Anand Sekar
Swivel Desk Project
Prototype Documentation
7/13/17

Problem Definition:

My father was diagnosed with ALS over a year ago; he is still able to walk, but only for twenty or so meters before tiring. His main physical difficulty is holding his neck up, such as when sitting on the couch. He is still occupied with a job which requires him to use his laptop, and my father prefers sitting on the couch whilst using the laptop. However, since the laptop is placed on his lap, it is difficult for him to keep his neck looking down; moreover he has difficulty placing and removing the laptop to and from his lap. We need to find a solution that enables my father to use the laptop on the couch we have without these difficulties; moreover, the solution must be general enough to be used with other places to sit (not just that one seat on that one couch).

Functional Requirements

- Holds two vertically separate surfaces at adjustable heights
- The top surface must be able to hold the laptop/ monitor at eye-level
- The bottom surface must be able to hold a keyboard and mouse
- Moves out of the way and back easily
- Should not be invasive to attached furniture
- The laptop does not need to be mounted on the surface
- Desk is planarly adjustable

Additional Specs

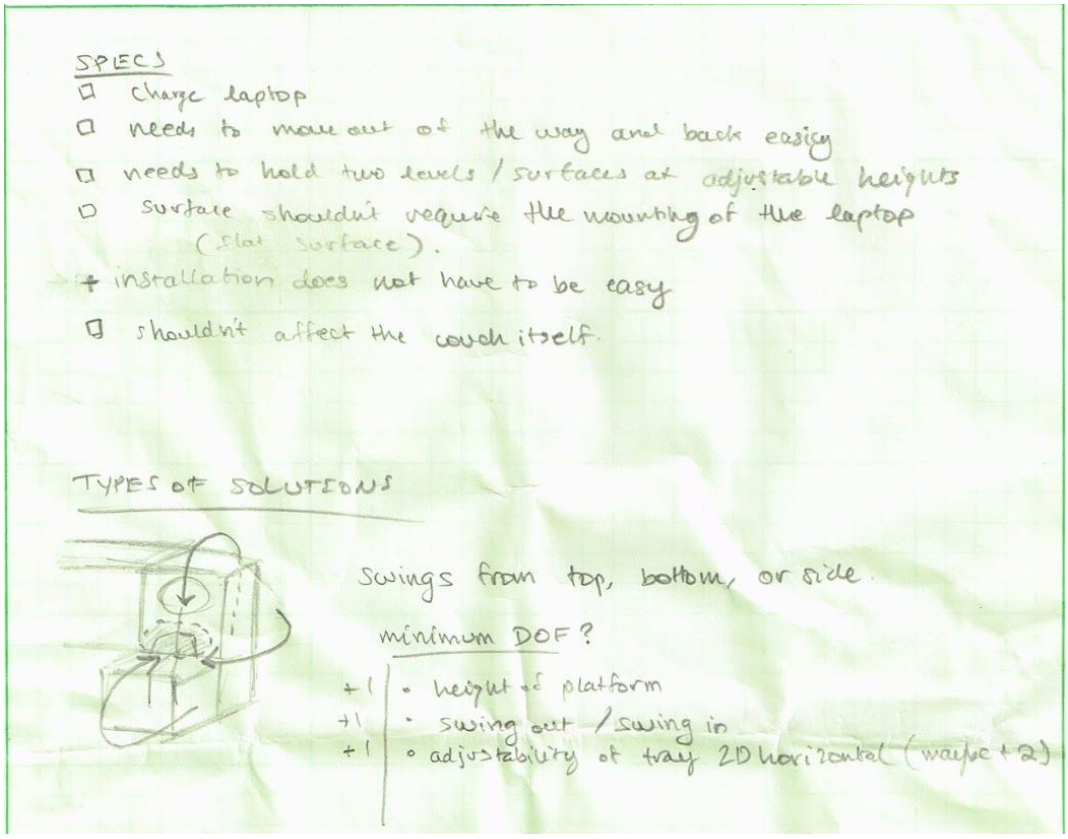
- Charges laptop
- Installation need not be easy

Market and User Research:

(fill this in later)

Conceptual Design Development:

Here are some notes and sketches I took on engineering paper which capture our process.



While visualizing solutions, I noticed a few patterns. Every solution either swung from the top, the bottom, or the side - so I decided that it might be easier to come up with a set of solutions for each type and then compare. Eventually, the solutions that were most viable after an initial sketch always turned out to be the side type. Another thing I noticed is that as I sketched solutions and structures to implement them, I always made a generic solution of modular mechanical parts to make the solution, and more. My solutions, although good, were too complex for a prototype and would take too long to implement for the given timeline. So, I established some minimum degrees of freedom, and thought of solutions to minimally fulfill them.

