Alternative Design 1 Report

Biomechanics Gait Analysis Lab

By
Kimberly Carr, Omar Chawiche, Angela Ensor
Team 3

Client Contact:
Dr. John D. Enderle
University of Connecticut
Biomedical Engineering Department
Bronwell Building, Room 217C
260 Glenbrook Road
Storrs, Connecticut 06269-2247
Phone: (860) 486-5521
1. Alternative Design Gait Analysis Lab I

1.1 Introduction

The gait analysis laboratory design 1 will incorporate a hands-on approach to gait analysis through the use of an integrated force plate, platform, two digital camcorders, National Instruments equipment, and an interactive National Instruments LabVIEW® software program.

A drawing of the overall system design is shown in Figure 1. The force plate will be designed and built using four load cells that were previously purchased by the department and withstands up to 300kg each. Data acquisition will be accomplished using the two digital cameras, a force plate, and the National Instruments PXI-1031 and SC-2345. The LabVIEW® program will be able to determine the acceleration, velocity, position, angles, and forces for one complete gait cycle.

To accurately measure the ground force reaction from foot strike, a force plate, imbedded flush into a platform, will be used in this design. The force plate will use four load cells that will measure the exerted force and send this data to the National Instruments SC-2345, which houses the SCC-SG24 modules, and the SC-2345 will be connected to the PXI-6040E data acquisition card in the National Instruments PXI-1031, from which the data acquired will be sent to the LabVIEW® program. This force measurement device will allow the user to determine the dynamic forces exerted on the ground during the gait cycle, where previously this measurement was taken statically using a weigh scale.

Digital cameras will be used to record a full gait cycle, each providing 2-D data. External markers will be placed laterally on the hip, knee, ankle, and toe of the right leg. In considering the use of multiple cameras, two cameras will provide the software with the data necessary to create 3-D analysis. The use of more than two cameras would aid in keeping the markers in view as they become obscured by arm swing or patient rotation, improving the tracking accuracy, but the markers could still be missed during parts of the gait cycle. A white screen will be placed behind the person walking, to reduce glare, picked up by the cameras from natural light, and prevent any unwanted circular shapes to be picked up by the LabVIEW® program. The walkway location, as shown in Figure 2, was
chosen to accommodate for the proper placement of the cameras.

Each camera records the gait cycle and the software determines the horizontal and vertical coordinates for each marker throughout the gait cycle, which is transformed into 3-D by the computer software. Tracking the markers provides the data needed to determine angles and distance over a gait cycle time period, which will further allow for determining velocity and acceleration. The images acquired will be received by the National Instruments PXI-1411 and sent to the LabVIEW® program.

The LabVIEW® program, along with Vision Development Module, will aggregate and synthesize the data received from the National Instruments PXI-1031 and display angles, forces, and acceleration vs. time, velocity vs. time, and position vs. time graphs, as well as the average acceleration and velocity. This portion of the lab is unique in that, some components of this program will allow the opportunity for students to build certain portions of the program, such as the force measurement function.

**Figure 1:** Complete System Drawing

### 1.2 Subunits
1.2.1 Force Measuring Device – Force Plate

1.2.1.1 Background
A force plate is a device that measures the ground reaction forces exerted by a subject as they step on it during gait. Force plates consist of a top plate which is separated from the bottom frame by force transducers at each corner. The forces exerted on the top surface are transmitted through the force transducers. Force plates allocate the measurement of both vertical and shear forces, as well as the center of pressure for the subject throughout gait.

1.2.1.2 Force Transducers
For this design we will use four Thames Side-Maywood (Southwood, Farnborough, England) 350a strain gauges/load cells that were previously purchased by the University of Connecticut Biomedical Engineering program shown in Figure 1 on the top of the next page.

![Thames Side-Maywood 350a Load Cell](image)

Figure 1 (a) & (b): Thames Side-Maywood 350a Load Cell

The technical specifications for the load cells are shown in Table 1 below.

