# ME 430 Final Report

The San Luis Obispo Children's Museum

ENERGY OF MOTION


Team Members:
Patrick Ligot
Brian Mich
Jaime Salazar
Erik Sanchez
Steven Azeka (Electrical Engineer)

Faculty Advisors:
Dr. Lou Rosenberg
Dr. Lynne Slivovsk

Sponsor: Mrs. Michelle Jenkins


June 2010

**Table of Contents**

**Tables**

## Relevant Figures

**Chapter 1 Introduction**

The objective of this project is to design an interactive energy exhibit for the San Luis Obispo Children's Museum. This exhibit will enhance the child's understanding of the concepts of energy production and consumption by relating their own movements in the museum to everyday energy uses. The project will consist of an appropriate off the shelf pedometer device that will record the number of steps a child will take on their visit, a base station kiosk that will provide the educational interface, and the cumulative energy display at the front of the museum.

The appropriate pedometer will be a durable, long lasting device that will be clipped or buckled to the children when they enter the museum. As they walk, run and play through the museum, the device will record their activity. The kiosk is a computer that converts the data recorded on the pedometer into units of energy. It will then run a program, which uses visual displays to relate energy to the kids; such as how long the child could have powered a common electric device or the amount of food the child would need to eat in order to produce that power. The kiosk is the key to the exhibit. It has to provide a fun experience for the kids while seamlessly building on their understanding of the concepts of energy. The cumulative energy display is a simple display that will count the total amount of child produced energy in the museum. As the kids exit and turn in their pedometers, they will add their total produced energy to the cumulative total. It will provide a big picture that will potentially show the kids what they are capable of producing.

This project aims to design an experience in order to educate and entertain. The most important aspect of the project is to deliver a product that draws attention and will last. Museums are an important educational resource and energy conservation is on the frontline of science and technology. This exhibit will give kids a better understanding about the costs and rewards of energy use.


Figure 1: Happy child wearing a pedometer

## Chapter 2 Background

An attempt was done by a previous Cal Poly San Luis Obispo Senior Project to make a device for kids to measure energy, and present the data recorded by the device in a fun and interactive manner. The project was successful in achieving a device that measured energy. However, it was too complex and expensive, resulting with an ineffective product.

Research has been done to search current energy meters being used today. Yet, the team was unable to find information or an existing device. A calorie meter was the most common device that came close to an energy meter; essentially a pedometer that converts steps to calories burned off by the user. However, this device is marketed towards adults rather than children, making them too complex for children to use.

The traditional pedometer is composed of a counter mechanism that is connected to a circuit, which counts the number of steps taken by the user in a series of flip flops or also known as registers. The entire circuit, including the counting mechanism, is powered by a 1.5-volt battery (a simple watch battery), and depending on the counter mechanism, dictates battery life.

There are three possible counter mechanisms for current pedometers to choose from. These mechanisms include:

1. Global Position System (GPS)
2. Lever arm
3. Accelerometer

Table 1 below describes the different attributes for each mechanism.

Table 1 – Pro's and Con's

| | GPS | Lever Arm | | Accelerometer |
|---|---|---|---|---|
| | | Hair Line Spring | Coil Spring | |
| Cost | High | Low | Low - Medium | Medium |
| Durability (Longevity) | High | Low | Low - Medium | High |
| Accuracy | High | Low | Low | High |
| Energy Consumption | High | Low | Low | Medium |

As for the display accumulator that will illustrate the energy usage at the discovery museum, there are various ways this can be attained. Two possible display solutions completed in the past are a Light Emitting Diode (LED) scrolling sign and a flat-panel television. Both have relatively long life spans and are maintenance-free.

**Chapter 3 Objectives**

I. Project Goals

- Design an experience that teaches kids about fundamental uses of energy by relating their physical movements throughout the museum to familiar energy applications.
- Meet the needs and requirements set by the SLO Children's Museum:
  - – Exhibit must incorporate three main parts, including an off the shelf energy meter, or pedometer, an interactive kiosk to interpret the gathered energy data and run educational software to relate the data to the visitor, and a cumulative energy display that keeps track of the museum's total kid-power produced over time.
  - –All aspects of the exhibit must be durable enough to withstand repeated use by the visitors of the SLO Children's Museum. Durability is paramount for the success of this project.
  - –All aspects of the exhibit must require little maintenance and should last several years. Parts that wear down over time must be inexpensive and easy to replace.
  - –The educational interface must deliver a clear and concise message to museum visitors. Conveying the content of the exhibit is the most important aspect of this project. The information presented here must be interesting and relevant to the kids and should be sufficiently accurate.
  - –The physical aspects of the exhibit must draw attention and be attractive in appearance. It has to be cool.
- Stay within budget allocated by the SLO Children's Museum:
  - –Development of energy meter - $2500
  - –Development of energy information kiosk - $4500
  - –Development of cumulative energy display - $1500
  - –Total budget for development - $8500
- Stick to project plan and deliver milestones on time. Major milestones include
  - –Concept Design Report delivered on 11/5/2009
  - –Final Design Report delivered on 12/1/2009
  - –Build Summary Report and Presentation delivered on 4/2010
  - –Testing Summary Report and Presentation delivered on 6/2010
  - –Final project delivery and implementation on 6/2010

## II. Design Specifications

| Pedometer | | | | |
|---|---|---|---|---|
| **Parameter** | **Description** | **Target** | **Risk** | **Compliance** |
| 1 | Battery Life | 3 Months | High | Testing |
| 2 | Impact Resistance | should withstand a 12 foot vertical fall with no damage | High | Testing |
| 3 | Connector Durability | 3 years | High | Testing |
| 4 | Life Expectancy | 3 years | Med | Estimate |
| 5 | Weight | under 0.25 lb | Med | Measured |
| 6 | Cost | under $25 | Med | Measured |
| 7 | Accuracy | Limited error (under 30%) | Med | Testing |
| 8 | Aesthetics | Positive user feedback | Med | Sponsor satisfaction |
| 9 | Size | Maximum dimensions 3"x3"x1" | Low | Measured |

| Kiosk | | | | |
|---|---|---|---|---|
| **Parameter** | **Description** | **Target** | **Risk** | **Compliance** |
| 1 | Fun | Positive user feedback (based on testing and interviews) | High | Sponsor satisfaction |
| 2 | Educational | Positive user feedback (must relate to common intuition) | High | Testing |
| 3 | Clarity | Positive user feedback (must be easy to read/understand) | High | Testing |
| 4 | Kiosk Depth | Maximum 1 foot | Med | Measured |
| 5 | Display Height | Maximum 28 inches | Med | Measured |
| 6 | Aesthetics | Positive user feedback (color, shape, etc.) | Med | Sponsor satisfaction |
| 7 | Ease of Use | 3 button maximum | Med | Measured |
| 8 | Life Expectancy | 10 years | Med | Testing |
| 9 | Power Consumption | Operate on 120V 60Hz AC circuit | Low | Testing |

| Cumulative Energy Display | | | | |
|---|---|---|---|---|
| **Parameter** | **Description** | **Target** | **Risk** | **Compliance** |
| 1 | Screen Size | Minimum text size of 4 inches | Med | Measured |
| 2 | Easy to Operate | Must be intuitive to use and quick to learn | Med | Sponsor satisfaction |
| 3 | Quick to update | Must be updateable within 30 seconds per meter | Med | Testing |

III. Electronics Requirements

## Program

*Functionality*

The children at the exhibit vary in age and the program will need to accommodate for different level of skills. The program should be simple enough for children of age 5 to participate and interactive enough for children 12 years old to be entertained. The action keys should not exceed four separate buttons and should enable basic actions. The entry of the information should only resemble number forms to minimize the complexity for the children.

*Robustness*

The kiosk will undergo stresses different from those normally exposed to in adult environments. Children will have the tendency to press multiple keys simultaneously and repetitiously. These actions will need to be limited throughout the program thus restricting user inputs. Additionally, the program will cycle through hundreds of times per day and need to be optimized to accommodate such stresses. Larger programs might bog down over long periods as apposed to light programs that do not.

