Overview

- **Introduction**
  - Clients
  - Project Objective
  - Previous Work
  - Patents

- **Optimal Design**
  - Measuring Devices
  - Optical System
  - National Instruments Devices
  - Computer Program and Display

- **Budget**

- **Timeline**

- **Conclusion**
Clients

- Dr. John D. Enderle
  - Program Director, Biomedical Engineering, University of Connecticut

- David Kaputa
  - Biomechanics Laboratory Instructor
Project Objective

Force Measurement System
- Force Plate & Platform
- Footswitches

Optical System
- Two Digital Video Cameras

National Instruments Devices
- Convert Analog Data to Digital (Force Measuring System)
- Voltage Source for Force Measuring Device
- Image Acquisition via S-video Cable from Two Video Cameras

LabVIEW® 8.0 & Vision Builder for Automated Inspection
- Process and Display Digital Data from Force Measuring Systems
- Process and Display Images from Two Video Cameras
Previous Work

**Foot Pressure Device**
- Insoles
  - Dynamic Weight Transfer and Local Pressure Concentrations

**Force Plates**
- Ground Reaction Forces
- Vertical & Shear Forces
- Center of Pressure

**Motion Systems**
- Video Motion Systems
  - Measure joint angle and acceleration

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F-Scan® System
www.tekscan.com

4060-NC Force Plate Series
www.bertec.com

Peak Motus
www.vicon.com
Patent Examples

- 6,997,882 6-DOF subject-monitoring device and method – Parker, et al.
  - Methods & Devices Using Accelerometer

- 4,631,676 Computerized video gait and motion analysis system and method – Pugh, James W.
  - Computerized Video & Motion System
**Force Plates**

- A force plate is a device that measures the ground reaction forces exerted by a subject as they step on it during gait.
  - Top plate
  - Force transducers at each corner

- Force plates allocate the measurement of both vertical and shear forces, as well as the center of pressure for the subject throughout gait using
Load Cells

- Four Thames Side-Maywood 350a strain gauges/load cells that were previously purchased by the University

- Strain gauge transducers employ four strain gauge elements electronically connected to form a Wheatstone bridge circuit
The force plate and platform will be made out of a material that is relatively light weight, durable, strong, and cost-efficient.

- Top Plate – 6061 Aluminum Alloy
- Bottom Plate & Platform – 304L Stainless Steel

### Mechanical Properties of 6061 Aluminum Alloy

<table>
<thead>
<tr>
<th>Condition (Temper Designation)</th>
<th>Tensile Strength (MPa)</th>
<th>Yield Strength (MPa)</th>
<th>Ductility (%EL in 50 mm)</th>
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<tbody>
<tr>
<td>Heat Treated (T4)</td>
<td>240</td>
<td>145</td>
<td>22–25</td>
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### Mechanical Properties of 304L Stainless Steel

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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<tbody>
<tr>
<td>Tensile Strength (MPa)</td>
<td>500</td>
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<tr>
<td>Compression Strength (MPa)</td>
<td>210</td>
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<tr>
<td>Proof Stress 0.2% (MPa)</td>
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<tr>
<td>Elongation A5 (%)</td>
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<tr>
<td>Hardness Rockwell B</td>
<td>92</td>
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Footswitches

- Footswitches are a convenient and inexpensive way of obtaining temporal measurements during gait.

- Typical measured parameters include:
  - Stance and swing times
  - Single limb support
  - Gait cycle duration

- FSR switches are used to construct the footswitches
  - 2 layers of plastic with printed circuit on inner surfaces
  - Applied pressure creates a switch closure resulting in a resistive electrical circuit
  - Resistance decreases as more pressure is applied resulting in a decrease in the voltage output
NI devices

- **PXI-1031:**
  - Combine 4-slots PXI
  - Wide range of applications
  - Accept 3U PXI and compact PCI module

- **PXI-1411:**
  - Color or monochrome acquisition
  - One external trigger/digital I/O line
  - Transfer rates up to 132 Mbytes
NI devices

- SC-2345:
  - Signal conditioning for DAQ system
  - 16 analog inputs
  - Provide up to 300v

- PXI-6040E:
  - Data acquisition device
  - Analog and digital triggering
  - 12 to 16 bit resolution
Optical system

- Two digital video cameras (Sony Handycam DCR TRV27)
  - Provide 3D image
  - Instantaneous record of the markers movement
  - Convert and record an analogue NTSC video source to digital video
  - MPEG movie EX mode: in which it will allow us to record uninterrupted to the full capacity of the memory stick media
Computer Program & Display

- Force Signal Processing
  - LabVIEW® 8.0

- Footswitch Signal Processing
  - LabVIEW® 8.0

- Optical System
  - LabVIEW® 8.0
  - Vision Builder for Automated Inspection
**Optical Display**

3D Optical

**Measurement Display**

Position Graph

Velocity Graph

Force

Acceleration Graph

**Video Image**

![Video Image](image-url)

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<tr>
<th>Angle 1</th>
<th>Angle 2</th>
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<td>Angle 3</td>
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<tr>
<td>Angle 5</td>
<td>Angle 6</td>
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<td>0</td>
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<table>
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<tr>
<th>Average Velocity</th>
<th>Average Acceleration</th>
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<table>
<thead>
<tr>
<th>Average Force</th>
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</thead>
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<tr>
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Laboratory Layout

Counter w/ Cabinets (254 in. X 34 in.)
Desk (34 in. depth)
Russell Traction Set-up (111 in. X 36 in.)
Table (144 in. X 60 in.)
Door w/ Frame (76 in. wide)
147 in.
65.5 in.
109 in.
96 in.
Camera 2
Computer System
National Instruments Devices
Tensile Testing Machine
Sink
Walking Path 96 in. Length
White Screen
Russell Traction Set-up (111 in. X 36 in.)
Table (144 in. X 60 in.)
## Budget

<table>
<thead>
<tr>
<th>Items</th>
<th>Required</th>
<th>Purchase</th>
<th>Retail (each)</th>
<th>Est. Project</th>
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<tr>
<td><strong>Optical System</strong></td>
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<td>Digital Cameras (2)</td>
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<td>Camera Tripods (2)</td>
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<td>Sony VCT-870RM Remote Control Tripod</td>
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<td>Reflective Ball Markers (1 set = 30 passive)</td>
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<td>Womens</td>
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<td>Mens</td>
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Timeline

- Initial meeting (week one)
- Optical system tested and completed by week six
- Force measurement system completed by week twelve
- Lab view program completed in conjunction with device testing and completion dates
- Combine and test entire project by week thirteen
- Complete final lab report by week fourteen
- Demonstration and presentation in week fifteen
Conclusion

Gait Analysis Laboratory

- Incorporate a hands-on approach to gait analysis through the use of an integrated:
  - Force Plate & Platform
  - Footswitches
  - 2 Digital Camcorders
  - National Instruments Equipment
  - Interactive National Instruments LabVIEW® Software Program

- Students will gain a deeper understanding of gait analysis through the use of 2 different types of measuring devices that are not currently available in the Biomechanics lab.

- Design fulfills the upgrade request for the Biomechanics gait analysis lab in providing a more robust example of biomechanics applications and bridging the gap between the classroom experience and clinical applications.
Acknowledgements

- University of Connecticut
  - Dr. John D. Enderle, Client and Advisor
  - David Kaputa, Client and Advisor
  - Christopher Liebler, Advisor

- National Instruments
  - Bharat Sandhu, Field Engineer
Questions ?