Sit to Stand Assistive Device

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Engineering Need

Getting in and out of a seated position can put too much of a burden on joints, causing pain and discomfort for those who have weaker joints and muscles, such as elderly people or those recovering from injuries.

Engineering Goal

A STS (sit-to-stand) assist device will be manufactured to reduce the burden on the limbs of individuals struggling to do so.

Design Study

- A list of requirements were created based on research (see Figure 4).
- Main design: a base and seating platform connected by a hinge, with a structure in between able to push the user up and created a substantial angle of incline.
- Each design was tested with the prototype being the independent variables being the prototype and the dependent variables being the user's effort, pain and comfortability.
- Three iterations of the main design were created: a **spring** seat lift, **pneumatic** seat lift, and a **hydraulic** seat lift.

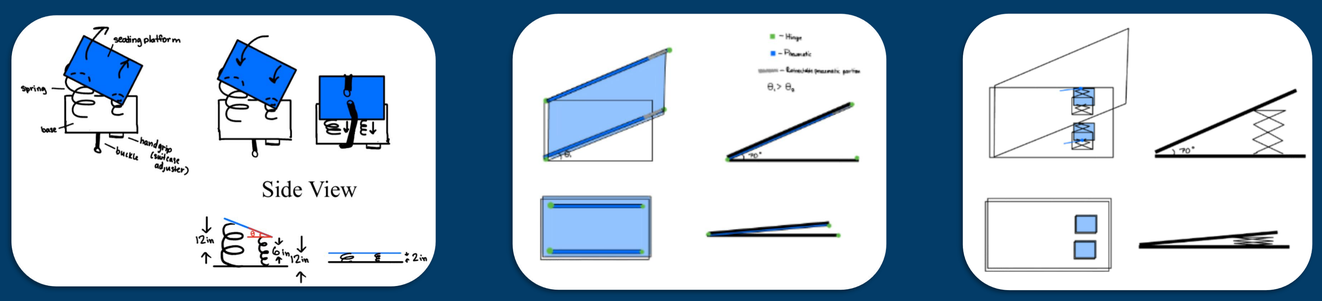


Figure 2: Spring, pneumatic, and hydraulic prototype sketches. Sketches were made in Notability.

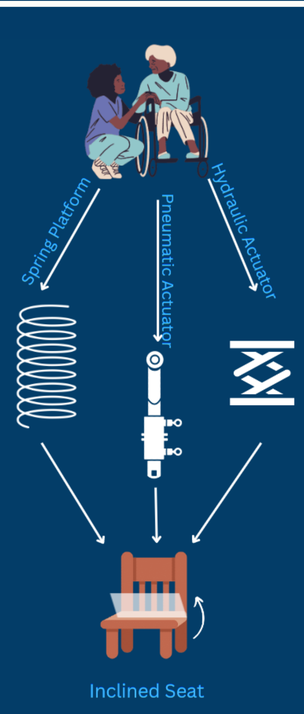


Figure 1: Graphical abstract of STS device.

Background

Difficulty in rising from a seated position may directly increase the risk of injury as STS transfers were found to be responsible for 41% of all falls in nursing homes (van Lummel et al., 2018).

STS related falls in nursing homes

- The sitting position places the hip joints in flexion, moving the knees closer to the chest.
- The standing position requires hip extension, where the knees move further from the chest (Hard to Stand up from a Chair?, n.d.).
- If the body is constantly practicing hip flexion, by sitting, hip extension becomes more difficult.

Pneumatic Actuators

Pneumatic actuators convert the energy of compressed air or gas into a mechanical motion (What Are Pneumatic Actuators, n.d.).

Hydraulic Actuators

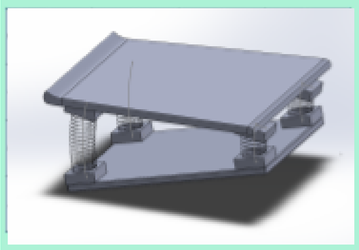
Hydraulic actuators consist of a cylinder or fluid motor, facilitating mechanical motion (*Actuation & Controls*, n.d.).

Methods of Construction

DESIGN DRAWINGS

Initial drawings were created in Noteability together in order to arrive at a group consensus of how our product would function.

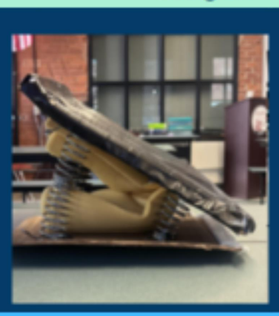
CAD MODELS



CAD models were created for 3D printed parts, and were used as increasingly in depth design models. The CAD modeling software SolidWorks was utilized to create our designs.

PROTOTYPE CREATION

Our proof-of-concepts for the different designs were created using materials found in school. These simply allowed us to visualize our final product without wasting the actual material to be used.



FINAL DESIGN CREATION

Our final product required different wood, metal, and CAD parts. These were altered in a machine shop, using machinery such as belt sanders, mills, and bandsaws.

Figure 3: Construction methods for project.

STS Assistive Device Decision Matrix

Requirement	Prototype 1 - Spring Platform	Prototype 2 - Pneumatic Actuator
The device shall significantly decrease the effort it takes the client to sit.	Pass	Fail
The device shall significantly decrease the effort it takes the client to stand.	Fail	Fail
The device shall be able to lift the average human body weight at least 6 inches.	Pass	Pass
The client shall have access to a control panel/remote that controls the device features.	Fail	Fail
The device shall significantly decrease pain felt by the client when standing.	N/A	N/A
The device shall significantly decrease pain felt by the client when sitting.	N/A	N/A
The seat shall be comfortable to sit in for long periods of time.	Pass	Pass
The device shall be able to provide heated/cooled seats for the user to achieve even more comfort.	Fail	Fail
The device shall be available in a variety of different colors/designs so the user can match their aesthetic.	Pass	Pass
The seat shall be large enough for comfortable seating.	Pass	Pass
The device shall weigh less than 20 lbs.	Pass	Pass
The device shall have integrated arm rests	Pass	Pass
The seat is transportable.	Pass	Pass
The device shall be cost effective: costing at most $200 in materials and construction.	Pass	Pass
The device shall be easy to use and master.	Pass	Pass
The device shall include a user manual for the client to reference if they need help operating the machine.	Pass	Fail

Figure 4: Decision matrix for designs, including each requirement and its weight on the left.

Conclusions

- A less harsh angle of incline was preferable over a larger one (less than 30° incline).
- Larger diameter pneumatics needed to be used in order to provide enough pressure on the client during STS.
- An electronically powered system would exceed the weight requirements and not be transportable → unnecessary prototype for client.
- Too much cushioning (greater than two-inch thickness) made the product an inappropriate size for the client.

Figure 5: Client W during test trial.

Acknowledgments

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