*Accurate Information*

The information provided by the kiosk needs to be accurate. The translation of the different energy equations to algorithms the computer recognizes needs to be accurate. The use of global variables will need to be taken into account because of the different computer language. Additionally, variable declarations need to accommodate for a range of values. Some values may be in the decimal range and other may extend into the several million.

*Cross Platform*

The program needs to be easily executable on a pc. The primary people that are supporting the program are the employs at the children museum. To run the program should be as simple as turning on the pc and then pressing a particular icon. Additionally, the program needs to accommodate for images created on Adobe Illustrator. The graphics design team is a separate entity from the senior project team.

*Hardware*

The program’s output needs to be suited for a 23” HD monitor at a resolution of 1920x1080. This will be reflected in the number of pixels and quality of the images to be exported into the program. Additionally, the program will need to support an input from the keypad in ASCII form.

## Keypad

*Keypad Durability*

Children will be interacting with this exhibit on the daily basis. Because of the high stress environment for the exhibit, all the parts need to be durable. The standard for measuring the level of protection a particular item can resist is the IP Code (International Protection Rating).

The first category to look at is the protection against foreign bodies (Table 2). The greater the number the more resistant the keypad will be against foreign bodies. As indicated before, the exhibit will be used on the daily basis for an extended duration and will need to be protected from numerous objects (dirt, clay, pencils, etc.). Level 6 will be the appropriate level of protection with the aforementioned considerations.

Table 2 – Degrees of Protection (Foreign Bodies) (Bourns Inc.)

| IP Level 1st Digit | Description of Protection Level |
|---|---|
| 0 | Not protected |
| 1 | Protected against solid foreign objects of 50 mm diameter and greater |
| 2 | Protected against solid foreign objects of 12,5 mm diameter and greater |
| 3 | Protected against solid foreign objects of 2,5 mm diameter and greater |
| 4 | Protected against solid foreign objects of 1,0 mm diameter and greater |
| 5 | Protected from the amount of dust that would interfere with normal operation |
| 6 | Dust tight |

The second category to look at is the protection against moisture (Table 3). The greater the number the more resistant the keypad will be against moisture. The exhibit will be used on the daily basis for an extended duration and will need to be protected from any potential exposure of liquids. The museum often exposes children to different liquids like soap and water that has the potential of entering our exhibit. The most common exposure of these liquids will be from the children's hands when pressing the keys. Level 4 will be the appropriate level of protection with the aforementioned considerations.

Table 3 – Degrees of Protection (Moisture) (Bourns Inc.)

| IP Level 2nd Digit | Description of Protection Level |
|---|---|
| 0 | Not protected |
| 1 | Protected against vertically falling water drops |
| 2 | Protected against vertically falling water drops when enclosure is tilted up to 15° |
| 3 | Protected against water sprayed at an angle up to 60° on either side of the vertical |
| 4 | Protected against water splashed against the component from any direction |
| 5 | Protected against water projected in jets from any direction |
| 6 | Protected against water projected in powerful jets from any direction |
| 7 | Protected against temporary immersion in water |
| 8 | Protected against continuous immersion in water, or as specified by the user |

The standard convention for IP Coding is seen in Figure 2. With the given information above, the minimum IP Code we are looking for is IP 64. This will prevent any moisture or foreign objects from entering the keypad unexpectedly, enabling the exhibit to work functionally for an extended amount of time.

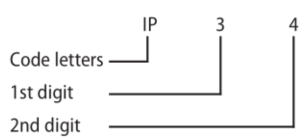



Figure 2 – IP Coding Convention (Bourns Inc.)

*Hardware Interface*

The keypad needs to be able to interface with the Energy of Motion program on the computer. The computer

has the multiple input ports available to receive data. The two most common are the USB and RS-232 serial port. Additionally, all the different parts need to be powered by a standard wall outlet.

*Software Interface*
The keypad needs to be able to interface with the Energy of Motion program on the computer. The keypad needs to produce a signal that the computer can translate into ASCII characters. The selected mapped characters need to avoid the escape and enter key. These are reserved keys in the program that exits the program and continues the program respectively. These will need to be remapped and not conflict with existing codes.

## Audio
The speakers need to be loud enough to overcome the ambient sounds at the children's museum. At the same time the exhibit needs to be quite enough to not interfere with the sounds being introduced by the other exhibits. The standard to determine the level of sound is dB (A).

"The dB(A) system says, that the sound pressure at the most audible frequencies are to be multiplied by high numbers while the less audible frequencies are multiplied by low numbers, and everything is then added up to get an index number." (www.windpower.org)

| Sound Level | Threshold of Hearing | Whisper | Talking | City Traffic | Rock Concert | Jet Engine 10 m Away |
|---|---|---|---|---|---|---|
| dB(A) | 0 | 30 | 60 | 90 | 120 | 150 |

Table 4 – Audio dB (A) Range (www.windpower.org)

The index range (Table 4) places typical human voices between 30 and 90 dB. With regard to the range, we are looking for the loudest possible sound (with respect to dB (A)) without conflicting with the audio of another exhibit. To determine the general deterioration of the sound level we refer to the following Table 5.

**Sound Level by Distance from Source**

| Distance m | Sound Level Change dB(A) | Distance m | Sound Level Change dB(A) | Distance m | Sound Level Change dB(A) |
|---|---|---|---|---|---|
| 9 | -30 | 100 | -52 | 317 | -62 |
| 16 | -35 | 112 | -53 | 355 | -63 |
| 28 | -40 | 126 | -54 | 398 | -64 |
| 40 | -43 | 141 | -55 | 447 | -65 |
| 50 | -45 | 159 | -56 | 502 | -66 |
| 56 | -46 | 178 | -57 | 563 | -67 |
| 63 | -47 | 200 | -58 | 632 | -68 |
| 71 | -49 | 224 | -59 | 709 | -69 |
| 80 | -50 | 251 | -60 | 795 | -70 |
| 89 | -51 | 282 | -61 | 892 | -71 |

Table 5 – Deterioration of Sound Level Over Distance (www.windpower.org)

The distance of the closest exhibit (excluding ours) is approximately 16 meters away. The deterioration at this

distance as seen in Table 5 would be 35 dB less then the original. Basing the sound levels at the children's museum on "Talking" (Table 4), the sound level observed by the closest exhibit is 25 dB. This would fall within the same sound levels of "Whispering" (Table 4). The result of these calculations demonstrates the need for an amplifier and speaker to produce a sound level of 60 dB or greater.

To cover the largest area with sound and to enable stereo benefits, the kiosk will need to employ two speakers. Because of the size of the kiosk, the speakers will need to fit within a three-foot span. Additionally, the speaker will need to be mounted on a wooden surface.

The national average height for a child between 2 and 12 years of age can range between 35 and 61 inches (2000 CDC Growth Charts for the United States: Methods and Development, Page 39). The average height indicates to us the speakers would be most beneficial if pointed downwards to accommodate the wide range of heights. Additionally, aiming the speakers downward would increase the deterioration of sound levels, as indicated in Table 5. A suspended area above the display would be the idea location achieving desired height and angle.

## Chapter 4 Design Development

*Concepts:*

**Pedometers**

- *USB Pedometers*

  USB pedometer requires a USB cable to transport the data gathered in the pedometer to the kiosk. Figure 2 shows the USB connection on the bottom left side of the figure. As it can be seen below pedometers consist of multiple shapes, size, color, and weights. As a group we are aware that the end user will be children and therefore must be esthetically appealing to the children, because as the saying goes children will judge a book by its cover.

- *Non-USB Pedometers*

  A non-USB pedometer is shown below in Figure 3. But it is more important to realize that the main difference between these two pedometers is the use of a screen on the actual pedometer. This will be a key factor later in the decision process.

Figure 3. USB Pedometer
The black circle shows the where the USB will connect to the pedometer.


Figure 4. Non-USB Pedometer: The screen allows the user to keep track of the amount of steps user takes at all times.

