INtable Design Brief

# Background

Danny Stickney has cerebral palsy, reduced arm range of motion, limited hand dexterity and is considered legally blind due to his cortical vision impairment. Still, Danny leads an active life despite his impairments and gives talks at conferences, takes classes, attend community events, and does his part to help with chores at home. Currently, Danny uses his manual wheelchair to get around and the more independence and capabilities he can acquire, the better!

To move, Danny requires the full use of both arms for propulsion. However, this renders simple tasks like holding everyday items impossible. When Danny uses both arms to travel, we observed items falling off his lap, extreme difficulty reaching items stowed behind him and immobility when holding items in his hands. Additionally, fallen objects were inaccessible without unwieldy pickup tools or the help of strangers. Before this project, Danny held things in his mouth when moving around. Through this project, we aim to come up with solutions to address Danny’s need for more accessible storage through different table ideas and designs so that we can ultimately increase Danny’s independence. This would not only improve Danny’s quality of life, but potentially millions of other people as well!

# Problem Statement

Danny’s wheelchair does not allow him to carry items on him without them falling off or limiting his mobility. After many considerations, our team landed on a table concept that would function both for storage but also for placing in-use items such as laptops for schoolwork and/or plates of food during meals. Our team also identified further user needs that would guide our design:

* Danny’s house has tight hallways and doorways. As such, the design must not take up space outside of the current wheelchair width.
* The design must act as an attachment and not require permanent modifications to the wheelchair such as drilling holes.
* Danny crashes into walls and doorways occasionally. As such, the attachment must be impact resistant and durable to harsh impacts.
* In addition to storing small items, Danny will be using the table for writing and laptop use. As such, the table must be sturdy enough to hold up at least a full size laptop.
* Danny will also use the table to place plates of food and eat from. That said, the surface must be slip resistant and easy to clean.
* Finally, we want to increase Danny’s independence. Thus, the design must be simple and intuitive so that it can be easily and independently deployed by Danny.

# Method

## UX: Design Criterions

Our first action item was to conduct interviews with Danny and his older brother and caretaker, Stanford, to immediately to further understand the problem. In addition to interviews, we observed Danny going through his daily routines so that we could see in-person, the small nuances that may not have been brought up during formal interviews. Through this process of understanding the end user, our team assessed four key points to address in our table design. These points include:

1. *Simplicity*: Danny’s low hand dexterity and cortical impairment meant no buttons, levers, latches, or pulleys could be included in our design.
2. *Practicality*: The aim is to allow for Danny’s usage when he is alone. Therefore, Danny must be able to use our design independently.
3. *Unobtrusiveness*: While we need to ensure the table does not extend past the width of Danny’s current wheelchair, we also realized small items such as hand brakes and wheel wells must not be obstructed.
4. *Detachability*: Danny’s wheelchair is foldable. A design that can be removed and detached or folded along with the wheelchair during transport is required.

## Ideation

After defining the problem and checking for existing solutions, our team started brainstorming and sketching preliminary ideas for our customized solution. This included getting inspiration from folding auditorium tables and meal tables in airplanes.

One design we were particularly interested in was of fold-away tray designs in auditoriums in which users can swing out a tray from underneath their arm rests. The advantage of this design is that the entire design was volume-minimal and its deployment followed a simple range of motions. There were no locks, no buttons, no latches needed either. While these provided inspiration, the classroom seat designs did not address the fact that Danny’s chair did not have an armrest to house the table. This idea could not be easily implemented with Danny’s current wheelchair without modifications to the design first.

With table inspirations at hand, we took to the drawing board and produced our own designs. Described below are some initial concepts after two rounds of design brainstorming sessions:

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|  | *An idea to overcome Danny’s wheelchair’s lack of armrests to install an auditorium style table. The piano hinge allows for the table to fold up and down, while a swivel on the bottom allows the table to swing left and right.* |
|  | *A working table surface that slides into a “frame” when stowed and slides out and folds over when in use!* |
|  | *A flexible table concept. What if we had a table that rolled away and can be rolled out taunt? It could be made of interlocked rigid panels or a flexible fabric altogether.* |
|  | *A sample “complete” design consideration. This design featured many mechanisms to allow for full customizations in regards to height, distance, table orientation, and even swivel.* |

Of course, the drawings above were significantly simplified and isolated to illustrate some of our design concepts and ideation. Within the ideation phase, we imagined our designs being used and sketched storyboards to illustrate each motion and action that the table might go through as it was being used.

# Final Approach and Design

With all considerations, we decided to move forward with a simple design inspired by an auditorium flip table--surprisingly, no compactly mounted table exists for wheelchair users yet! Existing tables/trays we saw were all bulky and cumbersome, with most requiring disassembly and reassembly in between transfers. In creating our flip table, we wanted to use large, sturdy pieces that could be easily maneuvered by Danny while keeping our table as compact as possible. Our final design consists of a fitted, mounted armrest along the side of the wheelchair, to which the table surface is mounted onto via a rotary hinge. The rotary hinge allows the table to swing upwards from the side and once vertical, fold over via piano hinges to create a horizontal writing surface. The motion replicates the fluidity of auditorium swing tables--no latches, no locks, no switches needed!

Keeping the design simple also allowed us to quickly create these tables at a low cost. In addition to practicality, we focused on creating an elegant table that Danny would be proud to display on his wheelchair.

# Outcome

Testing the prototype of the INtable with Danny revealed that the table’s motion worked for Danny, and that the table didn’t add any additional exterior volume to the wheelchair - it easily fit in all of the tight spaces in Danny’s house. Testing with earlier prototypes revealed that Danny had the tendency to rest the table horizontally towards him, along with vertically along the side of the chair. So, in our latest prototype, our team added a lip (keeping in mind both functionality and aesthetics) along the side of the armrest for the table to rest on when Danny was done using it. Much to our delight, our team also observed Danny using the table to hold his phone as he left to greet a friend minutes after our latest testing session!

# Cost

A great feature of our design is cost! The design makes use of only three flat sheets of acrylic, wood, or any alternative material such as carbon fiber if preferred. Additionally, the hinges and rotary bearings are all off-the-shelf items, with hinges being only $2.18 each retail--when purchased in bulk, we could see even larger cost savings! Likewise, the acrylic that we used in our prototype was $10 for a large 48” x 24” sheet. Our table design used approximately one of those sheets. Altogether, our table could be made for under $15 each. If brought into large-scale production, the ability to pursue injection molded plastic or stamped panels will bring our cost down even further! Buying hinges and screws in bulk will also significantly drive the price down! For wheelchair users who face $120+ alternatives, our solution is a win!

# Significance

It was incredibly heartwarming to see Danny’s delight when he could carry his food and clothing on a table that he could use independently. We noticed much less reluctance with Danny accepting items because he now has a place to store all of them without compromising his mobility. It was absolutely inspiring to see the independence that the INtable has given Danny and our team firmly believes that this table could do the same for other wheelchair users.

# Acknowledgements

We would like to thank Danny and Stanford Stickney for their encouragement and enthusiasm as they supported us in this project! We would also like to thank Dave Jaffe for being a wonderful mentor to our group.