevant health challenges. The first is the consequences of a stroke (mostly confined to the motor skills of the left side of her body), and the second is severe osteoarthritis (mostly confined to the joints of the right side of her body). Due to the high frequency of ischemic stroke and the fact that it is Ms. Lafond's left side that primarily suffers the physical consequences of the stroke, it is likely that she experienced a stroke on the right side of her brain, leaving her mildly hemiplegic (paralyzed on one side of her body) [2, 3, 4]. The "hypertonicity" described in the project statement is a direct result of this stroke. Hypertonicity is defined by increased tension stored in muscles at rest, causing stiffness/reduced range of motion [5].

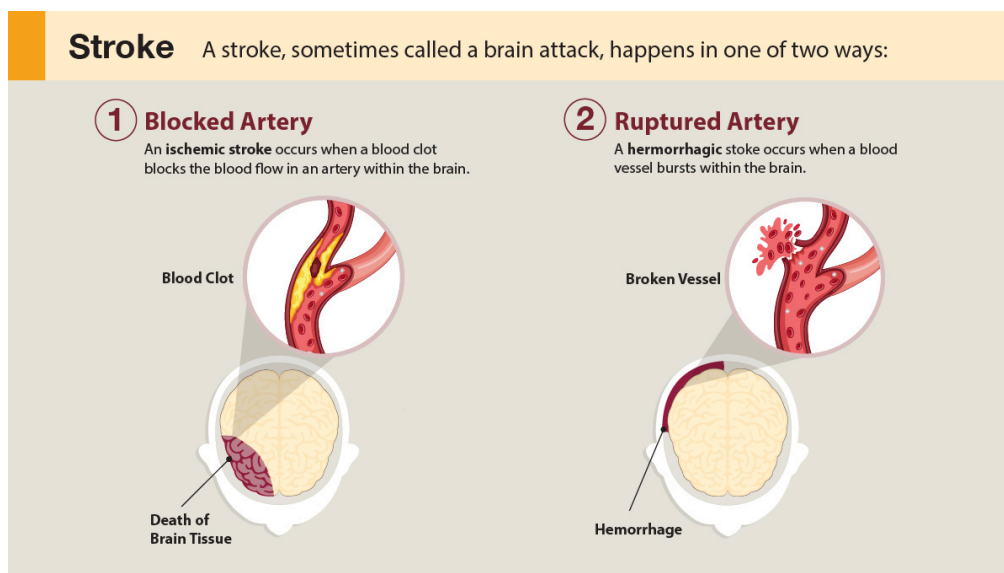


Figure 1: Types of Stroke [1]

Ms. Lafond also lives with severe osteoarthritis, affecting the opposite side of her body. Known as the "wear and tear" form of arthritis, it is extremely common among older people,

though not always at Ms. Lafond's severity [6]. Osteoarthritis is caused by the breakdown of cartilage protecting bones at joints, and the exposed bone-on-bone contact can lead to a variety of uncomfortable symptoms, including pain, stiffness, loss of flexibility, bone spurs, swelling, and more [6]. The severity of this osteoarthritis is the primary reason for Ms. Lafond's modified cane in the first place.

Existing Solutions

Her current cane was another jumping-off point for this project's initial research. Mobility aids come in countless shapes and sizes and are used by a huge variety of people, for equally as many medical reasons. The simple and common single-point cane is cheap, lightweight, and ideal for those experiencing mild to moderate osteoarthritis or other movement impairments that allow them to maintain a moderate degree of upper body strength and balance [7]. In other words, they are not ideal for the user. Multi-legged canes, like the one Ms. Lafond's device was built upon, increase the amount of support and stability provided by the cane, which is ideal for people with moderate to severe arthritis or hemiplegia, and come with the added benefit of being able to stand on their own [7]. Some, like Ms. Lafond's device, include wheels to mitigate the need to pick up the device with every step [8]. The third and final major family of canes is hemi-walkers or walker-cane hybrids, which are best for those with extreme lower body disability, as they allow a significant amount of body weight to be redirected into them [7].



Figure 2: Types of Mobility Aids [8]

Braces running from hip to knee, crutches, and wheelchairs serve similar purposes to canes [10, 11, 12]. Different varieties of crutches have been developed for patients with different degrees of physical ability. For example, forearm crutches are best for people living with long-term disabilities who also wish to maintain athletic fitness [11]. Platform crutches are better suited for those with neurological disabilities and largely shift body weight from the legs to the forearms resting on the crutches [11]. Wheelchairs provide an unparalleled amount of support

and also minimize the potential for injury while using them, which is especially important for patients with slowed reaction time [12].

Unfortunately, each of these mobility aids, including the custom one used by Ms. Lafond, comes with its own set of flaws. Wheelchairs, for starters, make it very difficult to ascend any kind of incline, and without human aid, require a lot of physical effort to operate [12]. Across all mobility devices, price is another issue, disadvantaging disabled people with lower socioeconomic status [13, 14]. The design of any assistive device must also conform to the personal measurements and preferences of each patient, adding complexity to the design of any potential solution to this design problem.

Broader Context

Finally, in developing a solution for Ms. Lafond, it is important to keep in mind the greater context of people with ambulatory disabilities (disabilities that affect how people walk) and how they interact with their environments. Canes, along with any other assistive devices, could very well be used by elderly patients, stroke victims, or those with severe osteoarthritis, but are also used by injured athletes, children, or people recovering from surgery [15, 16]. The people who use the devices must do so in a variety of settings, including when navigating around indoor spaces, climbing stairs, or standing up from a seated position [17, 18].

While this is a solid foundation for contextualizing the design challenge from our project partner, many questions remain, especially regarding the specific case of Ms. Lafond. Her medical condition is a highly personal topic, and it will likely be the case that a personal conversation with her will supplement this research well. However, this knowledge base provides a useful context for knowing which questions to ask on future visits.

Appendix B: Interview Summary

Introduction

In order to gain more background information about Ms. Lafond's condition we interviewed our client, Ms. Kathleen Wood. Our client spoke about Ms. Lafond's current capabilities and the problems with the existing solution: the Cane on Wheels. This summary explains the methodology and results of this interview.