**Themes**

All aspects of the exhibit will have a theme that ties them all together. The entire exhibit has to be eye catching

*Possible themes:*

- Super heroes
- Cartoon characters
- Nature
- Fireworks with lots of light
- Cars
- No theme and something with lots of lights and pictures.
- A running experiment

**Carrying Device**

- *Belt*

A belt like the one shown in Figure 4 was sketched as a possible solution. The belt would click on to the user using a clip like the one shown below (Figure 5). This type of clip was preferred because it's easy of use and it would allow the belt to be simply adjusted to multiple users, regardless of size. A pouch (shown in Figure 6) would also be attached to the belt, which would carry the pedometer and also serve as a case and protect the pedometer. The case would be allowed to move around the belt, to better suit the user. The case would also have a see through screen, so the display of the pedometer could be seen by the user (assuming it is a non-USB pedometer), without taking out the pedometer of its case. The pedometer would be fixed to the case, and only accessible to the employees with a special tool, to prevent the users from getting into it.

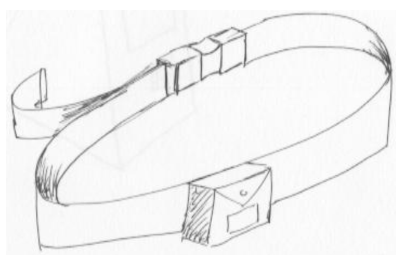


Figure 5. Belt with pouch concept

Figure 6. Clip concept for belt buckle.

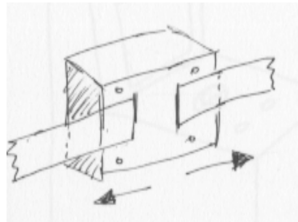


Figure 7. Pouch for pedometer concept. The pouch will be able to slide anywhere along the belt, allowing for easy adjustment.

- *Clip*

  Attaching the pedometer to the user with a metal clip placed on the back of the pedometer was another solution (Figure 7). The clip would attach itself to any piece of garment on the user.
- *Pocket*

  A very simple solution that was considered was to give a pedometer to each user and allow them to put it in their pocket.

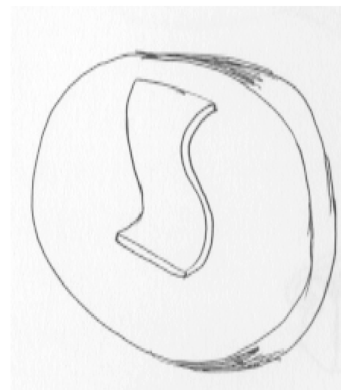


Figure 8. Clip Concept for Pedometer.

**Kiosk**

It has been considered that the kiosk will ask for an age in order to properly calibrate the distance walked by the user. This will only be an estimate to give the user a more accurate reading of the energy used while in the facility. As noted before, we are expecting a 30% error in the final values of energy usage given by the kiosk. The size of the kiosk is limited to two different locations in the museum, which will be decided later. The screen of the kiosk will be at eye level for an average seven-year-old child. Several options for the design of the kiosk have been considered and are listed below:

- *Arcade (Non-USB)*

  In this concept of the kiosk, the kiosk will look very similar to an arcade game system. As seen in Figure 8. It will be installed with a heavy-duty industrial keypad that will have numbers 1-9 and possibly two other buttons to help scroll through the energy presentation. The numbers will be used so that the user will input age and the step taken in the museum, which he or she will grab from the pedometer attached to them. Keeping in mind the program will prompt the user when to input what.

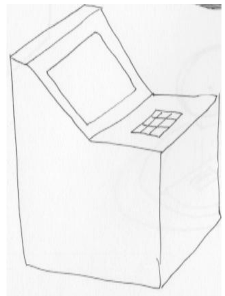


Figure 9.  Arcade concept for kiosk

- *ATM (Non-USB)*

  Everything will remain and work the same as the arcade concept. The only difference in these two concepts is the esthetics as it can be seen above.  Figure 9 is squarer and much more looking like an ATM machine.

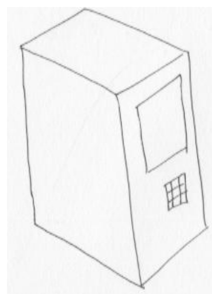


Figure 10.  ATM concept for Kiosk

- *Arcade (USB)*

  This concept (shown in Figure 10) is very different from the other ones, because everything is automated with the exception of the user plugging in his or her pedometer into the kiosk.  The kiosk will have a docking station for the pedometer, and a maximum of two buttons to help the user scroll through the learning experience.  Once the pedometer in connected to the kiosk, it will automatically download the information in the pedometer and prompt the user on the energy he or her have used in the museum.  As seen below two possible ways of connecting the pedometer to the kiosk have been thought of.

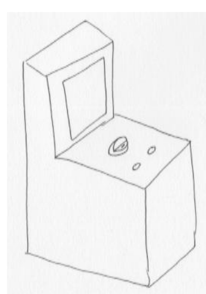


Figure 11.  Arcade Concept for USB Pedometer for kiosk.

Figure 11 shows how the USB pedometer can connect to the kiosk. The left drawing uses a USB cable, where the cable would be permanently be attached to the pedometer, and the free end of the cable will be used to plug into the kiosk. The right drawing illustrates that the pedometer will actually be docked onto the kiosk, without the use of any cables.

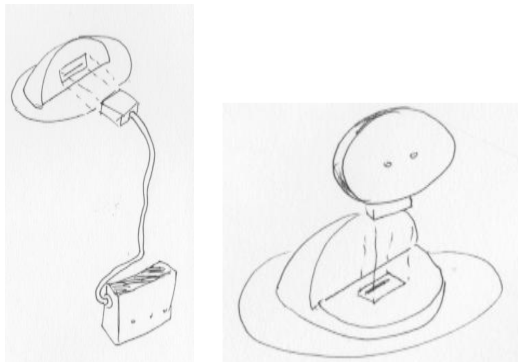


Figure 12. Attachment concepts for USB Pedometer to Kiosk. The left drawing allows the pedometer to connect to the kiosk through a USB cord. The right drawing allows the pedometer to directly dock to the kiosk.

**Content in Kiosk**

The content in the kiosk will be presented and organized in following order:

1. What the user could power:

| | | | | | | |
|---|---|---|---|---|---|---|
| Light bulb | Cell phone | iPod | Dishwasher | Clock | Radio | Can opener |
| Washing Machine | Blender | Toaster | Coffee Maker | Fan | Nintendo | Xbox |
| Sewing Machine | Laptop Computer | Blow Dryer | Microwave Oven | Desktop Computer | Television | DVD Player |

2. What the user needs to eat to expect that much energy:

| | | | | | | |
|---|---|---|---|---|---|---|
| Peanuts | Almonds | M&M's | Hamburger | Hot Dog | Steak | Ham and Cheese Sandwich |
| Rice | Apples | Oranges | Bananas | Beans | Chocolate | Macaroni and Cheese |
| Cookies | Spaghetti | Pickles | Artichokes | Broccoli | Pizza | Milk |

3. In real life what would it take to power what they have powered:

| | | |
|---|---|---|
| Solar Arrays | Nuclear Power Plant | Coal fired power plant |
| Geothermal Power | Windmills | Hydroelectric |

4. How many kids would it take to power a larger scale energy application:
   - Drive a car to the beach
   - Mow the lawn
   - Play a game of Football/basketball/soccer
   - Fly an airplane to Las Vegas
   - Take the train to Disneyland
   - Power the Empire State Building
   - Air condition your home / heat your pool
   - Run a marathon
   - Launch a rocket to outer space
   - Power the electricity at the SLO Children's Museum
   - Fly a helicopter to San Francisco
   - etc.

The information on the screen will be relative to what the user is familiar with.

**Cumulative Energy Display**
The Cumulative Energy Display will display the energy usage of an entire year, as stated before, so it was important that the display be a large one. The two options we came up were the scrolling LED display (Figure 12) and the LCD display (Figure 13). To add the steps in the Cumulative Energy Display, either the user or employee will type it in. This would be attained by either connecting the kiosk with the Cumulative Energy Display or adding a separate keypad to the Cumulative Energy Display and do it manually.