<table>
<thead>
<tr>
<th>Technical Specifications</th>
<th>Load Cell Capacity</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Load Ranges</td>
<td>300</td>
<td>kg</td>
</tr>
<tr>
<td>Rated Output</td>
<td>2</td>
<td>mV/V ± 0.1%</td>
</tr>
<tr>
<td>Accuracy Class</td>
<td>3000</td>
<td>n.OIML</td>
</tr>
<tr>
<td>Combined Error</td>
<td>&lt; ± 0.017</td>
<td>%*</td>
</tr>
</tbody>
</table>
Non-repeatability $< \pm 0.015 \%$
Creep (30 minutes) $< \pm 0.016 \%$
Temperature Effect on Zero Balance $< \pm 0.01 \%$/°C
Temperature Effect on Span $< \pm 0.006 \%$/°C
Compensated Temperature Range −10 to +40 °C
Operating Temperature Range −20 to +70 °C
Safe Overload 150 \%*
Ultimate Overload 200 \%*
Zero Balance $< \pm 2 \%$
Input Resistance 400 \ Ω ± 30
Output Resistance 350 \ Ω ± 1.5
Insulation Resistance $> 5000 \ MΩ @ 100V$
Recommended Supply Voltage 10 V
Maximum Supply Voltage 15 V
Environmental Protection IP66

The load cell dimensions are shown in Figure 2 and Table 2 below.

**Figure 2:** Thames Side-Maywood 350a Load Cell Dimensions

**Table 2:** Thames Side-Maywood 350a Load Cell Dimensions

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.5</td>
<td>15</td>
<td>24.6</td>
<td>51.6</td>
<td>31.5</td>
<td>130</td>
<td>13.5</td>
<td>18</td>
<td>M12</td>
<td>76.2</td>
<td>25.4</td>
<td>15.8</td>
<td>0.9 kg</td>
</tr>
</tbody>
</table>

All dimensions are in mm

In order to measure strain with a bonded resistance strain gauge, it must be connected to an electrical circuit that
is capable of measuring the minute changes in resistance corresponding to strain. The Thames Side-Maywood strain gauge transducers employ four strain gauge elements electronically connected to form a Wheatstone bridge circuit shown in Figure 3 below.

![Figure 3: Thames Side-Maywood 350a Load Cell Electrical Circuit](image)

Testing the Load Cells
To test the load cells at zero balance (electrical output with no load) a millivoltmeter is used to measure the load cell’s output under a "no load" condition. The output of a trimmed cell should typically be within ± 0.1% of the rated output.

To test for bridge resistance the resistance across each pair of input and output leads is measured. The input and output resistance is typically 350 ± 3.5 Ω (Ohms); if the resistance readings are 'out of spec' than the load cell requires repair.

1.2.1.3 Top Plate
The top plate for the force plate needs to be made out of a material that is relatively light weight, durable, strong, and cost-efficient. The material that will be used for the top plate of the force plate in this gait analysis laboratory is 6061 aluminum alloy. The composition and mechanical properties for 6061 aluminum alloy are shown in Table 3 and Table 4 below.
Table 3: Composition of 6061 Aluminum Alloy

<table>
<thead>
<tr>
<th>Weight Percent (wt%)</th>
<th>Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>97.9</td>
<td>Aluminum (Al)</td>
</tr>
<tr>
<td>1.0</td>
<td>Mercury (Mg)</td>
</tr>
<tr>
<td>0.6</td>
<td>Silicon (Si)</td>
</tr>
<tr>
<td>0.3</td>
<td>Copper (Cu)</td>
</tr>
<tr>
<td>0.2</td>
<td>Chromium (Cr)</td>
</tr>
</tbody>
</table>

Table 4: 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>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Treated (T4)</td>
<td>240</td>
<td>145</td>
<td>22-25</td>
</tr>
</tbody>
</table>

The Schematics of the force plate for the gait analysis laboratory are shown on the top of the next page in Figures 4, 5, and 6.

Figure 4: Top View of Force Plate

Figure 5: Side View of Force Plate
1.2.1.4 Ground Reaction Forces and Center of Pressure

Due to gravity, we constantly maintain contact with the ground, and therefore, interactions occur between the body and the ground. The ground reaction force (GRF) is the reaction force supplied by the ground and is basically the reaction to the force that the body exerts on the ground. The GRF of a subject can be calculated using a force plate and Figure 7a below shows the reference frame of the force plate, with the Z-axis being the vertical while Figure 7b below shows the reaction force vectors acting on small areas. A force plate has four tri-axial force sensors embedded that measure the force acting between the foot and the ground in three axes: transverse (X), anteroposterior (Y), and vertical (Z). Figure 7c below shows the four reaction force vectors measured by the sensors. Since the sum of all of the reaction forces from the ground (Figure 7b) is equivalent to the sum of the four forces measured by the sensors $F_1, F_2, F_3,$ and $F_4$ (Figure 7c), the system is equivalent to the system in Figure 7c.
Figure 7: Ground Reaction Force

Figure 7d shows a single force, $\mathbf{F} (F_1 + F_2 + F_3 + F_4)$, and a torque, $T_z$. $\mathbf{F}$ here is the ground reaction force. $T_z$ shown in the figure is the so-called free torque and has the vertical ($Z$) component only. The free torque is caused by the coupling effects of the forces about the vertical axis. System (d), $\mathbf{F} + T_z$, is again equivalent to system (c). The ground reaction force has three components: $F_x$, $F_y$ & $F_z$. Among these, $F_y$ is along the direction of the motion which reflects the propulsive or braking force. $F_z$ always thrusts the body upward.

