

Standing Paraplegic O.R. Device

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Abstract

Our client, Dr. Garrett Cuppels is a trained orthopedic surgeon who suffers from T12 paraplegia due to an injury. The loss of function and motor control of his legs has left him unable to perform standing surgeries in the operating room (OR). The Standing Paraplegic OR Device team has developed a design which will allow Dr. Cuppels to move around the OR in a standing position. The design consists of an electronically controlled platform with specially designed wheels that allow movement in all directions and a pair customized leg braces to support Dr. Cuppels. The group's goal is to construct, test, and make the design available for Dr. Cuppels's use within the next five months.

Problem Statement

Our client recently lost the ability to use his legs (T-12 paraplegia). However, before losing the use of his legs, he was a practicing orthopedic surgeon. He would like to return to surgery, but needs a device that would allow him to stand in the operating room. The device must be:

- Stable
- Serviceable
- Compact
- Cleanable
- Portable
- Safe
- Comfortable
- Affordable
- Compliant with hospital standards



(Picture from: <http://mylocalhealthguide.com/2008/09/02/seattle-swedish-orthopedic-surgery-center/>)

Client Requirements

Our client is solely concerned with his ability to perform all the tasks required of an orthopedic surgeon. Dr. Cuppels will require:

- An apparatus that holds him in the standing position comfortably and securely for up to three hours.
- A mechanism that allows him rotate both clockwise and counterclockwise.
- An easy-to-use, unhindered movement system that translates in all directions.
- A device that leaves a small footprint on the O.R. floor.



Final Design

Mecanum-Wheel Robotic Platform

- Design consists of a steel platform mounted on four Mecanum wheels driven by a 4-axis motion controller with motors.
- The platform is controlled by movement of a joystick
- Mecanum wheels allow for precision movement in any direction at any time including left and right translation.
- Platform designed with intent to mount custom bracing system for surgeon's legs
- Four-wheel design is very stable while stationary and during movement.
- Most closely reproduces movements of fully able surgeon in O.R.



Cost Analysis

Item Required	Estimated Cost
Custom Leg Braces	\$3,000.00
Galil DMC-41x3 4-Axis Motion Controller with Drive	\$2,200.00
Motors	\$1,000.00
Steel	\$800.00
4 Mecanum Wheels	\$700.00
Rechargeable Battery	\$400.00
Joystick Control	\$100.00
Total Cost	\$8,200.00



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Prospective Designs

Segway LeanSeat

- Design consists of Gen 1 Segway, LeanSeat, steel box frame and 4 linear actuators
- Forward movement performed by leaning body, and turning controlled by left hand grip, similar to a motorcycle
- Linear actuators mounted at four corners of the extended steel box frame
- Fast electric linear actuators extend for added stability when the Segway is placed in the desired stationary position

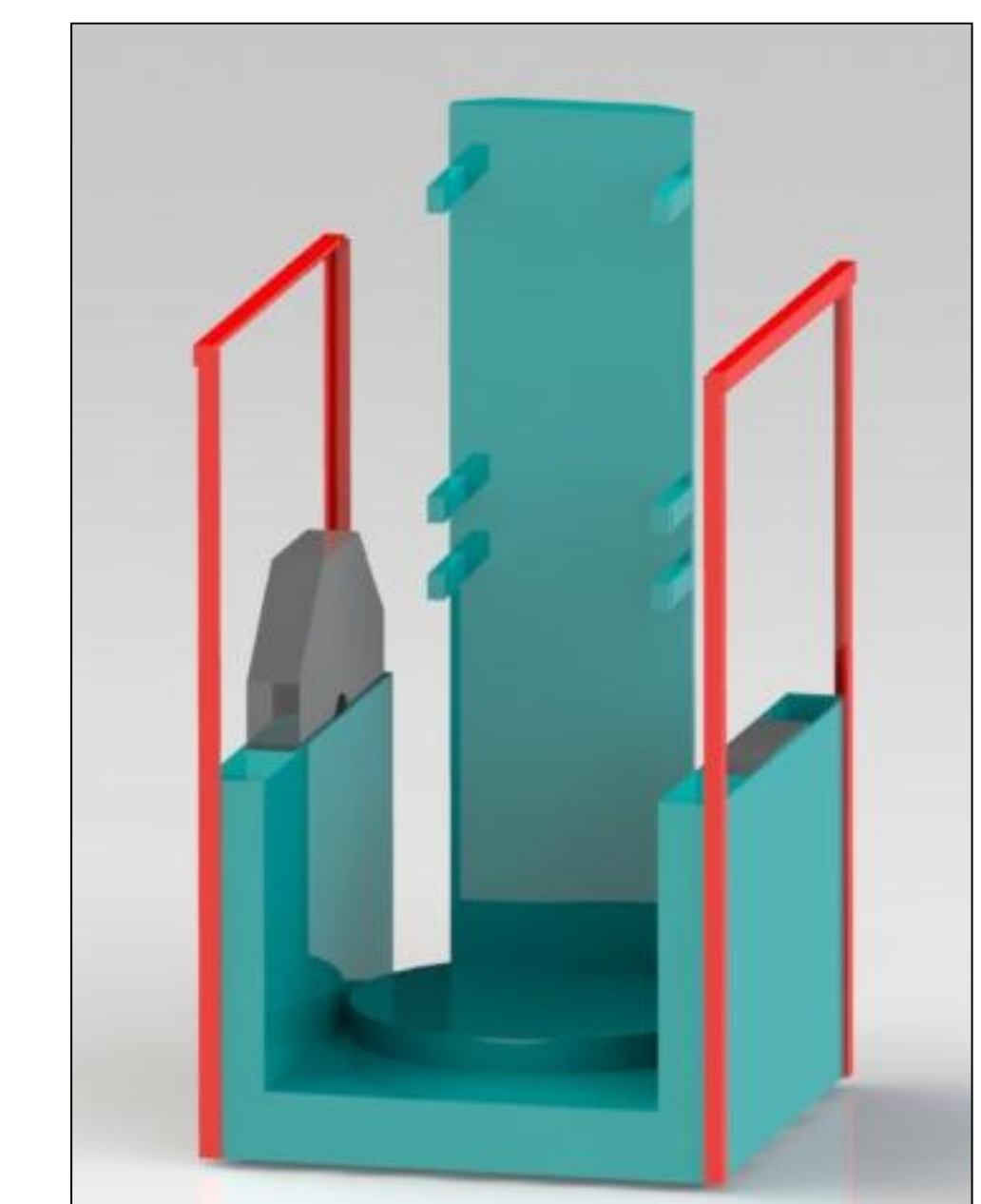


Drawbacks

- Transitioning between stable and mobile phases increases time in O.R.
- No ability to translate left or right while facing the operating table
- Completely novel stability mechanism which cannot be proven to work without testing.

Removable Weight Design

- Purely mechanical
- Free weights added to system for balance
- Small footprint
- Straps used to secure Garrett's knees and waist to device
- Central stand rotates via gear and track system



Drawbacks

- Unable to move dynamically during surgery without the assistance of others.
- Static design would add drastically to time spent in O.R.

Future Work

Present Mecanum-Wheel Robotic Platform to Berlin Memorial administrative and surgical staff

- Determine if our client would be hireable with this device
- If not, determine what intermediate steps could be taken to begin Dr. Cuppels' path to employment.
- Determine the amount of funding available from the hospital

OR Device approved

Intermediate device needed

- Buy wheels, motors, and controls
- Program design
- Test batteries
- Work on leg bracing system
- Test device
- Develop new designs
- Build device
- Test device