Figure 13. Scrolling LED Display concept for Cumulative Energy Display

Figure 14. LCD concept for Cumulative Energy Display

*Decision Process:*
For the pedometers, there were 3 types to consider, a hairline spring pedometer, an accelerometer pedometer, and a GPS pedometer. Also, each of these could either be a USB or Non-USB pedometer. Average hairspring pedometers have an expected lifespan of 1 million steps. We expect a maximum average of 3000 steps a day per pedometer. This equates to about a year of life per pedometer if we go with the spring driven version. This short lifespan combined with the expensive cost of USB pedometers (about 24 dollars per unit) and the fragile connectors involved will make maintenance costs very high over a 10 year period.

Another option is to go with a more dependable accelerometer driven pedometer. We estimate these will last approximately 5 years, but they are much more expensive to purchase (about 60 dollars per unit) and we still will run into problems with the USB connectors failing due to repeated abuse. The total cost here will be lower than the spring driven USB pedometer but will still be very high.
A third option is to buy non-USB pedometers. We can expect a similar lifespan to the USB equivalent, about one year, but cost per unit of a non-USB pedometer is about 4 dollars versus 25. This will make the cost of maintaining 150 pedometers at the exhibit over 10 years much lower and more manageable.

In order to decide on the best concept for the pedometer, a pros and cons list was created to see the advantages between a USB Pedometer and a Non-USB pedometer (shown in Table 3). Also, a cost analysis was done on the Non-USB pedometer, the spring USB Pedometer, and an accelerometer USB pedometer (shown in Table 4). The following tables show the pros and cons list and the cost analysis of the different pedometers.

Table 6. Pros and cons list for the USB and the Non-USB pedometer.

| **USB Specific** | | **Universal Non-USB** | |
|---|---|---|---|
| For (+) | Against (-) | For (+) | Against (-) |
| Automatic Data entry | Limited interaction | High user interaction (Entertainment) | Highly sensitive & fragile |
| 2 Button Max (kiosk) | Pedometer specific software | Various types of pedometers | Too many buttons |
| Easy access | Fragile electrical parts | No External Connections | Employee interaction |
| | High maintenance | Easier to replace | Life span of 5 years not guaranteed |
| | Very expensive ($25) | Inexpensive/ Highly accessible | |
| | Not durable | Easier to operate | |
| | Life of 5 years not guaranteed | | |

Table 7. Cost Analysis table of USB (Spring) Pedometer, USB (Accelerometer) Pedometer, and Non-USB (Spring) Pedometer.

| | Cost per unit ($) | Cost for 150 units ($) | How long it will last (based on 365 days) | Length of time at museum | Replacement | Cost after 10 years ($) |
|---|---|---|---|---|---|---|
| USB Pedometer (spring) | 24 | 3600 | 1 year | 10 years | once every year | 36000 |
| USB Pedometer (accelerometer) | 60 | 9000 | 5 years | 10 years | once every 5 years | 18000 |
| Non USB Pedometer (spring) | 4.05 | 607.5 | 1 year | 10 years | once every 1 year | 6075 |

*Assuming each pedometer is used every day with about 3000 steps per day, spring pedometer has life cycle of 1 million steps
**Realistically, expecting half usage=> half the cost

Based on this analysis, the Non-USB pedometer seemed like the best choice. However, there were many other concepts for the design of the other components, such as the kiosk and the cumulative energy display. To determine the best concept, a decision matrix was created for each component, such as the kiosk, the cumulative energy display, the pedometer, and the attachment of the pedometer to the user. Table 5 shows the decision matrix for the pedometer. Table 6 shows the decision matrix for the kiosk. Table 7 shows the decision matrix for the Cumulative Energy Display. For all three decision matrices, much weight was given to the life span, durability, aesthetics, maintenance, safety, learning experience, interaction, simplicity, ease of use battery life, and cost.

Table 8. Decision Matrix for Pedometer. The USB and the Non-USB pedometer were evaluated as well as the way the pedometer would be attached to the user (clipped onto the user, clipped onto a belt, or placed in a pouch on a belt). The highlighted number is the highest total among the concepts.

| **Pedometer** | **USB** | | | **Non USB (w/screen)** | | |
|---|---|---|---|---|---|---|
| | Clip on Pants | Clip w/Belt | Belt w/"Pouch" | Clip on Pants | Clip w/Belt | Belt w/"Pouch" |
| Life Span (5) | 1 | 3 | 5 | 1 | 3 | 5 |
| Durability (5) | 1 | 2 | 5 | 1 | 2 | 5 |
| Aesthetics (5) | 3 | 2 | 4 | 3 | 2 | 4 |
| Maintenance (5) | 2 | 3 | 5 | 2 | 3 | 5 |
| Safety (5) | 4 | 4 | 5 | 4 | 4 | 5 |
| Learning Experience (5) | 2 | 2 | 2 | 4 | 4 | 4 |
| Interaction (5) | 2 | 2 | 2 | 4 | 4 | 4 |
| Simplicity (5) | 1 | 1 | 1 | 3 | 3 | 4 |
| Ease of Use (5) | 5 | 5 | 5 | 5 | 5 | 5 |
| Battery Life (5) | 3 | 3 | 3 | 3 | 3 | 3 |
| Cost (5) | 3 | 3 | 3 | 4 | 4 | 4 |
| Reliability (4) | 2 | 3 | 4 | 2 | 3 | 4 |
| Size (4) | 1 | 1 | 1 | 1 | 1 | 1 |
| Shape (3) | 1 | 1 | 1 | 1 | 1 | 1 |
| Exchangeable Parts (3) | 0 | 0 | 0 | 5 | 5 | 5 |
| Materials (2) | 4 | 3 | 2 | 4 | 3 | 2 |
| Water Proof (1) | 0 | 0 | 5 | 0 | 0 | 5 |
| Weight (1) | 1 | 1 | 1 | 1 | 1 | 1 |
| Sum = | 159 | 176 | 233 | 209 | 226 | 288 |

Table 9. Decision Matrix for Kiosk. There were only 2 concepts for the Kiosk, the ATM style and the arcade style. The highlighted number is the highest total among the concepts.

| Kiosk | ATM Style | Arcade Style |
|---|---|---|
| Life Span (5) | 5 | 5 |
| Durability (5) | 5 | 5 |
| Aesthetics (5) | 3 | 5 |
| Maintainance (5) | 5 | 5 |
| Safety (5) | 5 | 5 |
| Learning Experience (5) | 4 | 5 |
| Interaction (5) | 3 | 5 |
| Simplicity (5) | 5 | 5 |
| Ease of Use (5) | 5 | 4 |
| Battery Life (5) | 5 | 5 |
| Cost (5) | 3 | 3 |
| Reliability (4) | 5 | 5 |
| Size (4) | 5 | 5 |
| Shape (3) | 5 | 5 |
| Exchangeable Parts (3) | 0 | 0 |
| Materials (2) | 3 | 2 |
| Water Proof (1) | 5 | 5 |
| Sum = | 306 | 324 |

Table 10. Decision Matrix for Cumulative Energy Display. There only two concepts for the cumulative energy display, a LCD monitor and a scrolling LED display. The highlighted number is the highest total among the concepts.

| Display | LCD Display | Scrolling LED Display |
|---|---|---|
| Life Span (5) | 5 | 5 |
| Aesthetics (5) | 5 | 5 |
| Maintenance (5) | 3 | 5 |
| Safety (5) | 5 | 5 |
| Learning Experience (5) | 5 | 5 |
| Interaction (5) | 5 | 5 |
| Simplicity (5) | 4 | 4 |
| Ease of Use (5) | 3 | 5 |
| Battery Life (5) | 5 | 5 |
| Cost (5) | 2 | 4 |
| Reliability (4) | 4 | 4 |
| Size (4) | 5 | 5 |
| Shape (3) | 5 | 5 |
| Materials (2) | 3 | 3 |
| Sum = | 267 | 297 |

*Design Development:*
From the decision matrices, cost analysis, and pros-and-cons list, the best concepts for the each component are as follows:

The best concept for the pedometer is a Non-USB pedometer placed inside a pouch attached onto a belt, as seen in Figure 1.  The pouch protects the pedometer from wear and tear, adding to the life span and durability of the pedometer. However, designing a pouch that would prevent children from accessing the pedometer, and yet allowing the staff members at the children’s museum to have easy access to the pedometer was a challenge. Therefore, the team found an alternative solution. The team decided to attach the pedometer to the belt solely with rivets. Rivets are safe, durable and affordable. In order to prevent children from re-setting the pedometer, the team decided to install a button blocker. The button blocker is a cap that fits over the button with a pin-hole at the top. This will allow staff members to re-set the pedometers using a pin to reset the pedometer. Non-USB pedometers are very affordable and easily replaceable as long as the pedometer has a screen to show the information that the child will have to type.