As shown in Figure 7 above, all of the forces acting between the foot and the ground can be summed up to yield a single ground reaction force vector ($\mathbf{F}$) and a free torque vector ($T_z$). The point of application of the ground reaction force on the plate is the center of pressure (CP). All the small reaction forces collectively exert on the surface of the plate at the CP.

Generally, the true origin of the strain gauge force-plate is not at the geometric center of the plate surface. Here, we assume that the true origin ($O'$ shown in Figure 8) is at $(a, b, c)$. The $Z$ component of the CP position is always 0. The moment measured from the plate is equal to the moment caused by $\mathbf{F}$ about the true origin plus $T_z$: 
Equations:

\[ M = (x-a,y-b,c) \times (F_x,F_y,F_z) + [\beta,T_z] \]  \hspace{1cm} (1)

or:

\[
\begin{bmatrix}
M_x \\
M_y \\
M_z
\end{bmatrix} =
\begin{bmatrix}
0 & c & y-b \\
-c & 0 & -(x-a) \\
-(y-b) & x-a & 0
\end{bmatrix}
\begin{bmatrix}
F_x \\
F_y \\
F_z
\end{bmatrix}
+ 
\begin{bmatrix}
0 \\
0 \\
0
\end{bmatrix} - 
\begin{bmatrix}
(y-b)F_z + cF_y \\
-cF_x - (x-a)F_z \\
(x-a)F_y - (y-b)F_x + T_z
\end{bmatrix} \tag{2}
\]

Eventually:

\[
x = -\frac{M_y + cF_z}{F_z} + a \\
y = \frac{M_x - cF_y}{F_z} + b \\
T_z = M_z - (x-a)F_y + (y-b)F_x
\]  \hspace{1cm} (3)

Therefore, the position of the CP can be computed from the moment caused by the ground reaction force about the true origin, \( M_x, M_y \& M_z \), the ground reaction force, \( F_x, F_y \& F_z \), and the location of the true origin, \( a, b \& c \). \( M_x, M_y, M_z, F_x, F_y \& F_z \) can be directly measured from the data output from the force transducers².

References for Section 1.2.1

1.2.2 Optoelectronic System

For this design project, two digital Sony Handycam DCR TRV27 cameras (shown in Figures 1 and 2 below) are used to create a 3-D coordinate system. The two digital cameras record the instantaneous position of each marker in order analyze the movement of the body in 3-D system.

![Sony Handycam DCR TRV27 Digital Camera](image)

**Figure 1**: Sony Handycam DCR TRV27 Digital Camera-side view

Features of the Sony Handycam DCR TRV27 digital cameras include:

- An advanced hole accumulation diode imager with 690k pixels, in which it will provide us with an excellent detailed and clarity of an image.
- MiniDV digital recording format delivers 3x the color bandwidth of VHS and lower signal to noise ratio compared to analogue formats, providing stunning video performance comparable to DVD.
- A clear color view of video subjects, and makes spotting or following subjects easier.
- A high speed bi-directional digital video/audio communication between two compatible devices equipped with an IEEE1394 interface, including camcorders, digital VTRs, capture cards, and PCs.
- It converts and records any analog NTSC video source to digital video via the analog inputs.
- A digital still memory mode captures high quality Megapixel still images at 1152 * 864 or 640 * 480 resolution directly to memory stick media.
- A playback zoom: during video playback, pause mode or while viewing still images stored on memory stick media, it can zoom up to 5x closer.
• An MPEG movie EX mode: in which it will allow us to record uninterrupted to the full capacity of the memory stick media. For example a 128MB memory stick will record up to 85 minutes of non-stop MPEG1 video.

• 10X Optical/120X Precision digital zoom: the optical zoom brings the action close up from far away. In addition, precision digital zoom interpolation technology means that extreme digital zooming is clearer, with less distortion than previous types of digital zoom.