Methodology

This interview began shortly after 4 pm on April 2, 2024, online through Microsoft Teams. Beforehand, both teams prepared questions for our client based on our previous secondary research. We initially sought more information concerning our client's history at Shirley Ryan Ability Lab and her relationship with Ms. Lafond. We then jumped into questions geared toward the general exploration of the project, before ending the Q&A portion of the interview with an exploration of more specific issues. Finally, an in-person observation was scheduled for April 5, 2024, at Shirley Ryan Ability Lab in Burr Ridge, IL.

Client Background Information

Ms. Wood has worked with Shirley Ryan Ability Lab for 23 years as a Physical Therapist, Outpatient Clinical Manager, and Occupational Therapist. She also works with physical medicine and rehabilitation doctors. In the past, she has worked with patients with diagnoses related to speech and musculoskeletal issues. We also learned that our client has worked with our user for around 2 months and that our user has a separate primary physician.

User Background Information

Our client described our user's condition as weakness on her right side due to her stroke, and severe left-side arthritis. Because of this, the user cannot pick up and place down any assistive devices, such as a traditional large base quad cane. For this reason, the current Cane on Wheels is the solution that has worked best for our user.

Ms. Wood described the Cane on Wheels to function by having the front two wheels move, with the two pegs dragging on the ground, allowing for maintained traction. Although the user does need to slightly shift her weight to the cane to prevent her right leg from dragging, the main function of this device is to help the user maintain her balance.

We asked additional questions concerning the user's typical day-to-day activities and needs, but because Ms. Wood did not have the information we asked for, she said she would ask

Ms. Lafond at a later date. The questions were then deferred to the in-person observation scheduled for April 5.

Current Design Issues

A Shirley Ryan Ability Lab orthotist fitted together the Cane on Wheels. However, the solution is no longer optimal for Ms. Lafond, who has shrunk 2 inches in height. Because of this, she cannot comfortably rest her arm on the cane, as the height is no longer appropriate for her. Furthermore, the user uses the cane on her left side because of the weakness in her right arm and for that reason, our user cannot use her right hand for other activities such as carrying her belongings. Due to the inability to hold anything on her right side, a bag is strapped on the device using velcro, allowing the user to carry her personal items.

Preferences for a Solution

Ms. Wood emphasized that our solution must allow the user to comfortably ambulate without human assistance. The solution must also be durable and tolerable for harder surfaces, to allow for ambulation outside and through variable weather conditions. Our client also mentioned that making the device flexible with an adjustable height would also be a valuable addition. Because the user has had success with the current device for a long time, our client mentioned that making the current solution shorter may be a viable fix. Finally, our client mentioned that allowing the user to continue to carry her personal items would be preferred.

Discussion

This interview allowed us to gain insight from an expert perspective on our user's conditions and capabilities. Because a potential device is specific to the user and current comfort is one of the main issues of the device, we must consider the fit that a potential device might have with the user during the design process. Just because the device might work for someone else does not mean it will work specifically for our user. We must also consider materials and design choices that we might make concerning the durability and longevity of the device, especially in variable weather situations. Since Ms. Wood mentioned making the device adjustable with height would be valuable, this implies that Ms. Lafond may experience additional shrinkage. If this is the case, we must consider that a nonadjustable solution may only constitute a temporary fix, meaning that a more permanent one might include some form of adjustability. Furthermore, Ms. Wood mentioned that Ms. Lafond has no way of carrying her possessions due to osteoarthritis without external human assistance. To solve this problem, our design must incorporate the ability to allow Ms. Lafond to carry her items. In all, the device must allow the user to ambulate in a more comfortable manner than the current Cane on Wheels.

Appendix C: Observation Summary

Introduction

Nathaniel Rogers and Edward Lee conducted an in-person observation of Ms. Lafond and her walking aid at the Shirley Ryan AbilityLab in Burr Ridge on Friday, April 5, 2024. Ms. Lafond's husband and her physical therapist, Kathleen Wood were additionally present during the observation to assist in providing details about the user and her walking aid. This observation was performed to gain a better understanding of Ms. Lafond's capabilities and conditions, examine the current walking aid's functionalities, learn about Ms. Lafond's day-to-day routine relative to the walking aid, identify key issues and suggestions for the aid, and collect relevant measurements of the user and walking assist. This summary explains the methodology of the observation, details the relationship between the user and the walking aid, and discusses the observation results.

Methodology

The observation took place in a walking therapy room at Shirley Ryan AbilityLab. Prior to the visit, questions were prepared about topics that ranged from daily routines and activities to issues with the walking assist itself. Firstly, Ms. Lafond was asked about her day-to-day routine with the cane. Then, she was questioned about the beneficial features and glaring issues of the cane. We then asked her to use the cane as she currently does by standing up from a sitting position, walking down the hallway, and turning corners. Lastly, Nathaniel performed measurements on the walking aid and Ms. Lafond using a measuring tape.

User Day-to-Day Routine

Ms. Lafond has had her walking cane for approximately 15 years. As a result, her daily schedule is heavily involved with her cane. Her daily routine involves:

- Using cane to walk to shower
- Sitting on a bench to change, get dressed, and wear knee-shin brace
- Walking to kitchen table with the cane
- Going on walks outside to parks
- Sits on bleachers in school gyms to watch grandchildren's sports games
- Shopping in grocery stores
- Going to pool to perform rehabilitation exercises
 - Uses cane to sit on benches and grassy hills

User Capabilities

In addition to the walking aid, Ms. Lafond receives a lot of help from her husband. Her husband helps her throughout the day in general maneuvering around the house, cooking food in the kitchen, holding doors open, climbing up the stairs, pushing grocery carts, and several other daily minute tasks. He assists Ms. Lafond with activities that could cause strain or stress. Specifically, when Ms. Lafond tries to climb up stairs, her husband has to climb up carrying the cane and Ms. Lafond uses the stair railings to climb up.

Furthermore, she has some movement limitations and specific capabilities:

- Shoulder strain occurs if more force is applied than finger holding allows
- Reaching for items is difficult
- Can only rotate clockwise
- Can't flex right foot or bend right leg

Features of the Cane

The cane Ms. Lafond utilizes has multiple features that assist her walk and daily travel.