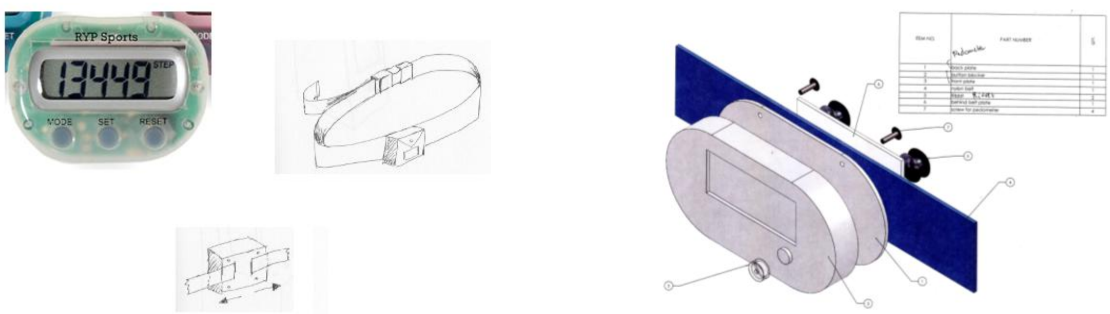



Figure 15. Non-USB pedometer with belt and pouch concept (Left) and rivets (Right)

Currently, the best kiosk concept is the arcade concept as seen in Figure 2.  Although the decision matrix points to an arcade type of set up, further statistical data will be taken to determine the actual aesthetics and interaction of the kiosk.  The kiosk is the key piece of the exhibit, as it will provide the experience and interaction for the children to learn about energy.  Therefore, further consideration must be given to the kiosk before the proper concept is finalized.

Figure 16. Arcade Concept for kiosk.

The best cumulative energy display (CED) concept is the scrolling LED display. The cumulative energy display only needs to add up the energy that each child has used in the museum and display that total. The CED will be connected to a computer that will hold all the information required to program the display. Since the scrolling LED display is cheap and easy to use, it was the best concept because of the simplicity of this component of the project.


Figure 17. Scrolling LED display concept for cumulative energy display

With the majority of the hardware concept decisions made, it is now important to further develop the interactive information within the software of the kiosk. The content information will be gathered over time through focus groups and brainstorming sessions with kids, as well as from statistical data and research. Then we will narrow down all the relevant energy applications to a smaller number of ideas that will be designed in detail for the exhibit. Potentially, there will be several energy levels. So if one child walks 1000 steps, he will be given content relating to that energy level (say 1000-2000). Within each energy level there will be several randomly generated lessons that could possibly come up. It is important that each energy lesson be designed in detail in order to offer the most valuable learning experience. This is the main design aspect of this project and development is ongoing.

## Program

*Programming Language Selection*

The most important factors when trying to select a language were the ease of coding and allowance of graphic intensive artwork. The first issue of "ease of coding" arises from the time constriction of the project and the learning curve needed for a new language. The second issue of "allowance of graphic intensive artwork" comes from the necessity of graphically stimulating the children at the museum. After both were taking into consideration Adobe Flash Action Scripting 3 was selected. This combined the simplicity of the scripting language and the allowance of incorporating Illustrator files.

*Development*

The most important part of creating the program was being able to find a simple flow diagram to follow. Figure 1 demonstrates the general functionality requested by the museum. Programming the fundamentals was implemented and then individual features were added on to the program one at a time. This would ensure the isolation of any particular problems and allow for a strategic modular path of completion.

## Keypad

The project started from the simple idea of trying to connect a USB keypad to the computer. After

doing research, there were none that would comply with the industrial standard we needed. We then looked towards keypads designed for kiosks. These added steps of having to deal with needed power supplies, serial interfaces and an encoder added to the complexity of the interface. There was additional software needed in order for all the different parts to interact with the program.

### Audio

The development of the system started off with the use of over the counter computer speakers. These were found to not meet the minimum durability standards and could not be placed in the exhibit in an aesthetic manner. The system then progressed to more durable car speakers that could be mounted directly into the top portion of the exhibit. This required an amplifier and audio wire converter to output equivalent audio.

## Chapter 5 Description of Final Design

*Design Description:*

**Overall Experience Description:**

The Energy of Motion Experience begins when the visitors first enter the museum. At the front desk, they will be issued energy meters to wear during their visit. They will then proceed through the museum, visiting all of the various exhibits and interactive displays within the museum. The physical movement of the visitors will be counted by the energy meters and displayed on the screen.

At the end of the visit, the kids will approach the energy information kiosk, where they will input their age and the number of steps displayed on their energy meter screen. The kiosk will then run the energy information presentation in order to relate their energy expenditure to items and applications that they understand. The presentation will contain stunning graphics and be narrated with audio and subtitles displayed on the screen to accommodate users of all ages and interests.

After the presentation is over, the user will be instructed to return his/her energy meter to the receptacle at the front desk. Here, a staff member will record the total number of steps and input it to the Cumulative Energy Display for all to see.