Anand Sekar | Mechanisms | 7/6/17

- like implementation -

Shaft collar

tightens around pole

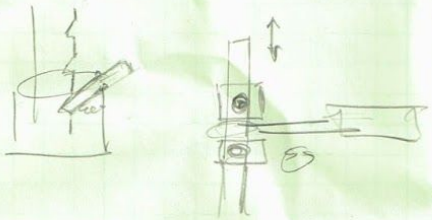
* like bike seats.

Axial clamp (as on tripods)

you could have linear ratchet like the gym seats / pool recliners

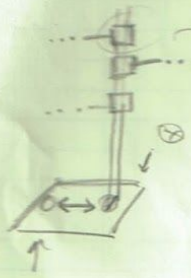
rotational:

- wrench ratchets
- ball clamp (soldering arm)



Above are a few of the mechanisms I'd sketched which "locked." Shaft collars, tightening around a pole, locked linearly along the pole, but also locked rotationally while doing so. I needed something that could move up and down and lock there, but also left and right and lock there. A type of easy-to-handle shaft collar are those found on bike seats. Another idea I had for linearly locking height of the desk was to use a mechanism similar to exercise machine seats and pool recliner - a type of linear ratchet (as sketched on the left). The simplest solution made from such components turned out to be two shaft collars on a smooth pole sandwiching a component around the pole which would be free to rotate. I pursued this idea further leading to the design of the prototype.

Anand Sekar | SIDE | 7/2/17



slides under couch

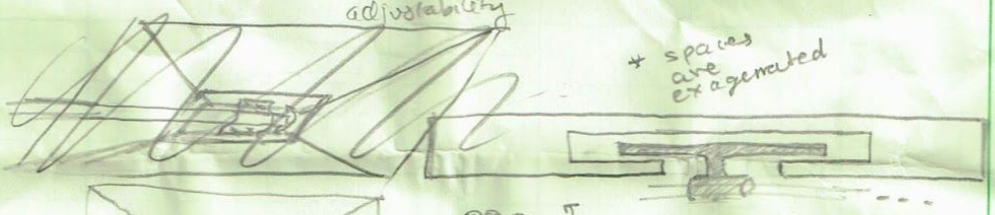
this can attach to other modules such as...

Tray module

Note:
⊖ this design is too complicated for what you need.

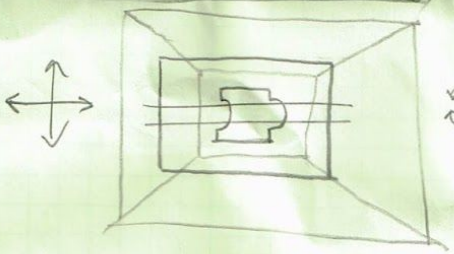
⊕ if flexible / modular.

w/ 2D adjustability



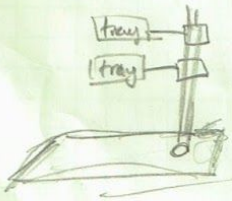
* spaces are exaggerated

cut side view



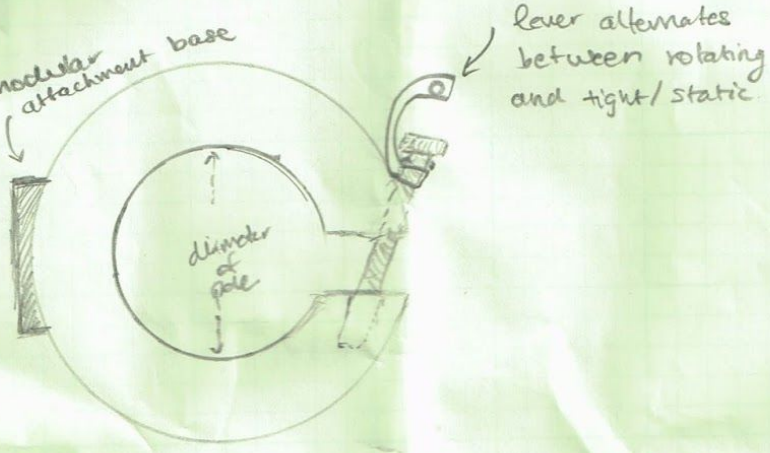
bottom view

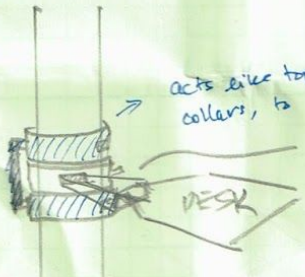
So, the minimum side design would be.