- Vertical forearm collar rest
- Gripping handle
- Hooks to hang personal items
- Two front wheels
- Two back stoppers

Cane Use

Ms. Lafond improperly utilizes the cane currently due to her reduced height. Ideally, the cane would be used by placing her forearm into the respective collar and gripping the handle. However due to her height loss, her arm can't properly fit inside the collar. Now, to grip the handle, she has to rest her arm at an uncomfortable angle where her forearm lies on the top of the collar rest, which misuses the component. Alternatively, she grips the top of the forearm collar rest as a handle rather than holding the actual grip handle of the cane.

Current Cane Issues

The walking aid had several primary problems that limited or restricted Ms. Lafond from properly using the cane.

- Cane is too tall for Ms. Lafond's current height
 - Cane is too far in front of user during use
- Too heavy to comfortably lift
- Grip handle is uncomfortable
- Requires wide turns

User and Cane Measurements

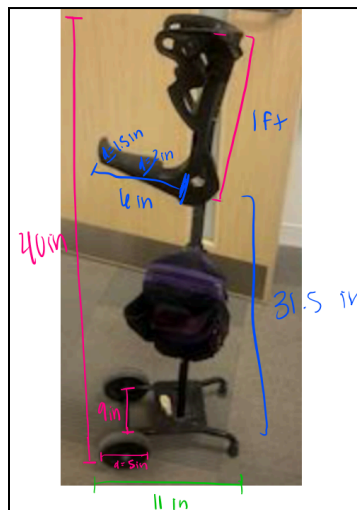


Fig 1. Cane Dimensions

As per Figure 1, the current cane had the following dimensions:

- Cane height: 40 in.
- Height of cane to handle: 31.5 in.
- Length of base frame: 11 in.
- Wheel diameter: 5 in.
- Handle length: 6 in.
- Handle diameter: 2 in.
- Forearm collar: 12 in.

The user additionally had relevant dimensions.

- Floor to user's bottom of thumb joint: 30 in.
- Floor to user's wrist: 31 in.

User Design Priorities

Ms. Lafond and her husband had several suggestions on what general improvements or directions could be considered for improving the current cane design.

- Allow sharper turns
- Moving backwards with cane is not necessary
- Build smaller grip diameter
- Provide foam on the grip
- Make cane components easily replaceable/fixable
- Reduce the height of the forearm rest as necessary
- Allow for more comfortable storability through folding the cane

Discussion

This observation gave us significantly more insight into Ms. Lafond as a person, how she interacts with the cane on a day-to-day basis, and her challenges with using the cane. Although the initial problem involved her height relative to the cane, as a result of the observation, the range of issues with the cane expanded significantly. The cane can now be focused on not only height, but additionally, improved storability, forearm comfortability, weight, grip handles, and smooth rotations. With these added perspectives, multiple features of the cane can be designed on and prototyped to build an overall better cane for Ms. Lafond. Furthermore, there are many more medical conditions that limit Ms. Lafond's physical capabilities including grip strength and foot manipulation. As such, it will be important to keep in mind Ms. Lafond's comfort in finger and foot movements which will allow her to use a cane without extraneous effort or strength. Specifically, the observation allowed heavier insight into user-specific details such as only being able to rotate clockwise when performing turns. With this information, ideas for the walking aid can be developed by adjusting the center of mass or incorporating clockwise rotation-specific features. Overall, because the cane plays such an important role in Ms. Lafond's daily life from getting ready in the morning to enjoying recreational activities, maintaining comfortability and ease of use as a high priority for ideation will be crucial to avoid making the walking aid a hassle to use.

Appendix D: Project Definition

Project Name: ComfyCane

Client: Ms. Kathleen Wood, Ms. Lafond

Team Members: Alex Hou, Edward Lee, Nathaniel Rogers, Luke Wejman

Date: May 26th, 2024

Mission Statement

Design a durable device that improves the user's balance while increasing comfort when walking in indoor and outdoor environments.

Project Deliverables

- Project Report (Website Form)
- Final Prototype
- Design Sketches for the Final Prototype
- Design Summary

Constraints

- All expenses in regards to constructing the prototype must be within the given budget of \$150
- Must have a presentable prototype by May 29, 2024

Users and Stakeholders

- Ms. Lafond
- Ms. Kathleen Wood
- Mr. Lafond
- Shirley Ryan Ability Lab

Requirements

Requirement	Specification
Independence	• The user must be able to comfortably ambulate without excessive external

● Allows for increased independent ambulation ● Allows the user to balance with the device's assistance. ● The device should be easy to operate and accommodate other needs of the user ● The device must be usable by Ms. Lafond as a functional and effective walking aid ● Must accommodate the measurements and abilities of the user.	human assistance, likely from Mr. Lafond. ● The user must verbally express increased comfort with use compared to her previous device. i.e. the problems with the previous device have been fixed, ● The user must be visibly more comfortable when the device is in use, including more even shoulders, confirmed through a height measure. ● The device must receive strong verbal support that can be specifically attributed to our design, from a physiatrist/other medical professionals at SRALab regarding the device's effect on Ms. Lafond's ability to ambulate.
Safety ● Must be able to be used safely on a day-to-day basis ● The device must support the expected weight load ● The device must stay balanced when in use.	● Support at least 50 pounds including body weight and personal items ● The device must be stationary when not in use. ● The device will not tip over when 70 lb-ft is applied to it.
Durability ● Must be able to function in all accessible indoor and outdoor environments ● Be simple to repair should a break occur	● Maintain shape, function, and safety after being submerged in water for an extended duration to prevent damage from rain exposure and other sources of water damage. ● Maintain shape, function, and safety for extended duration in environments -20°F to 100°F. ● Must be able to be intuitively repaired by Ms. Lafond's husband using easily obtainable parts. ● Must not be easily broken when excessive force is applied to it.