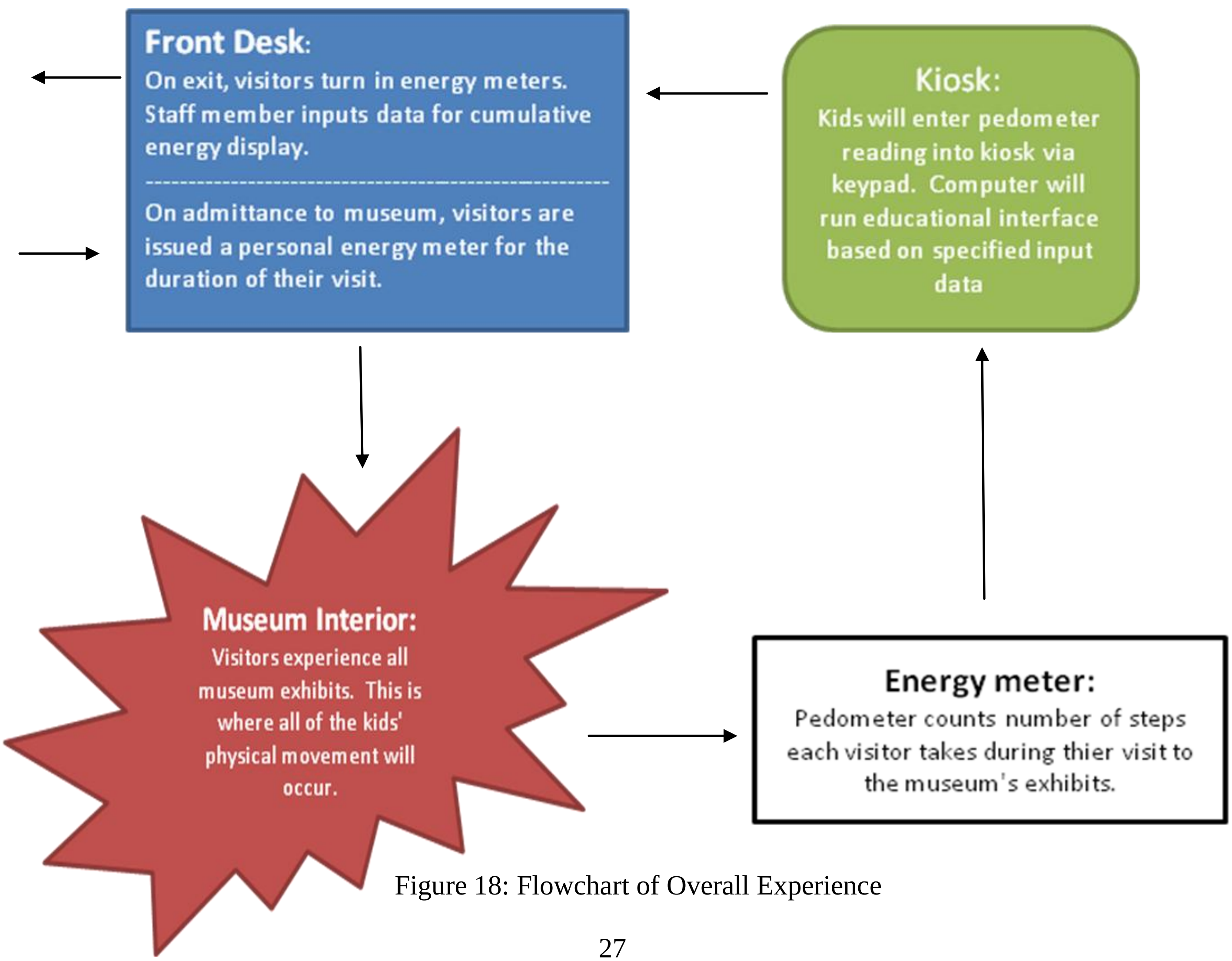



Figure 18: Flowchart of Overall Experience

**Content Structure Description**
The most complex aspect of our design is the layout and flow of the educational content within the kiosk. The computer will have a program that will help teach children about energy. When a child with a pedometer is about to leave the museum, he or she will approach the kiosk. The introduction slide, shown below, will be displayed.

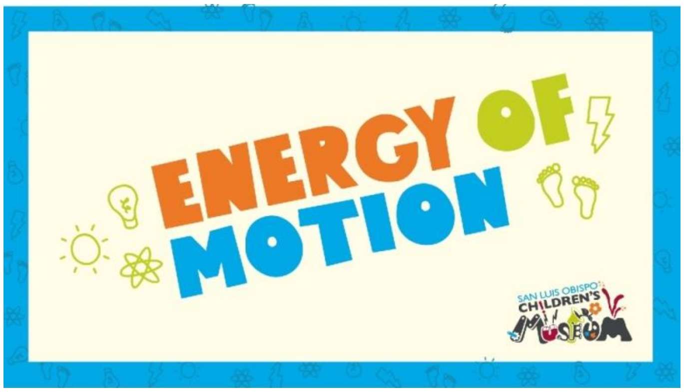



Figure 19. Energy of Motion Introduction Slide

The instruction sheet shown below will be placed on top of the monitor screen that will show the child how to navigate through the program.

**INSTRUCTIONS**

Press ENTER to begin and to go to the next screen

Press CLEAR if you made a mistake and need to enter a new number

Press CANCEL to go back to the home screen

Have Fun!

The child will press the green “ENTER” button on the keypad. This will prompt the program to begin. A friendly greeting will welcome the child to the exhibit and will tell them to enter the number of steps found on their pedometer, shown in the slide below. It will also tell them to continue navigating through the program using the same green “ENTER” button they used to begin the program.


Figure 20. Pedometer Number Slide

Once the child enters the number of steps, the voice will prompt the user to enter their age and the slide below will be displayed.


Figure 21. Age Slide

Recall from the analysis section, that the number of steps and age are the only inputs to run the program and teach kids about energy. The program will then run four presentations (food, small and large scale, and power plant applications) that will relate the energy produced by the child to a particular energy application. The first application presentation that will be shown is the food application. The monitor will display one of the eight random food items that were selected from the food applications that has the same energy in kilocalories as the amount of energy they produced while visiting the museum. Here is an example of one of the eight food application slides installed in the program that a child will see:


Figure 22. Food Application Slide

Next, the program will randomly select one of the eight small scale applications and tell the child how long they could power that electrical appliance in seconds. Here is one of the eight small scale application slides installed in the program that a child will see:

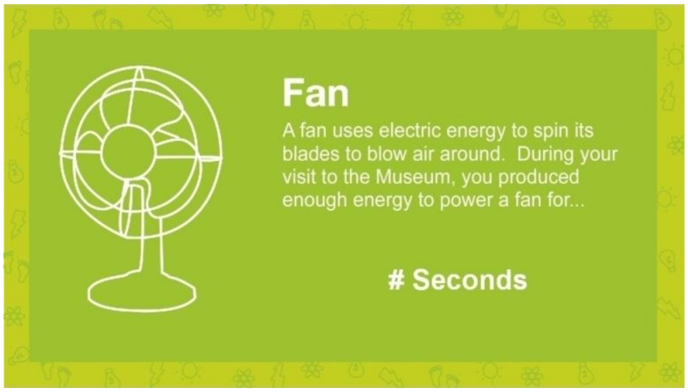



Figure 23. Small Scale Application Slide

Next, the program will show a large scale application. It will randomly select one of the eight large scale applications and will tell the child how many children, with the same energy the child produced during their visit, it will take to power that application. Here is one of the eight large application slides installed in the program that a child will see:


Figure 24 Large Scale Application Slide

Finally, the program will randomly select one of the seven power plant applications and will tell the child how many children, with the same energy the child produced during their visit, it will take to power that application. Here is one of six power plant application slides installed in the program a child will see:

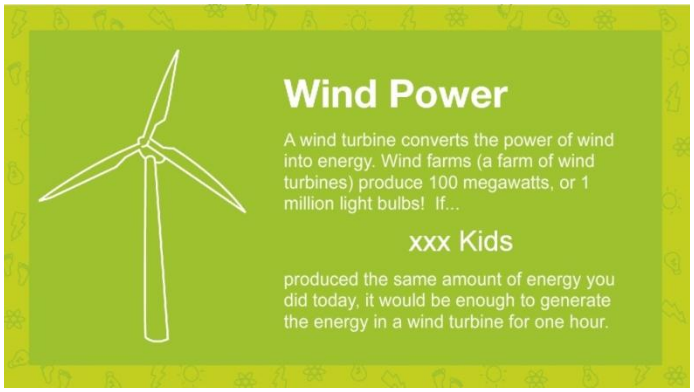



Figure 25. Power Plant Application Slide

The last slide is a closing slide with the name of the senior project team members.


Figure 26. Credits slide

**Content Design Description**
Arguably, the most important part of this project is to convey the educational material to the user through the content of the kiosk presentations. After the user enters his or her age and number of steps walked into the kiosk using the keypad provided, the program will run an appropriate presentation to fit the energy spent. Each presentation will consist of four unique energy applications:

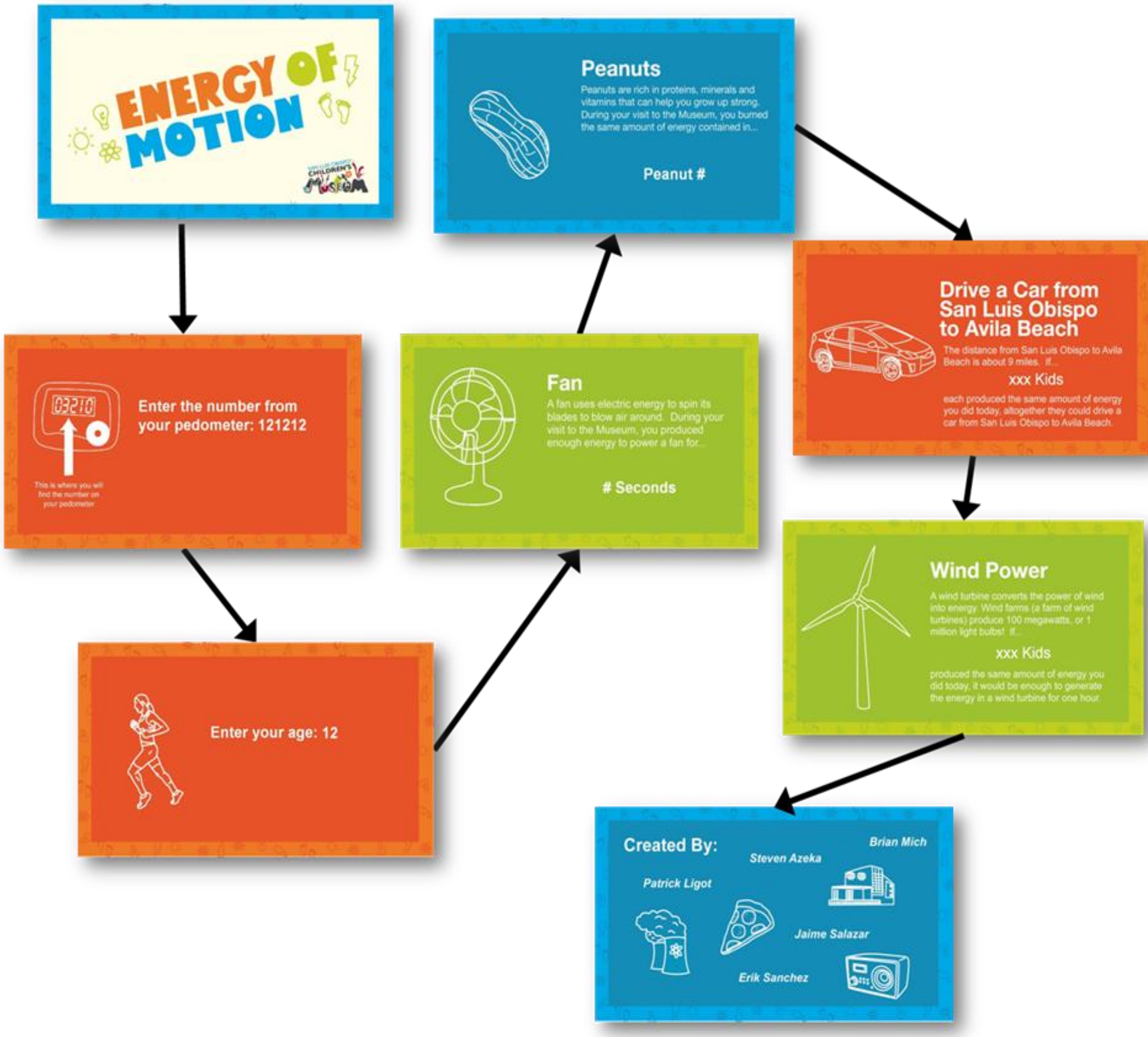
- An application illustrating a common electronic device and the amount of time it could be powered using the energy the user spent.
- A larger scale application showing how many users would be needed to accomplish some feat with the energy spent. Example: It would take 1000 kids to create enough energy to power a car from your house to the SLO Children's museum.
- A food energy application showing a food item that contains the amount of energy the user spent.
- A 'real world' application that shows the user how commercial power is produced and on what scale.

Each presentation will also contain 5 non-unique slides to be used in every presentation:

- A slide to introduce the exhibit. This slide will also prompt the user for his/her age and the number of steps taken at the museum.
- A slide that defines the concept of energy and introduces its common units, Watt-hours. This slide will also display the number of Watt-hours spent at the museum.
- A slide that defines the concept of food energy and introduces its common units, Calories. This slide will display the number of Calories spent at the museum.
- A conclusion slide telling the user how to return the energy meters and to thank him/her for visiting.

Gathering the information for the presentations and designing each slide will be the biggest chunk of design work for this project. Energy calculations need to be made for 80 unique application slides. Voiceover and graphic work also needs to be considered for the content.

Figure 27. Sample presentation flowchart



**Cumulative Energy Display (CED) Interaction Description**
Another user we need to consider in the design of this project is the staff that will be updating the Cumulative Energy Display. It is important to design an efficient process for adding energy data to the CED system and having it displayed quickly and accurately.

The process begins when the user returns at the end of their visit to the museum and hands in his/her energy meter. The meters will be deposited in a collection bin. The staff member will at some point during his/her shift, enter the number of steps displayed on each pedometer into the computer system where it will be automatically converted to energy and added to the current total of energy displayed on the CED screen for all to see.

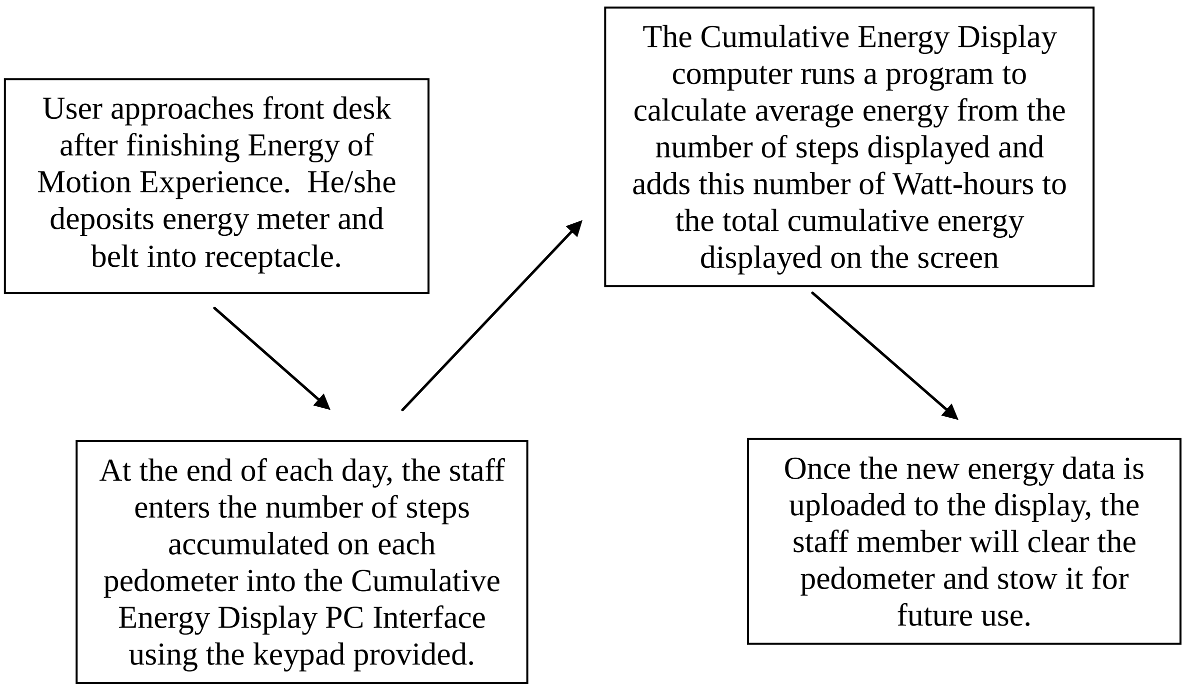



Figure28: Flowchart of CED interaction

*Analysis:*

**Converting steps walked to energy spent**

According to the Health Science and Technology Academy, the total amount of energy (kcal) burned while walking for a specific amount of time (hr) at various speeds can be determined using the following:

- At 3 mph (moderate pace, level surface): 1.5 kcal/(lb*hr)
- At 3.5 mph (brisk pace, level surface): 1.73 kcal/(lb*hr)
- At 4 mph (very brisk pace), level surface): 2.27 kcal/(lb*hr)

For the project, we assumed the children and adults will be walking at 4 mph to get higher energy values. The following equation was used to find the energy produced by people:

Energy (kcal) = Energy Expenditure kcal/(lb*mi) x Weight (lb) x Distance Walked (mi)

- Energy Expenditure = .57 kcal/(lb*mi)
- Weight = Given (lb)
- Distance Walked = [(Stride) x (# of Steps)] (ft) x $\frac{1\ mile}{5280\ ft}$
    - Stride = (.414 x Height, ft)

Distance Walked = [(.414 x Height, ft) x (# of Steps)] (ft) x $\frac{1\ mile}{5280\ ft}$

Therefore,

Energy (kcal) = .57 kcal/(lb*mi) x Weight (lb) x Distance (mi)

Energy (kcal) = .57 kcal/(lb*mi) x Weight (lb) x [(.414 x Height, ft) x (# of Steps)] / 5280

Simplifying, we get:

Energy (kcal) = Weight (lb) x Height (ft) x (# of Steps) / 22375

Therefore, the energy expenditure of children in kilocalories is a function of three variables: weight, height, and number of steps walked. The steps were determined by the number displayed on the pedometer, so the weight and height of children needed to be determined. A pediatric chart was used to find the average weight and height for people ages two through twenty. Table 7 shows the average weight in pounds and height in feet based on children's age.