- just have an extension cord for charging the laptop at the bottom

I sketched one part - a shaft collar combined with a modular joint off which a cantilever could be attached. I also sketched out the desk which would be attached to the cantilevering rod; this desk would be able to move forward, back, and left and right (as specified by the degrees of freedom) and locked by tightening screws joining the bottom and top surface (not sketched above).


modular attachment base
lever alternates between rotating and tight/static
diameter of pole


acts like top & bottom collars, to set height.
tightness of middle clamp component
VELCRO

This is the final part I had sketched - the ideal part which I visualized. Three of these parts and a pole and a desk module would ideally compose my solution.

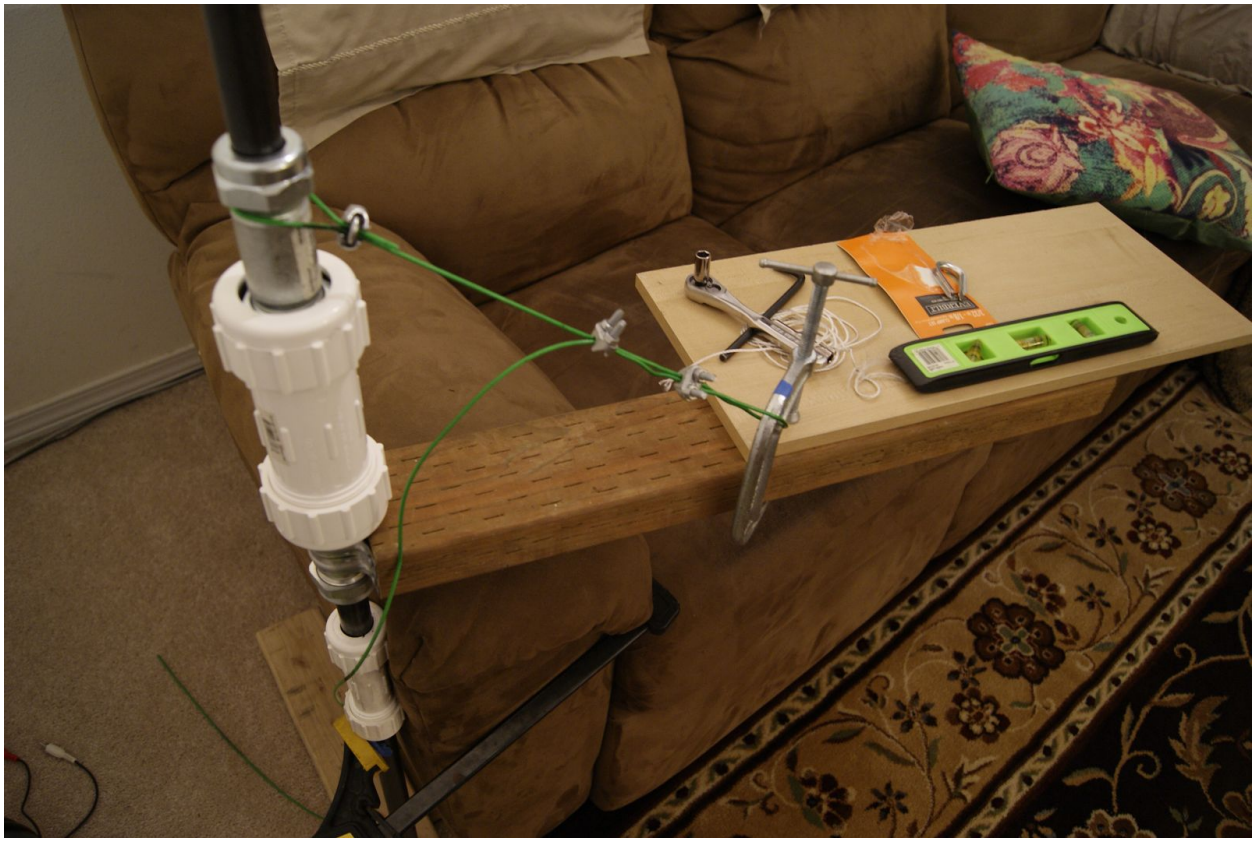
Functional Prototype

As of Thursday the week before, I was given until Sunday 7PM to implement a functional prototype. On Saturday, I went to the local Home Depot and started by looking at poles. The plumbing section had steel pipes, copper pipes, and PVC pipes; steel is the best material out of these because it is the most rigid. Since my solution involves putting a significant amount of torque on a pole by attaching a cantilever, I needed stiff materials. Moreover, I needed a solid base for the pole, otherwise it would tilt or bend. The plumbing pipes had a floor mount for the end; it was precisely what I was looking for. There were several types or parts for these poles - various types of couplings, T's, caps, (names of things I can't remember) etc.. And these parts were not designed to go over the poles, but rather attach the ends of poles together in certain ways. One part I was able to hack was the compression coupling - which was barely able to slide over the pole it was meant for. The compression coupling was able to slide through the pole (with some effort), and twisting the ends of the couplings tightened it around the pole solidly. Both PVC and metal compression couplings fit; the metal ones worked far more smoothly but were significantly more expensive compared to the PVC, so I got the PVC compression coupling to act as the bottom shaft collar, and the metal compression coupling to act as the middle, main load-bearing component. Then, I had to find a way to mount a perpendicular surface to the compression coupling; I was able to find some attachments for electrical conduits which perfectly fit around the coupling, and two of these conveniently fit in a 2" by 4" rectangle. I had 2" x 4" wood at home, plus some scrap wood. Once I had these parts, I got home and screwed it all together with. The base was composed of a single 2x4 piece of wood with two wooden "feet" coming out from the bottom which were thin enough to be tucked under the couch; the pole mount was screwed on top. I attached a 2x4 to the compression coupling, and clamped a small desk at the end. Here's how it turned out at this point:

Then, after testing it out on the couch, I realized it sagged once a bit of weight was placed on it. This was inevitable due to the mechanical leeway allowed by sliding parts and cantilevers combined. I implemented two solutions to solve this. I attached a string and a ratcheting wrench on top, which could be easily winded and de-winded to pull the desk up at the preferred angle.

After some more testing, I realized the pole itself would move and was susceptible to tilting, so I clamped it to the couch arm.