Accessibility/Ease of Use • Must be easy to clean • Must not draw excessive attention when used in public • Must fit easily into a car • Must allow Ms. Lafond to carry her personal belongings. • Must offer adjustability • Must be dark purple	• Easily cleanable with a disinfectant wipe • Must be no larger than the free space in the Lafond's vehicle • Be able to hold 2-5 lbs of Ms Lafond's personal belongings. • Must be height-adjustable by 3 inches • Chosen material must be dark purple, or accommodating with dark purple paint.
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Appendix E: Instructions for Use

1. To adjust the shaft height, loosen the knob (Fig 1).



Fig. 1. Loosening Knob

2. Adjust the shaft height by pushing the pin in (Fig 2).



Fig. 2. Pushing in Pin and Adjusting Height

3. Raise or lower the height as appropriate until the pin clicks into a slot (Fig 2).
4. Tighten the knob (Fig 3).



Fig. 3. Tightening Knob

5. Adjust the angle of the armrest by unscrewing the wing nut located at the top of the shaft (Fig 4).

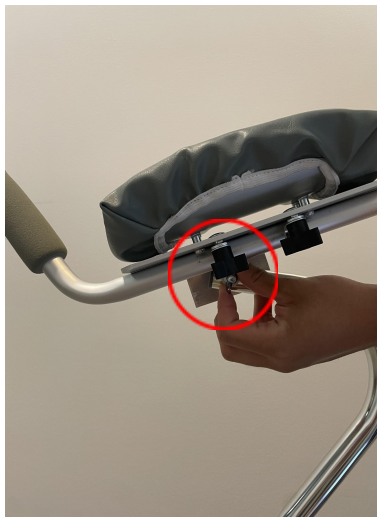


Fig. 4. Unscrewing Wing Nut

6. Rotate the armrest until a comfortable position is reached (Fig 5).



Fig. 5. Rotating Armrest

7. Rescrew the nut tightly to secure the armrest orientation (this may require the use of a Phillips head screwdriver to hold the screw in place while tightening the wing nut) (Fig 6).



Fig. 6. Tightening Nut and Wing Nut

8. Orient device so the handle of the device is parallel to the direction you will be moving and the handle is in front of you (Fig 7).



Fig. 7. Orienting Device

9. Stand to the right of the cane (Fig 8).



Fig. 8. Standing Right of Cane

10. Place left forearm into the armrest (Fig 9)



Fig. 9. Placing Forearm into Armrest

11. Grab the handle comfortably (Fig 10).



Fig. 10. Gripping Handle

12. Roll the device forward while walking alongside the device (Fig 11).



Fig. 11. Walking Forward

Appendix F: Bill of Materials

Item	Quantity	Source	Total Cost
Essential Medical Supply Quad Cane with Large Base	2	Amazon	\$59.80
Drive Medical 10105-1 Platform Walker/Crutch Attachment	1	Amazon	\$54.68
Prime-Line 9005754 Machine Screws, Round Head, Phillips/Slotted Combination Drive, 1/4-20 x 4 In.	1	Amazon	\$9.81
Shopping Cart Wheel 5" x 1-1/4" 3/8" Bore Polyurethane Wheel	1	Amazon	\$26.80
Stainless Steel 1/4"-20 Hex Nut	1	Home Depot	\$1.38
1/4" Stainless Steel Flat Washer	1	Home Depot	\$5.62
1/8" Thick Aluminum Sheet Metal	1	Home Depot	\$6.88
Loop Clamp 7/8" Diameter	1	Avidity Science	\$3.55
1/4"-20 x 1-1/2" Combo Pan Head Stainless Steel Machine Screw	1	Home Depot	\$1.38
#10-24 x 1/2" Combo	1	Home Depot	\$1.38

Round Head Stainless Steel Machine Screw			
#10-24 Stainless Steel Machine Screw Nut	1	Home Depot	\$1.38
¼"-20 Zinc Plated Wing Nut	1	Home Depot	\$1.38

Total Spent by Team: \$114.48

Total Cost: \$174.04

Appendix G: Instructions for Construction

Table 1: Materials

Step(s) Needed	Material	Source	Amount
1	Prime-Line 9005754 Machine Screws, Round Head, Phillips/Slotted Combination Drive, 1/4-20 x 4 In.	Amazon	x4
1	Shopping Cart Wheel 5" x 1-1/4" 3/8" Bore Polyurethane Wheel	Amazon	x2
1, 2	Essential Medical Supply Quad Cane with Large Base	Amazon	x1
1, 6	Stainless Steel 1/4"-20 Hex Nut	Home Depot	x5
1, 6	1/4" Stainless Steel Flat Washer	Home Depot	x10
3	1/8" Thick Aluminum Sheet Metal	Home Depot	3" x 3"
4	Drive Medical 10105-1 Platform Walker/Crutch Attachment	Amazon	x1
5	Loop Clamp 7/8" Diameter	Avidity Science	x1
6	1/4"-20 x 1-1/2" Combo Pan Head Stainless Steel Machine Screw	Home Depot	x2
6	#10-24 x 1/2" Combo Round Head Stainless Steel Machine Screw	Home Depot	x2
6	#10-24 Stainless Steel Machine Screw Nut	Home Depot	x2
6	1/4"-20 Zinc Plated Wing Nut	Home Depot	x1

Table 2: Tools

Step(s) Needed	Tool	Safety Info
1, 2	Level	N/A
1, 2, 3	¼” Drill Bit	N/A
1, 2, 3, 4	Drill Press	WARNING: Improper use of the drill press could result in serious injury. Keep hands and loose clothing away from moving parts. Always wear eye protection and secure the piece you're working on before operating.
1, 2, 3, 4	#4 HSS Center Drill Bit	N/A
1, 2, 3, 4	Ruler	N/A
1, 2, 3, 4	Dry Erase Marker	N/A
1, 2, 3, 4	Bar Clamps	CAUTION: Improper use of the bench vise could result in minor injury. Keep hands and fingers clear of moving parts to avoid pinching.
1, 2, 3, 4, 5	Sandpaper (<i>Optional: Palm Sander, Belt Sander</i>)	CAUTION: Improper use of sandpaper could result in minor injury. Avoid direct contact with the abrasive surface to prevent skin irritation.
1, 2, 3, 4, 5	Bench Vise	CAUTION: Improper use of the bench vise could result in minor injury. Keep hands and fingers clear of moving parts to avoid pinching.
1, 3, 4	Scrap Wood	N/A
1, 6	Phillips Head Screwdriver	N/A
1, 6	Adjustable Wrench	CAUTION: Improper use of the wrench could result in minor