Figure 2: Sony Handycam DCR TRV27 Digital Camera-back view

Three Styrofoam balls shown in Figure 3 below will be used as the motion markers that will be placed on the hip, knee, and ankle joints of the subject’s leg. The video recordings of these markers will allow us to calculate the position vs. time, velocity vs. time, and acceleration vs. time for each marker on the subject.

Figure 3: Styrofoam balls used as motion markers

The cameras will record a complete gait cycle of the subject, as depicted in Figure 4 below.
Figure 4: Complete Gait Cycle

In order to achieve a high-quality recording that will lead to optimal results, the digital cameras will be spaced several feet apart as shown in Figure 5 on the top of the next page.

Figure 5: Camera Spacing Diagram

References for section 1.2.2


3. www.bjcraftsupplies.com
1.2.3 National Instrument Devices

Figure 1: National Instruments PXI-1031

PXI-1031, as shown in Figures 1-3, combines 4-slots PXI backplane with a structural design that gives it the ability to be used in a wide range of applications.

The key features of the NI PXI-1031 include the following:

- Accepts 3U PXI and Compact PCI (PICMG 2.0 R 3.0) modules
- 4-slot chassis with universal AC input, and automatic voltage/frequency ranging
- DC power input (PXI-1031DC only)
- On/Off (Standby) power switch on the front panel for easy access
- AUTO/HIGH temperature-controlled fan speed based on air-intake temperature to minimize audible noise
- (Optional) Carrying handle for portability
- Rack mountable

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![Diagram of PXI-1031](image)

1. Controller Expansion Slots
2. Captive Screw
3. PXI Filler Panel
4. PXI Backplane
5. Rubber Foot
6. PXI Expansion Slots
7. Star Trigger Peripheral Slot
8. Embedded Controller Slot
9. Power Switch (Standby)
10. Power Supply Airflow Intake Vents
Figures 2-3 show the rear and front view of the PXI-1031. As mentioned before, this device contains 4 different slots. One of these slots contains the NI-1411, shown in Fig. 4, which consists of a PXI plug-in image acquisition device that accepts digital video input from standard color or monochrome cameras. It also includes image acquisition driver software. The PXI-1411 Series includes features that improve overall image acquisition and image processing speed, using the onboard programmable ROI feature, only a portion of the image would be acquired. The National Instruments PXI-1411 can be used with several different software programs include LabVIEW®, Measurement Studio, and C/C++. The National Instruments PXI-1411 will receive images from both cameras and send it to the computer.
The force plate will be connected to the National Instruments BNC-2120, shown in Fig. 5, which is connected to the PXI-1031, where it will read the data from the force plate and convert it to digital data that the computer will be able to read.

Figure 4: National Instruments PXI-1411

Figure 5: National Instruments BNC-2120
This National Instruments BNC-2120 is generally used to connect analog input, analog output, digital I/O and counter/timer signal. The National Instruments BNC-2120 also provides a function generator, quadrature encoder, temperature reference, thermocouple connector, and LED so the functionality of the hardware can be tested. This device will be connected to the force plate, as well as the National Instruments PXI-1031, so the information will be received from the force plate through the National Instruments BNC-2120 and PXI-1031, which will convert the signal to digital data before being received by the computer.

References for Section 1.2.3
1.2.4 Computer Program

The computer program used for this design will be able to receive the digital signal, or bytes of data, from the digital camcorder and the force measuring device, which has been converted from analog data by the National Instruments BNC-2120. The products and specifications required to accomplish the necessary data acquisition to produce the desired results, is listed as follows in Figure 2 below.

### Operating System
Windows 2000/NT/XP/Me/9x

### Hardware
Pentium III or later (600 MHz Celeron)
Microsoft Internet Explorer 5.0 or later
256 MB of RAM

### Software Applications
National Instruments LabVIEW® 7.1 or later
National Instruments Vision Development Module
  - IMAQ Vision 8.0
  - Vision Builder for Automated Inspection (AI)

**Figure 2:** Operating System, Hardware and Software Application Requirements

All software applications are produced by National Instruments and will be referred to by the application name, through the remainder of section 1.2.3.

1.2.4.1 Digital Image Acquisition and Displays
The digital data, or bytes of data, are received from the National Instruments PXI-1031, by the Vision Development Module, IMAQ software, serving as the interface path between LabVIEW® and the PXI-6040E, to deal with any issues such as programming interrupts, and performs the functions that acquire and saves the images. IMAQ Vision performs functions such as image analysis, interpretation,
manipulation, processing, storage and display. IMAQ Vision Builder for Automated Inspection has abilities that include setting up coordinate systems, performing pattern matching, geometric analysis, and measurements. Examples of the IMAQ Vision Builder for Automated Inspection are shown in Figs. 3-4.

