INTRODUCING AN ASSISTIVE REHABILITATION DEVICE:

GROUP N
DEC. 22, 2015
Management

Shaquile Nijjer – Chief Executive Officer (CEO)
  ◦ Responsible for: software - data analysis

Zachary Nunn – Chief Technology Officer (CTO)
  ◦ Responsible for: hardware

Karsten Harder – Chief Operating Officer (COO)
  ◦ Responsible for: hardware

Alexandra Talpalaru – Chief Information Officer (CIO)
  ◦ Responsible for: software - data analysis

Ashley Lesperance – Chief Financial Officer (CFO)
  ◦ Responsible for: software - application
Pods

Quantify gait
Properly locate abnormalities
Assess and correct problems at the root

[1]
Outline

Background
◦ What is Gait?
◦ Motivation for this project

Market Competition

Schedule

High-Level Overview
◦ Design Overview
◦ Videos/Testimonials

Budget

Future Developments

Conclusion

Questions
Background

Over-Pronation
- Plantar fasciitis
- Problems with the Achilles
- Knee joint pain
- Hip joint pain

Over-Supination
- Ankle strain
- Decrease in walking efficiency
- Hip joint pain
- Low back pain
- Etc...
Background (2)
Motivation

Correct the users over-pronation or over-supination

Get an athlete back into their sport

recommend proper arch support products
  ◦ flat-foot

Improve an older adults walking strategy
  ◦ improve their quality of life
Current products on market

<table>
<thead>
<tr>
<th>Product</th>
<th>BTS Gaitlab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Reflective markers, IR video cameras, inertial sensors, GRF measurement walkway, wireless EMG, workstation, video recording system, TV screen, control station</td>
</tr>
<tr>
<td>Location</td>
<td>Laboratory</td>
</tr>
<tr>
<td>Cost</td>
<td>$100,000 + $205/assessment</td>
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</table>
Current products on market: Pressure sensing system

<table>
<thead>
<tr>
<th>Product</th>
<th>Dr. Scholls Custom Fit Foot Mapping Tech</th>
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</thead>
<tbody>
<tr>
<td>Description</td>
<td>2,000 pressure sensors Lift foot one at a time to identify how areas of foot pressure may change in motion</td>
</tr>
<tr>
<td>Location</td>
<td>Drugstores</td>
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<tr>
<td>Cost</td>
<td>Unavailable for users</td>
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[8]
Current products on the market: Moticon: OpenGo

<table>
<thead>
<tr>
<th>Product</th>
<th>OpenGo</th>
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<tbody>
<tr>
<td>Description</td>
<td>Force-Sensitive insole. Provides Pedobarograph data Clinical &amp; research</td>
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<tr>
<td>Cost</td>
<td>$4000 - $7000</td>
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Design outline
## Schedule

<table>
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<tr>
<th>Activity</th>
<th>Start</th>
<th>Days</th>
<th>Complete</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
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<tbody>
<tr>
<td>Order parts</td>
<td>9/5/15</td>
<td>25</td>
<td>100%</td>
<td>8-Sep</td>
<td>6-Oct</td>
<td>3-Nov</td>
<td>1-Dec</td>
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<td>100%</td>
<td>15-Sep</td>
<td>13-Oct</td>
<td>10-Nov</td>
<td>24-Nov</td>
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<td>Insole design</td>
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<td>50%</td>
<td>22-Sep</td>
<td>20-Oct</td>
<td>17-Nov</td>
<td>1-Dec</td>
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<tr>
<td>Calibration and noise filtration</td>
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<td>30-Sep</td>
<td>27-Oct</td>
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<tr>
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<td>3-Nov</td>
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<tr>
<td>Mobile app</td>
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<td>10-Nov</td>
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<tr>
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<td>17-Nov</td>
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Schedule (Revised)

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Insole design

Force Sensitive Resistor (FSR)

Sensor Layout

- 20 in Heel of Foot
- 16 in Arch of Foot
- 20 in Ball of Foot
- 8 in Toe of Foot

A total of 64 FSR sensors
Insole Circuit

- D1 5V
- D2 5V
- D3 5V
- D4 5V
- D5 5V
- D6 5V
- D7 5V
- D8 5V

FSR

Analog Read

1K

5V
Black Box Design

Arduino Board
• Voltage Limits: 6-20V
• Memory: 32KB
• Clock Speed: 16Mhz
• 5V Regulator and Auto-Selector