		injury. Keep fingers clear of moving parts to avoid pinching.
2	Razor	WARNING: Improper use of the razor could result in serious injury. Handle with extreme caution to avoid cuts. Always use a sharp blade and maintain control over the razor.
3	½” Drill Bit	N/A
3, 4	13/64” Drill Bit	N/A
3, 5	Band Saw	WARNING: Improper use of the band saw could result in serious injury. Keep hands and fingers away from the blade. Always use push sticks or other safety devices. Wear eye protection and ensure the piece you're working on is securely positioned before operating.
3	Metal Pan and Box Brake	WARNING: Improper use of the metal pan and box brake could result in serious injury. Keep hands and fingers away from the clamping and bending areas.
5	Mallet	CAUTION: Improper use of the mallet could result in minor injury. Ensure a firm grip and avoid striking with excessive force.

Instructions

Estimated Time for Completion: 2 hr 30 min

Step 1: Base

1. Start with the bottom part of the *Essential Medical Supply* cane
2. Remove the rubber feet on the legs circled in Fig. 1
3. Mark a line/circle ¾” from the bottom of each exposed leg as shown in Fig. 2
4. Secure the cane in a bench vice under the drill press as shown in Fig. 3
5. Level the cane as shown in Fig. 3
6. Level the cane by placing the level on top of and parallel to one of the legs
7. Insert the HSS center drill bit into the drill press
8. Align the bit to contact the leg of the cane at the line marked in Step 1.3 with the drill off
9. Align the bit to contact the leg of the cane on the line of action across the diameter of the leg with the drill off
10. Clamp the bench vice to the drill press in at least two spots

11. Turn on the drill press
12. Repeatedly lightly tap the HSS center drill bit until a circle with a $\sim 3/32$ " diameter is marked
13. Turn off the drill press
14. Remove the HSS center drill bit from the drill press
15. Insert the $1/4$ " drill bit into the drill press
16. Turn on the drill press
17. Drill all the way through both walls of the cane leg
18. Turn off the drill press
19. Unclamp the bench vice from the drill press
20. Remove the cane from the bench vice
21. Stack $\sim 2\text{-}1/2$ " of scrap wood on the platform of the drill press (Fig. 4)
22. Place the bench vice on top of the stack of wood (Fig. 4)
23. Insert the cane into the bench vice upside down relative to Step 1.4
24. Repeat Steps 1.5-1.6
25. Remove the $1/4$ " drill bit from the drill press
26. Repeat Steps 1.7-1.9
27. Clamp the bench vice to the stack of wood in at least two spots (Fig. 4)
28. Clamp the stack of wood to the drill press in at least two spots (Fig. 4)
29. Repeat Steps 1.11-1.18
30. Remove the $1/4$ " drill bit from the drill press
31. Unclamp the stack of wood from the drill press
32. Unclamp the bench vice from the stack of wood
33. Remove the cane from the bench vice
34. Sand the outsides of any holes with surface protrusions (CAUTION: Hole edges may be sharp)
35. Place a 4" machine screw through one washer, one wheel, then another washer on a workbench
36. Repeat Step 1.33 for another screw
37. Add another washer to each screw used in Steps 1.34 & 1.35, followed a *loosely fitting* hex nut, followed by another washer (Fig. 5)
38. Push each screw assembly through the holes drilled in Steps 1.17 & 1.29 such that the wheels are facing out (Fig. 6)
39. Add one washer and one *firmly tightened* hex nut on the free ends of each of the screws (Fig. 6)

Step 2: Shaft

1. Start with the upper part of the *Essential Medical Supply* cane

2. Use a razor to cut off the grip on top of the curved portion (Fig. 7)
3. Mark a line 1' from the bottom of the shaft perpendicular to the predrilled holes (Fig. 8)
4. Use a bench vice to clamp the shaft with the line pointing upward (Fig. 9)
5. Level the cane with the level lying both along the handle and the main length of the shaft
6. Insert the HSS center drill bit into the drill press
7. With the drill off, align the bit to contact the leg of the cane at the line marked in Step 2.3 (Fig. 9)
8. Align the bit to contact the leg of the cane on the line of action across the diameter of the leg with the drill off (Fig. 9)
9. Clamp the bench vice to the drill press (Fig. 9)
10. Turn on the drill press
11. Lightly tap the HSS center drill bit repeatedly until a circle with a $\sim 3/32$ " diameter is marked
12. Turn off the drill press
13. Remove the HSS center drill bit from the drill press
14. Insert the $1/4$ " drill bit into the drill press
15. Turn on the drill press
16. Drill all the way through both walls of the cane leg
17. Turn off the drill press
18. Unclamp the bench vice from the drill press
19. Remove the cane from the bench vice
20. Sand the outsides of any holes with surface protrusions (CAUTION: Hole edges may be sharp)
21. Mark a line $3/4$ " in from the very top end of the shaft handle (Fig. 10)
22. Use a bench vice to clamp the shaft with the line pointing upward to drill a hole perpendicular to the predrilled holes
23. Repeat Steps 2.5-2.20

Step 3: Bracket

1. Start with the 3" x 3" sheet of aluminum
2. Draw a line down the middle of the square ($1\frac{1}{2}$ " from any edge)
3. Use the metal pan and box brake to bend the aluminum 90°
4. Draw a line down the middle of either side ($3/4$ " from either edge) (Fig. 11)
5. Mark two spots on this line $1/2$ " in from either short edge (Fig. 11)
6. Mark a third spot $1\frac{1}{2}$ " from either short edge (Fig. 11)
7. Place the metal piece on a piece of scrap wood
8. Remove the $1/4$ " drill bit from the drill press
9. Insert the HSS center drill bit into the drill press