Figure 3: IMAQ Vision Builder for Automated Inspection
**Figure 4:** IMAQ Vision Builder for Automated Inspection

The Vision Builder for Automated Inspection generates LabVIEW® code that allows for custom and optimal inspection algorithms that, used in conjunction with LabVIEW® software, will meet our application and display requirements.

### 1.2.4.2 Force Signal Processing

The signal from the force transducers will need to go through a circuit board, such as the National Instruments PXI-4204 or PXI-4220, and the National Instrument BNC-2120 and PXI-1031 to produce data that may be used by the LabVIEW® program. Once the signal from the force measurement device is sent to the computer, the LabVIEW® software will translate this data into a displayable measurement in engineering units. An example of a displayable measurement is a graph, such as the graphs shown in Figures 5-6 on the top of the next page.
**Figure 5:** Digital Waveform Graph (graphical indicator from LabVIEW® 7.1)

![Waveform Graph](image)

**Figure 6:** Waveform Graph (graphical indicator from LabVIEW® 7.1)

**References for Section 1.2.4**


**2. Realistic Constraints**

Engineering standards are very important when designing a biomedical device. For this design project, we are using the International System of Units (SI units) in order to keep with engineering standards around the world. Also, we are utilizing basic static laws of applied loads, moments, and points of application in order to analyze the raw data that is output from the force transducers.

Some economic considerations for this design project include the proposed budget (although not yet specified) and the longevity of the device itself. Although currently we do not have a limited budget, our design needs to be
within a reasonable cost, ranging from approximately $450 to $1,500. The gait analysis laboratory that is being designed will need to be used in the University of Connecticut’s biomechanics laboratory which is presently offered in the Fall semesters. Therefore, our device should be able to last at least five years of operation.

A major environmental consideration for this design project is the weather conditions and temperature ranges in Connecticut. The gait analysis laboratory will need to be stored in a closet that may or may not have a good source of heat and will hence need to survive the relatively harsh temperatures of Connecticut winters.

Two very important ethical constraints for this design project come from the Code of Ethics for Engineers. The first ethical constraint is the statement “Strive to prevent a person from being placed at risk due to the use of technology”. This constraint demands that the gait analysis laboratory be set-up in such a way that will keep the subjects and testers’ safe at all times of operation and assembly. The second ethical constraint is the statement “Work toward the containment of costs by the better management and utilization of technology”. This constraint asks that we utilize existing materials that are on hand or that are cheaper than others on the market as well as to make things ourselves which is more cost-effective than purchasing from suppliers.

3. Safety Issues

Safety consideration is one of the most important issues in any project, especially when dealing with electricity. In general, any equipment or device uses electricity and, when it is in contact with people, it must be electrically isolated from the power main or battery power. Even if the instrument is not in direct contact with the person, it must be grounded.

In our design for the gait analysis lab, the students will only be in contact with the force plate that is electrically wired. Besides walking and stepping on the force plate, students will only have to run the PXI-1031 and BNC-2120 equipment which were built by the National
Instruments and the safety of these devices were taken into consideration by the company, prior to building and during testing of the equipment.

All of the wires that are connecting the force plate, National Instruments equipment, cameras, and the computer, will be placed in a cable tunnel or conduits, as shown in Fig. 1, so that wires are not hazardously placed, in such a way that somebody may trip on them, and that also will reduce the chances of somebody receiving an electrical shock.

Also the right size of electrical cable will be used so that the power voltage will not be so large as to cause the cables to heat up and potential produce a fire. Another safety issue to take into consideration is the material that will be used in the force plate and the connection circuitry of the load cells. In this design, the force plate will be created using metals. Metal is a good electrical conductor and could dangerous if the circuitry is set-up properly. For that reason, the circuitry that is connecting the load cells together should be isolated from contact with the metal force plate.

By using conduits to arrange the wires and the right voltage source, students will be safe to use this lab. Overall, our main safety concern in building the design is the electrical components that include cables, circuitry, and voltage source.

![Figure 1: Cable Tunnels and Conduits](image)

4. Impact of Engineering Solutions
Designing a gait analysis program can have many impacts that are global, societal, economic, and environmental. Learning about gait analysis and its applications will provide a better understanding of the impact of biomedical engineering solutions for students and, hopefully, the students will be able to discover some of the global, societal, economic, and environmental impacts in the gait analysis lab. Some of those impacts will be discussed next.