Bluetooth Board
• Voltage Limits: 3.3-16V
• Clock Speed: 8MHz
• Low Energy to Reduce Power Loss
  ◦ 10 meter range
  ◦ Battery
  ◦ 9V power
  ◦ Reliability of 2hours at full power
PCB Design
Ground Reaction Force (GRF)

[12]

[13]
Data & data processing

High signal to noise ratio
Identify gait stages in the stance period

- Initial contact
- Loading response
- Mid-stance
- Terminal stance

[12]
Processing steps - Heel

![Diagram showing pressure values for different heel conditions (Normal, Over pronation, Over supination)]
Processing Steps - Ball

![Graph showing pressure values for normal, over pronation, and over supination](image)
Pedobarograph
Video Demonstration
## Cost/Financing

<table>
<thead>
<tr>
<th>Our goal</th>
<th>Reality</th>
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<tbody>
<tr>
<td>Insole Design</td>
<td>Insole Design</td>
</tr>
<tr>
<td>Black Box Design</td>
<td>Black Box Design</td>
</tr>
<tr>
<td>Total Device= $180</td>
<td>Total Device=</td>
</tr>
</tbody>
</table>

Initial insole design was 10 FSR sensors at $10 each

Actual design has 64 FSR sensors. **PROBLEM!!!** That would cost $640 and we spent only $15.

So how did we do it?
Conductive sheets are used to ship electronics for static protection.

Let's make our own force sensitive resistors.

Explored different conductive sheets and found LINQSTAT™ MVCF-Series.

We purchased 11' square piece for $3.56 which was used for our insole.

If we were to mass produce and make 1500 insoles, the price for conductive sheet in each insole would reduce to $0.02.
Future Development

Having a working application, our product is ready for mass production

Optimize insole and black box manufacturing

Estimated cost of materials in mass production of 1500 units

- Insole $0.66/unit
- Black Box $8.50/unit (battery not included)
"This sounds like a very interesting product that can be useful to a wide array of people" - Carl. G, Hodgson Orthotics

"After an injury, the first thing we check is their gait, and correct any asymmetries. I would definitely use and recommend a device like this for anyone with abnormalities"
- Michelle. A, Physical Therapist, Eagle Ridge Physio
Conclusion User Quotes

"OMG it actually works"
- Joel Bradsen

"This product would have sped up my recovery of my Achilles injury"
- Traian Talpalaru

"Being a personal trainer, I would use this product to ensure proper form in training"
- Tania Rodgeman

"As a nurse I'm on my feet all day. Finding areas of high pressure would be useful when buying orthotics to minimize foot pain"
- Zahra Creighton

"This could revolutionize the shoe industry"
- Jacob Nunn
Questions
Acknowledgements

Andrew Rawicz
Steve Whitmore
ESSEF
Jamal Bahari
Lucas-Karim Merhi
References


References Cont.


Appendix

D.V. Rai, L.M. Aggarwal
"The Study of Plantar Pressure Distribution in Normal and Pathological Foot"
## Estimated/Actual Cost of Materials

<table>
<thead>
<tr>
<th>Item</th>
<th>Estimated Price ($CAD)</th>
<th>Actual Price ($CAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluetooth Breakout</td>
<td>19.95</td>
<td>19.95</td>
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<tr>
<td>Arduino</td>
<td>70.00</td>
<td>43.98</td>
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<tr>
<td>Force Sensitive Resistors</td>
<td>100.00</td>
<td>0</td>
</tr>
<tr>
<td>Force Sensitive Resistor Sheet</td>
<td>59.50</td>
<td>35.60</td>
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<tr>
<td>Wire/Conductive Thread</td>
<td>6.95</td>
<td>25.95</td>
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<tr>
<td>Fabric</td>
<td>10.00</td>
<td>N/A*</td>
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<tr>
<td>Shoe Insoles</td>
<td>20.00</td>
<td>7.00</td>
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<tr>
<td>Batteries</td>
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<td>Additional Items</td>
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<td>Laminate Material</td>
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<td>Enclosure</td>
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<td>Prototyping Board</td>
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<tr>
<td>Miscellaneous</td>
<td>90.00</td>
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<td>Shipping and import fees</td>
<td>60.00</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>456.40</strong></td>
<td><strong>284.43</strong></td>
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Foot pressure distribution during walking

[20]