10. Align the metal piece + wood such that the leftmost spot is directly under the bit
11. Clamp the metal piece + wood to the drill press in at least two spots
12. Turn on the drill press
13. Lightly tap the HSS center drill bit repeatedly until a circle with a $\sim 3/32$ " diameter is marked
14. Turn off the drill press
15. Remove the HSS center drill bit from the drill press
16. Insert the $13/64$ " drill bit into the drill press
17. Turn on the drill press
18. Drill all the way through the aluminum sheet
19. Turn off the drill press
20. Remove the $13/64$ " drill bit from the drill press
21. Repeat Steps 3.9-3.19 for the rightmost spot
22. Use a $1/2$ " drill bit (instead of a $13/64$ " drill bit) to repeat Steps 3.9-3.19 for the middle spot
23. Draw a line 1.5" from either short edge on the other face of the bracket (Fig. 12)
24. Draw, on the same face of the bracket, a line 1" from the long edge corresponding to the other face of the bracket (Fig. 12)
25. Mark a spot at the intersection of these two lines
26. Use a $1/4$ " drill bit (instead of a $13/64$ " drill bit) to repeat Steps 3.9-3.19
27. Sand the outsides of any holes with surface protrusions (CAUTION: Hole edges may be sharp)
28. Use a bandsaw to cut the bracket along the lines shown in Fig. 13
29. Sand all edges and corners of the bracket (CAUTION: Bracket edges may be sharp)

Step 4: Armrest

1. Start with the uppermost portion of the *Drive Medical Platform Walker/Crutch Attachment*
2. Remove the velcro arm strap
3. Use a phillips head screwdriver to remove the four screws holding the platform to the aluminum bracket (Fig. 14)
4. Align the bracket on the bandsaw to cut along the line shown in Fig. 15
5. Keep only the flat part of the cut bracket
6. Sand the cut edge of the bracket (CAUTION: Bracket edge may be sharp)
7. Slide the bracket prepared in Step 3 onto the *Drive Medical* bracket as shown in Fig. 16
8. Mark spots on the *Drive Medical* bracket through the bracket prepared in Step 3 (Fig. 17)
9. Separate the two brackets
10. Insert the HSS center drill bit into the drill press

11. Align the *Drive Medical* bracket such that one of the spots is directly under the bit
12. Clamp the metal piece to the drill press in at least two spots
13. Turn on the drill press
14. Repeatedly lightly tap the HSS center drill bit until a circle with a $\sim 3/32$ " diameter is marked
15. Turn off the drill press
16. Remove the HSS center drill bit from the drill press
17. Insert the $13/64$ " drill bit into the drill press
18. Turn on the drill press
19. Drill all the way through the aluminum sheet
20. Turn off the drill press
21. Remove the $13/64$ " drill bit from the drill press
22. Repeat Steps 4.10-4.21 for the other spot

Step 5: Storage Hook

1. Use a bandsaw to cut the loop clamp along the line shown in Fig. 18
2. Sand the cut edge of the loop clamp (CAUTION: Cut edge may be sharp)
3. Use a bench vice to hold the loop clamp in line with the body of the shaft (Fig. 19)
4. Use a mallet to shape the loop clamp to the curvature of the shaft (Fig. 19)

Step 6: Final Assembly

1. Slide the bracket prepared in Step 3 onto the *Drive Medical* bracket as shown in Fig. 16; align the holes
2. Use a phillips head screwdriver and adjustable wrench to place a $1/2$ " #10-24 machine screw through each hole and tighten with a #10-24 hex nut (Fig. 20)
3. Use a phillips head screwdriver to reinsert and tighten the four screws holding the platform to the aluminum bracket (Fig. 14)
4. Add the grip bar part of the Drive Medical Platform Walker/Crutch Attachment to the bracket as comfortable (Fig. 21)
5. Tighten the grip bar
6. Position the bracket made in Step 3 + armrest to the shaft prepared in Step 2 as shown in Fig. 22
7. Place a $1/4$ "-20 $1-1/2$ " machine screw through the aligned holes
8. Add a washer and wing nut to the other side of the screw; tighten (Fig. 22)
9. Hold the upper hole of the loop clamp from Step 5 to the hole drilled in the shaft in Step 2.16
10. Place a $1/4$ "-20 $1-1/2$ " machine screw through the aligned holes

11. Add a washer and hex nut to the other side of the screw; tighten (Fig. 24)
12. Use the built-in pin mechanism to recombine the upper and lower parts of the *Essential Medical Supply* cane (Fig. 25)

