

Abstract

Our client, Dr. Garrett Cuppels is an orthopedic surgeon who suffers from T12 paraplegia. The loss of function and motor control of his legs has left him unable to perform standing surgeries in the operating room (O.R.). The Standing Paraplegic Omni-directional Transport (SPOT) team has designed a functional prototype to allow Dr. Cuppels to move around the operating room in a standing position. The design consists of an electronically controlled platform with Mecanum wheels that allow movement in all directions and an EasyStand to support Dr. Cuppels. The group's goal is to construct, test, and make the design available for Dr. Cuppels.

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:



(Picture from: <http://mylocalhealthguide.com/2010/09/02/seattle-swedish-orthopedic-surgery-center/>)

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

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 occupies less space in the operating room.

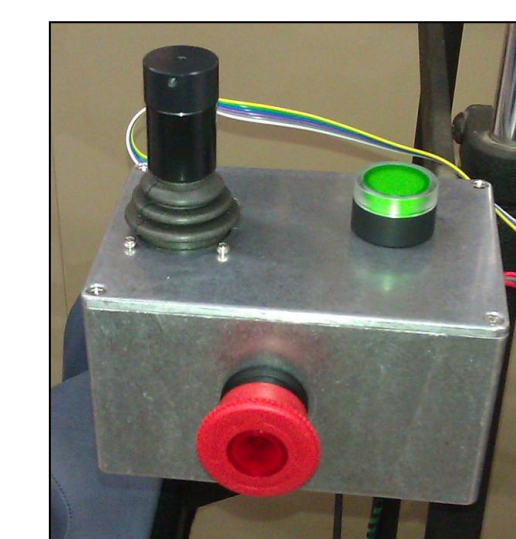
Final Design

Standing Paraplegic Omni-directional Transport Device



Mecanum Wheels:
45° rotors allow for omni-directional movement

EasyStand 5000:
Stabilizes client in a standing position



User Interface:
Gives the user complete control over movement

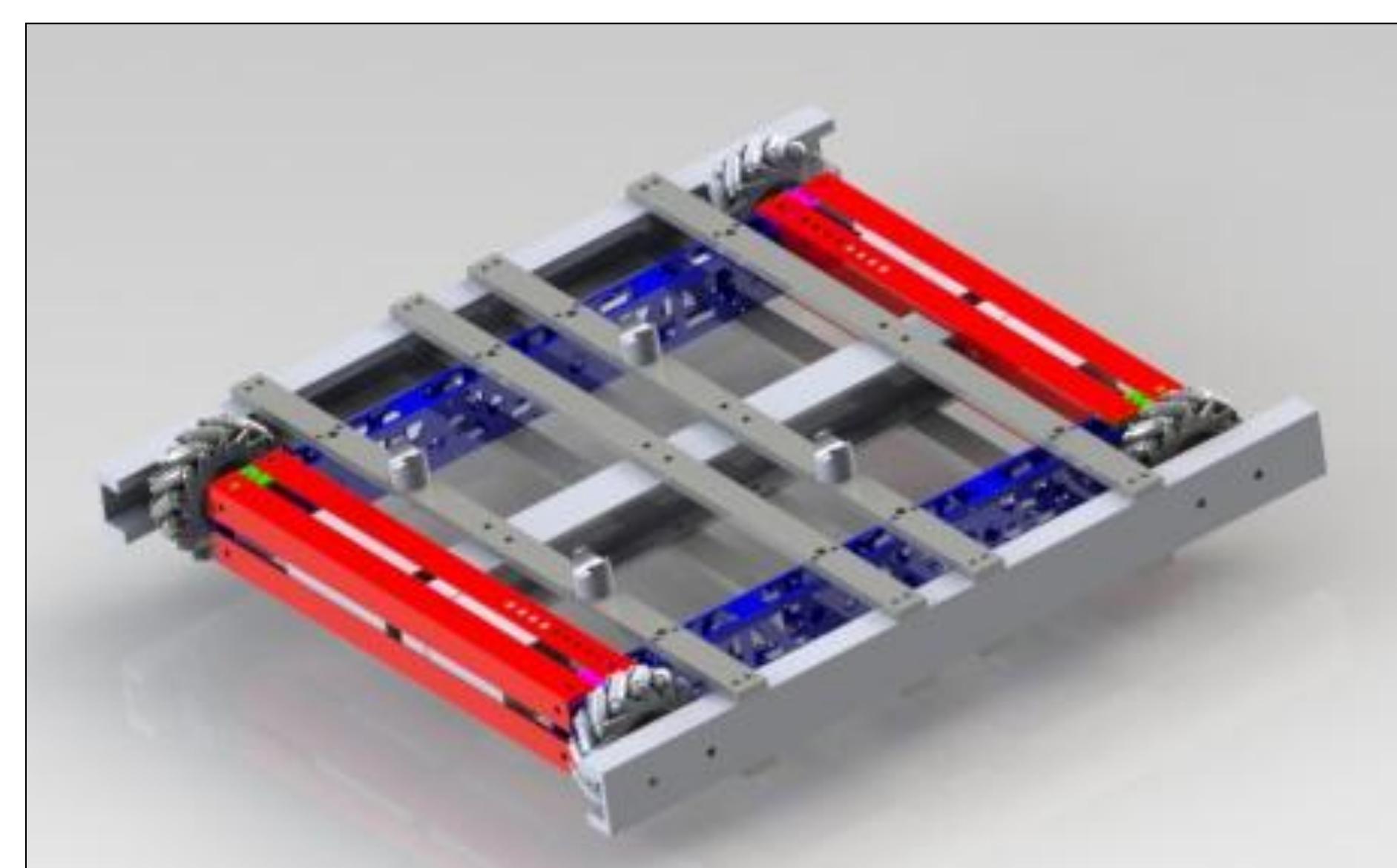
Main Features

- Four independently controlled motors
- Movement controlled by joystick
- Mecanum wheels allow for precision movement in any direction
- The EasyStand provides upright stabilization for the client.
- Allows client to perform necessary movements

Cost

Donated Parts	\$7,000.00
Purchased Parts	\$3,500.00
Total Cost	\$10,500.00

Mechanical

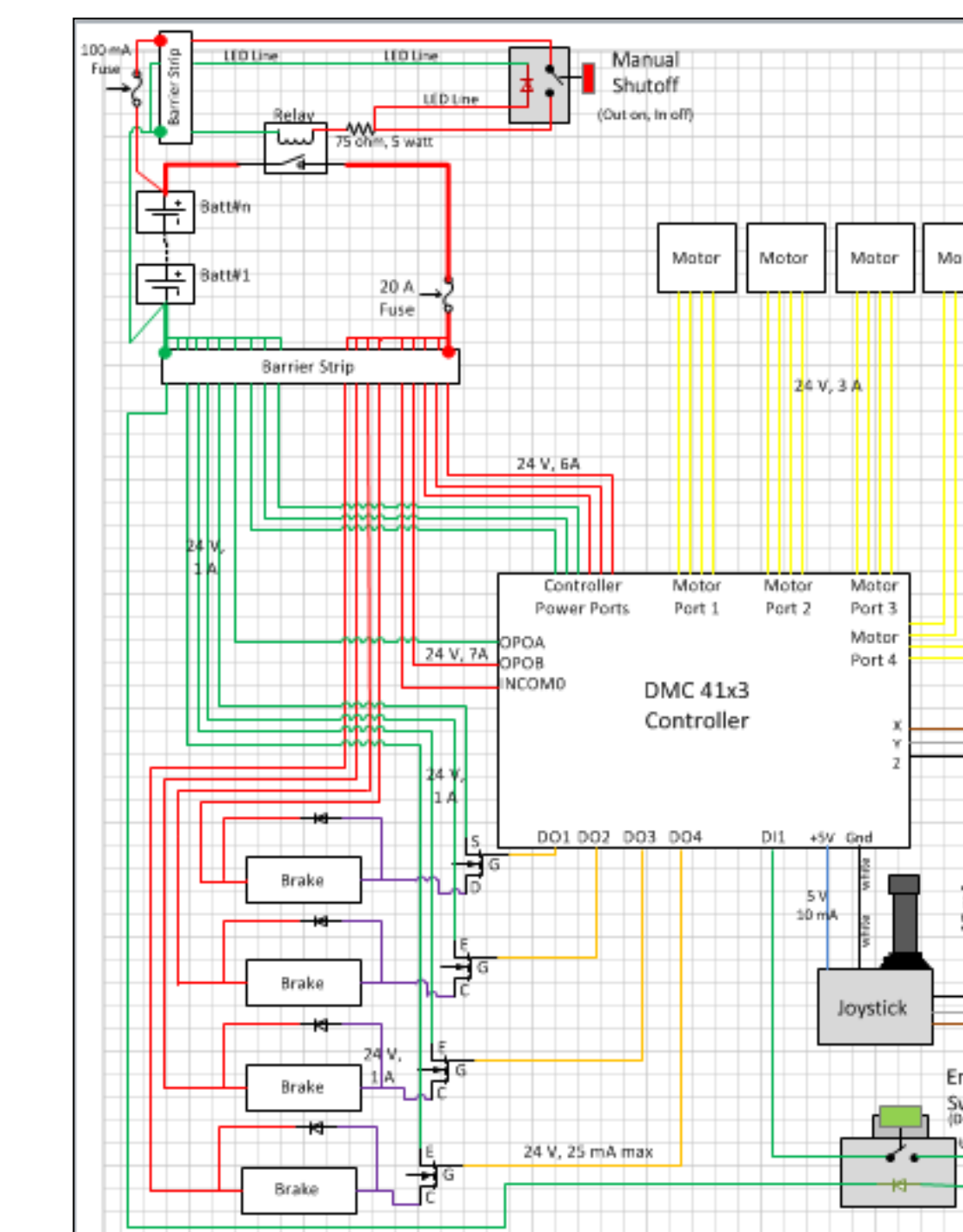


The base serves as the support system for the entire device and also houses the circuitry, motors, and brakes. It features:

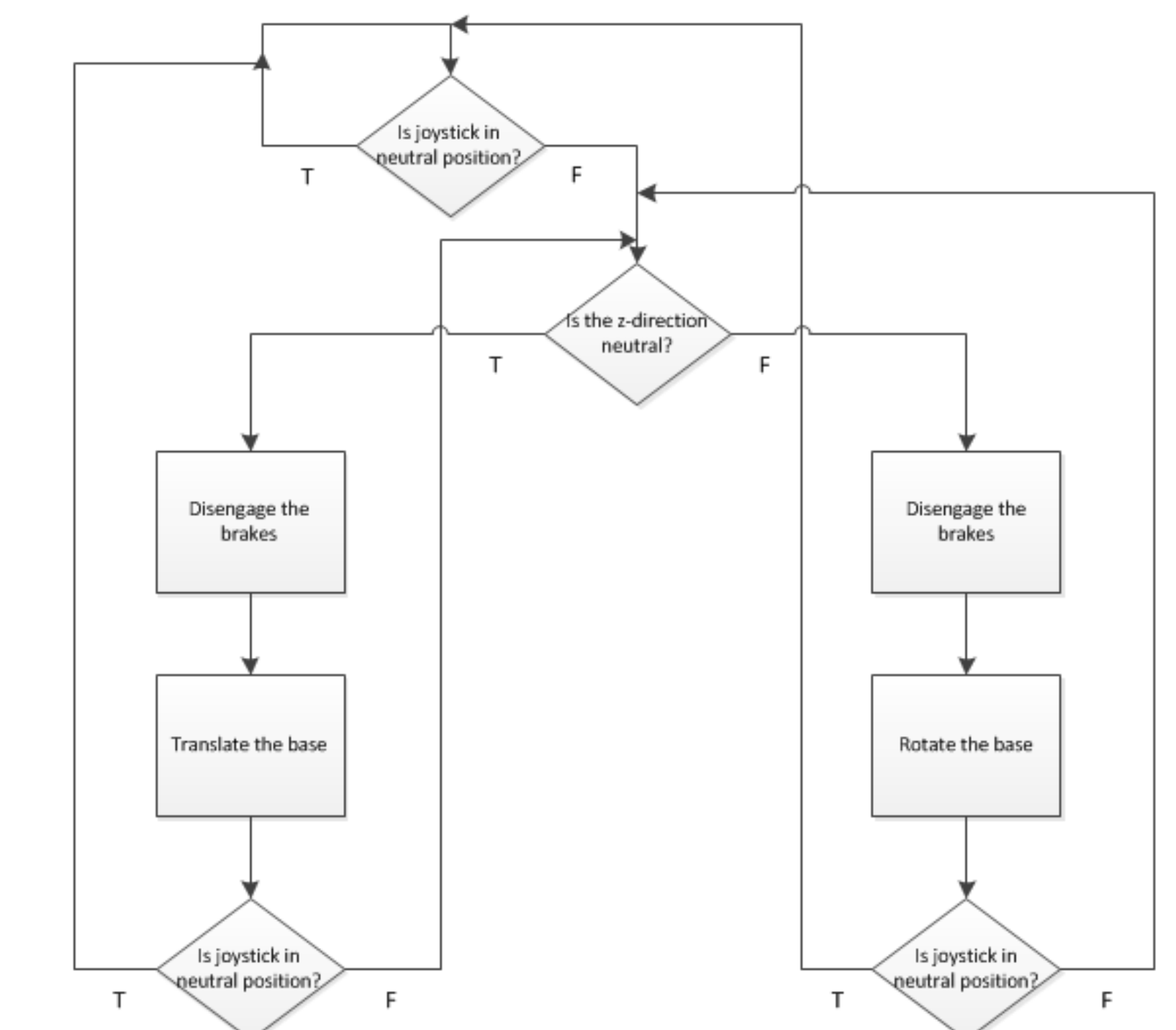
- Eight steel reinforcement rods
- Two aluminum C-channels
- A central aluminum I-beam
- Four mecanum wheels
- EasyStand mounting system

Electrical & Programming

Circuit Diagram



Program Flowchart



The circuitry and programming are integrated to give the user precise and safe control of SPOT. Features include:

- Three-axis joystick
- Four-axis motion controller programmed in digital motion control code
- Electrically released spring brakes
- Stepper motors
- Red emergency stop button, a "hard" on/off switch
- Green enable button, a "soft" on/off switch
- Waterproof cables
- Various securely mounted circuit and wiring components

Testing & Future Work

Testing of the torque necessary to move the base, proved that our previous estimates were incorrect. The device needs to be improved from a working prototype to a reliable machine for Dr. Cuppels to accomplish surgical tasks. Enhancements are needed in the following areas:

- Battery charging
- Adequate covering of the base
- Greater torque production by implementing:
 - New motors
 - New controller
 - Gear boxes
 - External amplifiers