Globally, in researching applications of gait analysis, these types of programs were found in countries such as Australia, United Kingdom, China, and all across the United States. The Hugh Williamson Gait Analysis Laboratory, as part of the Royal Children’s Hospital in Melbourne, uses their lab to perform research and to develop ways of providing useful information to surgeons and therapists, primarily for children with Cerebral Palsy and also Spina Bifida. The Derby Gait and Motion Laboratory, in the United Kingdom, evaluate adults and children with Cerebral Palsy, stroke, and amputated limbs. The Institute of Biomedical Engineering, Tsinghua University, in Beijing, China has been involved in the use of gait analysis for analyzing Cerebral Palsy. Clinical gait analysis is also used at the Gait Analysis Laboratory at the Connecticut Children's Medical Center.

The use of gait analysis to treat diseases and disabilities has a positive impact on society. By discovering ways to treat physical conditions, people with disabilities may be able to receive better medical treatment or therapy, and assistive devices. These treatments could help patients become more productive and independent. Research and use of gait analysis for patients with Cerebral Palsy has been performed on a global scale, at all of the institutes mentioned previously. Cerebral Palsy is an incurable disorder that hinders the control of muscle movement and can affect the use of one or any combination of limbs. The lack of motor control makes walking very difficult, for which gait analysis could be a great tool in determining proper treatment.

The economic impact can affect consumers, both patients and providers. The cost of building a gait analysis laboratory is extremely expensive. The patients that use the facilities that use “state-of-the-art” equipment often have higher fees, which may exceed insurance coverage or may not
be covered at all. The benefit to the patient, and the usefulness in determining proper treatment by the health professional, must outweigh the cost. The growing expectation for a quality life, demands tools to better serve the recovery or treatment process and gait analysis is one of those tools. A patient may require treatment in order to regain the ability to work, which could provide a better income than disability compensation, thereby improving the individual’s economic situation.

Environmentally, the impact can be found in the creation of materials and electronics that must eventually be thrown out. As materials and electronics age, they must be replaced to ensure operational safety and quality results. While some materials can be recycled, this is not true for all materials and, unless the user is environmentally conscious, all of the materials could conceivably be thrown away. Recycling is very expensive, but the cost to the environment may be irreversible and every effort should be made to recycle as much of the used materials as possible.

Depending on how one views the definition of ‘environment,’ the patient’s environment could be impacted as well. The environment in which the patient lives could improve and expand greatly. This may mean the patient becomes mobile, or more easily mobile, and is able to gain access to areas of their environment that were previously restricted by their condition. The recommended treatment from gait analysis may allow the patient to re-enter the workforce and regain involvement in the environment of society.

Designing a gait analysis program has already greatly impacted the world in a global, societal, economic, and environmental sense and shows how engineering solutions can make a positive difference in the world, if put to good use.

5. Life-Long Learning

In the Biomechanics gait analysis lab, we learned about gait analysis processes in general, including ‘what is gait analysis?’ and ‘what is it used for in the medical field?’ We also learned about the gait cycle and how is it divided into different parts. We have increased our understanding of this process and will highlight some of the knowledge gained with comparisons to what we had previously learned.
During the biomechanics lab, we built a simple LabVIEW® program to process the information recorded from the digital camera. In this design, by building the gait analysis program, we acquire more details and learn more about the different parts of the program and how each part functions and communicates to produce the desired, complex results.

By building the program, we will learn more modules in LabVIEW® and gain more in-depth knowledge of the data the program receives and how it is used. The difference between creating this program and the one used in the biomechanics class is that we are building the program and not simply using it. The students using the new design will be given portions of the program to get started and will be expected to build a portion of it. Due to time constraints, were students only have one lab section, building the entire program and finishing the entire lab would be impossible.

As far as the optical device, we learned the differences between using one or two cameras, and which one is the better option. We have also learned how the cameras should be placed, to include how far apart the two cameras should be place in order to give an accurate motion recording. Also getting to know the quality of the cameras and how the quality affects the results has been a learning experience.

Concerning the markers used in gait analysis lab, we have found that, in order to detect 3-D motion properly using the cameras, three markers should be placed on each body segment instead of one, as was done in the previous Biomechanics gait analysis lab.

The PXI-1031 and BNC-2120 national instrument equipments are being used for the first time in this lab, meaning that we had no prior knowledge about these devices. After creating the first alternative design for the new lab, we have gained more knowledge about how these instruments functions to transform the data from the cameras and the load cells, so that the collected data can be analyzed.