Figures

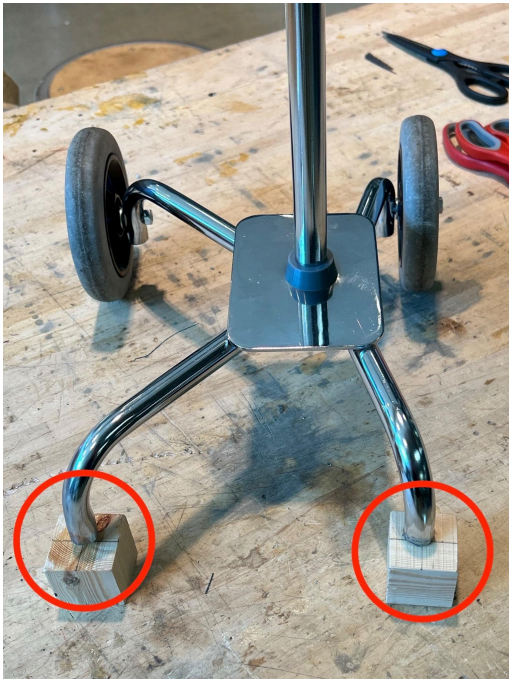


Fig. 1: Legs for which rubber feet are to be removed



Fig. 2: Marking distance for axle holes



Fig. 3: Cane in vice and aligning under drill press



Fig. 4: Setup for drilling second axle hole



Fig. 5: Wheel assembly part i



Fig. 6: Wheel assembly part ii



Fig. 7: Top of cane with grip removed



Fig. 8: Shaft hole map 1



Fig. 9: Drilling first shaft hole



Fig. 10: Shaft hole map 2



Fig. 11: Brace hole map 1



Fig. 12: Brace hole map 2

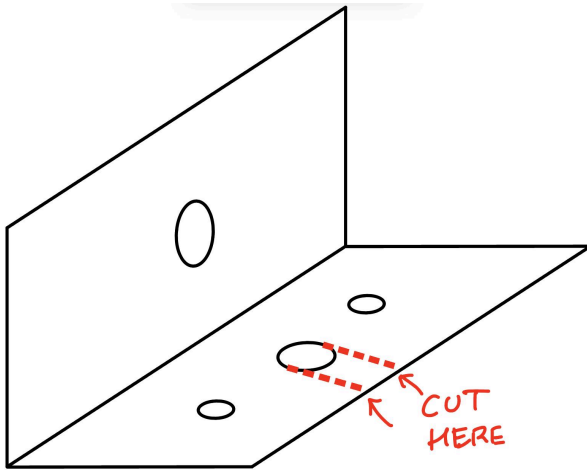


Fig. 13: Bracket 1 bandsaw cut lines

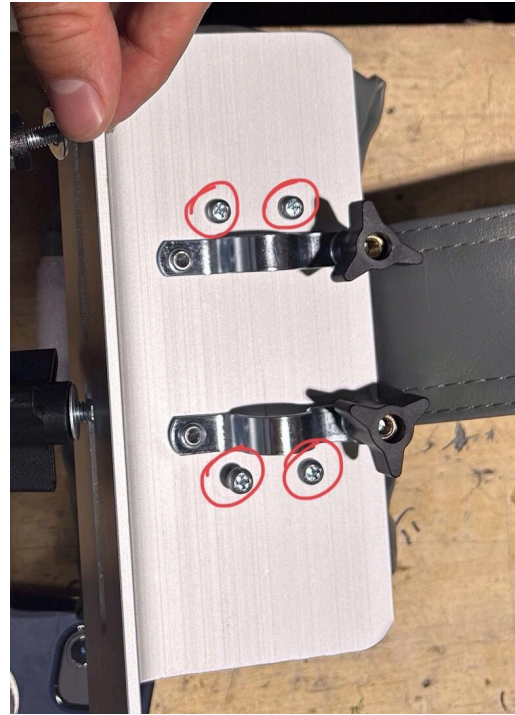


Fig. 14: Screws holding platform to bracket

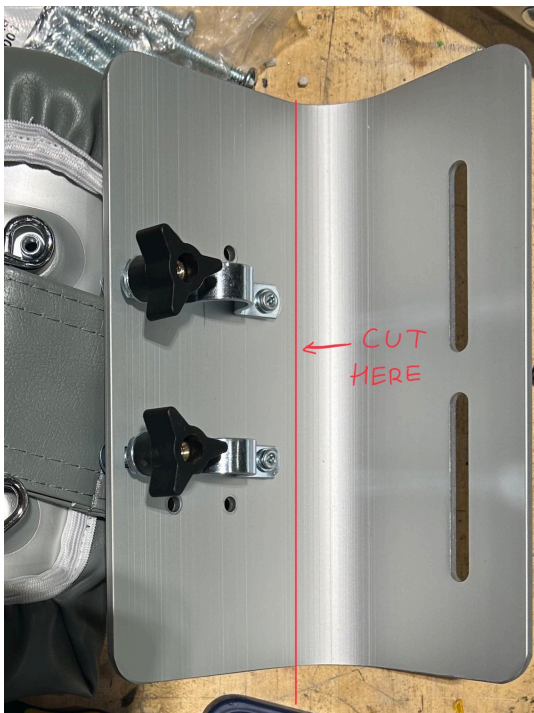


Fig. 15: Bracket 2 bandsaw cut lines



Fig. 16: Bracket junction point

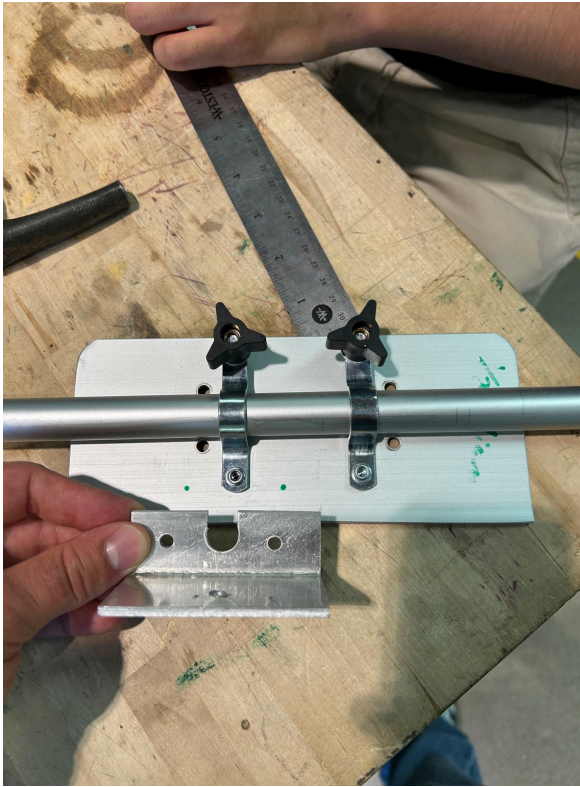


Fig. 17: Armrest hole map

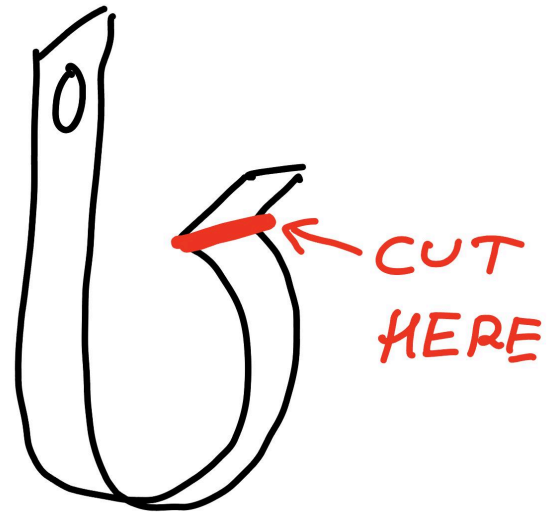


Fig. 18: Loop clamp bandsaw cut line

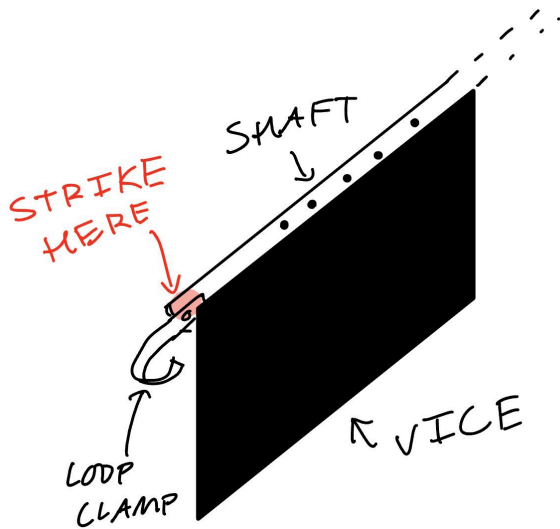


Fig. 19: Shaping the loop clamp



Fig. 20: Connecting brackets



Figure 21: Inserted Grip Bar



Fig. 22: Bracket-shaft assembly



Figure 24: Storage hook attachment



Figure 25: Final Product

Appendix H: User Testing Summary and Feedback

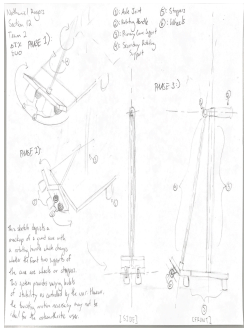
User Testing 1

Introduction

On Thursday, May 6th, Nathaniel traveled to the Burr Ridge, IL, Shirley Ryan Ability Lab Center to receive feedback on the team's Cane on Wheels mockups from our project client Kathleen Wood, and the current user, Ms Lafond.

Methodology

Mockup Testing Chart

Mockups	Spring Brakes	Lightweight Frame	Platform Cane	Rotating Brakes
Photo				
Mockup Description	The goal of the Spring Brakes is to provide a braking mechanism for the cane, where the brakes would activate at the bottom of the cane when the user applies pressure.	The Lightweight frame is aimed to reduce the size of the device by simplifying the size of the bottom frame from a solid metal sheet to connected pipes.	The Platform Cane goal is to provide additional support for Ms Lafond's arm while using the device.	The Rotating Brakes aims to provide an alternative braking method through reversing the direction of the wheels.
Testing	The mockup and explanations of usage were presented and used by Ms. Lafond. It	Mockup was not able to be presented to the user.	The mockup and explanations of usage were presented and used by Ms.	No current mockup at the time of testing. Idea was presented

	was explained to Ms Lafond that the mockup operated by applying weight to the cane in order to activate the brakes.	Photos and conceptual information of the mockup were presented to Ms. Lafond.	Lafond.	to the user and client.
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Table 1

Results

Mockup Results Table

Mockup	Feedback
Spring Brake	● Ms. Lafond stated that she doesn't apply weight on her current model, and would not like to apply weight to the new device. ● Therefore, this mockup will not be applicable for the final design.
Lightweight Frame	● Ms. Lafond gave positive feedback about this mockup ○ New Frame could improve stability ● Noted Requirements that would have to be met: ○ Must not exceed 5.68 lbs ○ Must be able to hold 2-5 lbs of additional belongings ○ Device must be designed such that it is positioned beside her, not in front of her.