Then, we noticed that the pole need not be this high, and we should shorten its height. This meant that we needed a better solution to hold the desk up; moreover this wouldn't necessarily work with multiple levels. The module should be able to support its own weight. A solid part, either on the top or the bottom would not work, since no matter what, the weight placed on the desk would tilt the desk. So, for the sake of this design and this prototype, I stuck with a variable tension solution, but improved upon the ratcheting wrench in terms of strength and height. I acquired a second metal compression coupling, then got a larger PVC compression coupling to couple the two smaller compression couplings. Then I attached a cable to the end of the top coupling and to the clamp. This is the prototype at its current stage:



The cable-holder screw components (whatever their actual name is) is certainly not as adjustable as the ratcheting wrench, but it gets the job done. The cable holding it is certainly strong and can easily take the tension.

Prototype Analysis

Evaluation according to specifications

- Holds two vertically separate surfaces at adjustable heights
    - The second surface is not implemented, but it would simply mirror the first one and the first level works, and given the weight I have placed on the desk and the torque I have tested on the pole, a second level would work.
    - Improvements: It is NOT easily adjustable. The user would have to twist the outer and inner compression couplings in intricate ways to change the height - and they would have to lift the weight of the cantilever to do so. Moreover, using a compression coupling to join two smaller compression couplings is complex and while twisting one, you twist the others. This is very difficult, and is more so when the pole is twisted (screwed) into the base mount.

- The top surface must be able to hold the laptop/ monitor at eye-level
    - Yes, it is able to hold a laptop at eye-level.
- The bottom surface must be able to hold a keyboard and mouse
    - Yes, it is able to hold a keyboard and a mouse.
- Moves out of the way and back easily
    - Yes, although locking and unlocking its rotation can be very tricky.
- Should not be invasive to attached furniture
    - Yes, the clamps don't affect the furniture itself.
- The laptop does not need to be mounted on the surface
    - Yes, this can hold the laptop without mounting.
- Desk is planarly adjustable
    - Somewhat, the adjustable clamp clamping the desk to the bar allows one to do this, but it is difficult and requires basically removing the desk while doing so.

Improvements Needed

- Eliminate the difficulty caused by multiple compression couplings. The ideal part would be a simple lever, such as the bike seat clamp, to lock and unlock the component in place.
- Add adjustability to the tension cable. The way the cable is currently attached is static and is not adjustable when more weight is added to the cantilever.
- OR - redesign the mechanism so that it is not a cantilever, so that the structure does not bend so easily with added weight.
- OR - keep the cantilever and strengthen/ tighten components as much as possible and add adjustability as mentioned a couple bullet points above.
- Keep the base stiff - don't leave it simply screwed in.
- Make it such that the final desk doesn't need to be removed and re-clamped for adjustability.

Additional Specifications added by Appa:

- Have a cup holder, similar to the one on a camping chair, which can hold his water bottle or any standard cup
- Have a border/ ridge on the edges of the board holding the laptop to prevent it from sliding off.