Walk & Roll Bot
Capstone Design Project 2013-14
Introduction

- Project: Motorized Omnidirectional Standing Wheel Chair
- Sponsor: Walk & Roll Foundation, Dale Rogers
- Team:

<table>
<thead>
<tr>
<th>Sean Dobbins</th>
<th>James Egelston</th>
<th>Wyatt Harris</th>
<th>Alex Kensil</th>
<th>Cory Rantanen</th>
</tr>
</thead>
<tbody>
<tr>
<td>MECA</td>
<td>MECH</td>
<td>MECA</td>
<td>MECH</td>
<td>MECH</td>
</tr>
</tbody>
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- Faculty Advisor: Daisuke Aoyagi
Project Background

Walk & Roll Foundation
- Founded by Jon and Chelsie Hill in 2011
- Walk & Roll Bot
  - Brainchild of Dale Rogers

Customer Needs & Project Goals
- Omnidirectional
- Standing
- Affordable
- Expandable in future
- Eventually for consumers
- Useful for Team HotWheelz
- “Wow” Factor
## Sponsor Requirements

### Must Do:
- Omnidirectional mobility in both seated and standing positions
- Comfortably raise and support riders in standing position
- Navigate through a doorway and be able to spin inside of an average domestic hallway
- Ascend handicap ramps
- Lightweight to accommodate transport in the back of vehicle
- "Tip-over" monitoring
- Failsafe "Standing Mode" (Mechanical Bypass)
- Affordable
- Aesthetically pleasing

### Should Do:
- Allow wireless control for remote operation
- Proportional speed control
- Arm Rests that fold out of way
- Floor sensing rangefinder
- On Board Battery Charger
- Adjustable standing time
- “Learning” and playback for wheelchair movements***

### Would be Nice:
- iPhone App
- Suspension
- Self Docking Charging Station
## Engineering Specifications

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Metric</th>
<th>Method</th>
<th>Target</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Must Do</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max Height</td>
<td>Inches</td>
<td>Tape measure</td>
<td>&lt; 80&quot;</td>
<td>Standing position</td>
</tr>
<tr>
<td>Max Width</td>
<td>Inches</td>
<td>Tape measure</td>
<td>&lt; 25&quot;</td>
<td>-</td>
</tr>
<tr>
<td>Rider Height</td>
<td>Inches</td>
<td>Tape measure</td>
<td>5'2&quot; - 5'10&quot;</td>
<td>-</td>
</tr>
<tr>
<td>Rider Capacity (Max)</td>
<td>Lbs</td>
<td>Scale</td>
<td>&lt; 200 lbs</td>
<td>-</td>
</tr>
<tr>
<td>Total Weight</td>
<td>Lbs</td>
<td>Scale</td>
<td>&lt; 150 lbs</td>
<td>Fully assembled</td>
</tr>
<tr>
<td>Modular weight</td>
<td>Lbs</td>
<td>Scale</td>
<td>&lt; 50 lbs</td>
<td>Individual Components</td>
</tr>
<tr>
<td>Ascend incline</td>
<td>Degrees</td>
<td>Inclinometer</td>
<td>&gt; 1:12 (5° incline)</td>
<td>With rider in seated position</td>
</tr>
<tr>
<td>Run time</td>
<td>Hours/Min</td>
<td>Stopwatch</td>
<td>&gt; 6 hours</td>
<td>With rider/max draw</td>
</tr>
<tr>
<td>Omnidirectional Travel</td>
<td>Degrees</td>
<td>Floor test</td>
<td>16 unique vectors</td>
<td>Flat floor</td>
</tr>
<tr>
<td>Zero-point Turn</td>
<td>Inches</td>
<td>Tape measure</td>
<td>+/- 1”</td>
<td>Smooth/flat floor</td>
</tr>
<tr>
<td>Final Costs</td>
<td>US Dollars</td>
<td>Total cost of Unit</td>
<td>&lt; $3000</td>
<td>Manufacturing/Assembly</td>
</tr>
</tbody>
</table>

| **Should Do**                |              |                 |                   |                                |
| Step climb/Clearance         | Inches       | Tape Measure    | 0.75"             | With Rider                     |
| Time to Stand                | Seconds      | Stopwatch       | 30 s +/- 5 s      | “                              |
| Max. Seated speed            | Mph          | Tape measure/Stopwatch | 5-6 mph       | “                              |
| Max. Standing speed          | Mph          | Tape measure/Stopwatch | 2-3 mph       | “                              |
Design Changes

- **Mechanical:**
  - Base
    - Structural webbing between plates
    - Lower profile modular base link
    - Larger omni-wheels
    - Double rear omni-wheel
    - Belt driven

- **Electrical:**
  - Microcontroller
    - From parallax to arduino
  - Batteries
    - 55 Ah to 15 Ah
Design Solution

- Omnidirectional Movement
- Standing Mechanism
  - Linear Actuator
  - COG shift foot plate accomplished by cantilever
- Lightweight spec drove material decisions (aluminum/carbon)
- Modularity achieved by 3 removable portions
  - Base
  - Chair
  - Battery
Fabrication

- **Purchased:**
  - Pacific Water Jet
    - Lift-arm components
  - Transfer Flow (FREE!)
    - Omni-base plate
- **In-House:**
  - Modular Base Link
  - Bushings
  - Spacers
  - Hubs
  - Tie Rods
  - Tapping
  - Bead-Blasting
  - Welding
Testing

- Steel omni-base proof-of-concept
  - Validation of omni-wheel geometry
  - Validation of rider ergonomics
- Code test platform
- Final performance testing pending
Final Budget

- Material
  - ~$250
- Purchased Parts:
  - $2,300
- Tooling
  - ~$300
- Labor:
  - 800 hours total
    - Estimated @ $41.31/hr = $33,048

Total w/ Labor: $35,898  Total w/o Labor: $2,850
Reflection

- Problems:
  - Omni-wheel Sourcing
  - Aluminum Warping
  - Fasteners
  - Fabricators
  - Vendors
  - Machine Time
  - Composites
  - Motor Drivers
  - Wireless Capabilities

- Solutions Achieved:
  - In-house manufacturing
  - Exchanging Parts
  - Remaking Parts
  - Modifying Parts
  - Negotiating
  - Waiting
Reflection (cont.)

- Merits of the Design Solution
  - Pretty
  - Lightweight
  - Robust
  - Cheaper than thought possible
Conclusion

- Overall:
  - Project specifications became overwhelming with given time span and complications
  - Great design experience
  - Great manufacturing experience

- Time is the enemy
- Be wary of trusting small-time fabrication shops