Platform Cane	● Ms. Lafond gave positive feedback about the mockup, but provided requirements that would need to be met:

	○ Arm Handle must be able to rotate, range of 180 degrees ○ Cane's height must be able to be manually adjusted, range of 5 inches ○ Grip ridges on handle of cane
Rotating Brakes	● Ms Lafond stated that she would not like to apply weight to the new device. ● Therefore, this mockup will not be applicable for the final design.

Table 2

Discussion

Following our meeting with Kathleen Wood and Ms. Lafond, our team can properly assess our mockups, and give careful consideration whether each mockup will be able to meet the requirements and specifications given to us in the feedback. From this, we can move forward by eliminating any mockups that do not meet our feedback requirements, and focus on the mockups that meet the requirements. Additionally, our team will work to create new or improve our mockups to meet the specifications provided by our clients. Furthermore, as we work towards a final design, our team will work to find materials that can properly execute and combine our mockups.

User Testing 2

Introduction

On Wednesday, May 29th, Luke traveled to the Burr Ridge, IL, Shirley Ryan Ability Lab Center to receive feedback on the team's Cane on Wheels prototype from our project client Kathleen Wood, and the current user, Ms Lafond.

Methodology and Results

During User Testing, the user, Ms Lafond, was provided the current prototype. The shaft's height and angle of the arm platform were adjusted accordingly to fit Ms Lafond properly. From there, Ms Lafond attempted to walk using the device with initial assistance from Ms Wood. After using the device, Ms Lafond and Ms Wood gave the following feedback for the prototype:

- Feels more comfortable compared to older version, and easier to control
- The screwed in hook is too low to properly hang her bag on it
 - Hanging the hook higher on the cane was deemed impractical, as it poses a safety risk for balance and potentially hitting her leg
 - An alternative solution was provided, where Ms Lafond would wrap her purse from the top of the cane, in a manner that it does not poses a danger to her safety
- Ms Lafond felt the front wheels were a little to big for her liking
 - Mr Lafond and Ms Wood however believed this was a matter of adjusting to the new device
- The arm platform was unable to remain in a stable position when pressure was applied by the user
- The height adjustment was very well received by Ms Lafond

Discussion

Following our meeting with Kathleen Wood and Ms. Lafond, our team can properly understand and conclude any final adjustments we make to our final prototype. Now, our team can move forward by assessing the parts of the prototype that either need to be removed or improved, and determine the best course of action as we wrap up our project. In addition, it will be important for our team to keep in mind our budgetary and time constraints, as we decide what remaining problems can be feasibly solved in a week's time, and which we will not be able to adequately fix by the time of our final presentation.