Table 11. Growth Chart Data for Boys and Girls

| Age (yrs) | Weight (lb) | Height (ft) |
|---|---|---|
| ≤ 2 | 26 | 2.69 |
| 3 | 32 | 2.92 |
| 4 | 36 | 3.20 |
| 5 | 41 | 3.44 |
| 6 | 45 | 3.64 |
| 7 | 51 | 3.82 |
| 8 | 56 | 3.96 |
| 9 | 63 | 4.23 |
| 10 | 72 | 4.37 |
| 11 | 79 | 4.53 |
| 12 | 88 | 4.69 |
| 13 | 98 | 4.91 |
| 14 | 109 | 5.13 |
| 15 | 118 | 5.24 |
| 16 | 125 | 5.28 |
| 17 | 132 | 5.55 |
| 18 | 135 | 5.57 |
| 19 | 139 | 5.60 |
| ≥ 20 | 142 | 5.60 |

For simplicity, people older than 20 will have their averaged height and weight based on a 20 year old. Although the age and weight can vary tremendously for people older than 20, the programming for older people would be take too much time. This was discussed with our advisor and data for ages up to 20-year olds was sufficient.

The following equations for used for the remaining applications:

Food Applications: Energy (kcal) = Weight (lb) x Height (ft) x (# of Steps) / 22375
Small Scale Applications: Energy (Watt*s) = Energy (kcal) x 4184 W*s
Time (sec) = Energy (Watt) / Energy of Application (W)
Large Scale Applications: Energy (Watt*s) = Energy (kcal) x 4184 W*s
Power Plant Applications: Energy (Watt*s) = Energy (kcal) x 4184 W*s

If an 8 year old boy walks 3000 steps, he would input his age, 8, and the number of steps he walked at the museum (3000). So to determine the energy he walked, you would calculate the following:

Energy (kcal) = Weight (lb) x Height (ft) x (# of Steps) / 22375
Energy (kcal) = 56 (lb) x 3.96 (ft) x (3000 steps) / 22375
Energy = 29.73318436 = <u>30 kcal</u>

The boy produced or burned 30 kilocalories of energy during his visit at the museum.

**Relating energy spent to common energy applications**

Once the child's energy expenditure is determined, it is important to explain it in terms that they can easily understand. Four different applications will be used to describe their energy expenditure: small scale electrical applications, large scale electrical applications, food applications, and power plant applications. Here are the applications:

1. Relating energy expenditure to common electronic devices:

Table 12. Power Consumption of Electronic Devices

| Electronics | Power consumption |
|---|---|
| Blow dryer | 1000 watts |
| Cell Phone | 26.4 watts |
| Fan | 88 watts |
| Laptop Computer | 45 watts |
| Light Bulb | 60 watts |
| Microwave | 1000 watts |
| Radio | 15 watts |
| Toaster (GE.com) | 1000 watts |

2. Relating energy expenditure to food energy content:

Table 13. Energy Content of Various Foods

| Food Item | Energy Content (kcal/100g) | Energy Content per item |
|---|---|---|
| Apple | 12 | 16 |
| Banana | 49 | 69 |
| Chocolate Chip Cookie | 52 | 116 |
| Hot Dog | 89 | 105 |
| Orange | 270 | 324 |
| Peanuts | 305 | 137 |
| Pickles | 488 | 78 |
| Slice of Pepperoni Pizza | 89 | 105 |

3. Relating energy expenditure to energy production of various power plants:

Table 14. Power Plant Applications

| Power Plant | Consumption |
|---|---|
| Hydropower[1] | 2078 MW |
| Geothermal[2] | 80 MW |
| Nuclear[3] | 2200 MW |
| Solar[4] | 4 MW |
| Petroleum | 550 MW |
| Wind[5] | 100 MW |

[1] Hoover Dam Hydroelectric turbine, 2078 MW
[2] Geothermal, Calistoga geysers dry steam turbine, 80 MW (geoheat.oit.edu)

[3] Diablo Canyon Nuclear Power Plant, 2200 MW
[4] Solar, 3-5 MW for domestic arrays
[5] Wind farm near Lompoc, 100 MW

4. Relating energy expenditure to large scale energy applications:

Table 15. Energy Consumption of Large Scale Applications

| **Application** | **Energy (w-hr)** |
|---|---|
| Drive a car from SLO to Avila Beach[1] | 22600 |
| Heat a hot tub | 186000 w-h/month |
| Launch a rocket into space | 27.8E6 |
| Mow a lawn[2] | 2050 |
| Plane from SLO to San Francisco[3] | 195000 |
| Power Electricity at the museum for a day | 154000 |
| Run a marathon | 3345 |
| Train from SLO to Disneyland[4] | 4800000 |

[1] 100 hp vehicle driving at 30 mph. Distance to Avila Beach is approximately 9.1 miles
[2] 5.5 hp lawnmower. It takes half an hour to mow the lawn.
[3] Cesna Skyhawk plane with a single 180 hp engine at 120 knott cruise speed
[4] One 800 kW output GE Genesis locomotive. Distance is approximately 216 miles and takes 6 hours of travel time

*Safety:*
In addition to meeting the functional goals described previously, the entire Energy-of-Motion exhibit components must be designed to withstand heavy usage by children and also with child safety as the ultimate guiding factor. The system will be designed for use by children ages 5-12. Therefore, it is critical to design each part of the exhibit so they do not create a safety hazards.

The energy meters must be suitable for young children. Having a non-USB drive pedometer versus a USB-integrated pedometer will enhance the safety of the product. The design of the USB-port and electrical wiring of the latter would be critical in the safety aspect of the pedometer. The belt of the pedometer must be fabricated using a material that is user-friendly without any sharp edges and the clip of the belt must be designed so that it does not break easily, resulting in a tripping hazard or possibly a choking hazard for infants or toddlers.

Finally, the energy information kiosk and cumulative energy display will also be designed with safety as a primary consideration. They must have buttons suitable for children to play without risking injury. All electrical wiring must be inside the products so as not to create tripping hazard or risk of injury. The team must also consider the materials carefully so children will be able to use the exhibit safely. With these design considerations, the Energy-of-Motion Exhibit will be a fun, yet safe product that will be an asset to the museum.

*Components and Materials:*

**Costs**

Table 16. Energy Meter Costs

| Vendor | Part # | Part Name | Quantity | Description or size | Material | Price |
|---|---|---|---|---|---|---|
| Bodytronics | ECONOSTEP | Econostep Step Counter | 130 | Simple step-only operation, Counts steps up to 99,999 | Plastic | $487.50 |
| Bodytronics | PEDOBELT | Pedo-Belt Pedometer Belt | 130 | Soft Elastic belt with comfortable buckle | Nylon | $388.70 |
| iii Design | N/A | Sponsor label | 130 | Sticker for pedometer | N/A | Included in kiosk design |
| Home Depot | 23243 | Stanley MR55C5 Right Angle Riveter | 1 | Rivet pedometer to belt | Aluminum | $16.99 |
| Home Depot | 8859 | Rivets | 400 | 100 rivets per pack | Aluminum | $15.16 |
| OSH | N/A | Button Covers | 400 | -Covers reset button<br>-$.25 per button | Plastic | $100.00 |
| Testing | N/A | | | -What we've spent so far | | $300.00 |
| | | | | | Total: | $1,308.35 |

Table 17. Kiosk Costs

| Vendor | Part # | Part Name | Quantity | Description or size | Material | Price |
|---|---|---|---|---|---|---|
| securitystoreusa.com | 483692 | Essex KP-34K 12 Pad 3x4 Black Bezel | 1 | 5 1/8" x 3 3/8" x 7/16" | Stainless Steel | $191.88 |
| iii Design | N/A | *Skin and the slides for kiosk | 1 | Background and content for kiosk | N/A | $2,000.00 |
| Steve Gonzales | N/A | *Kiosk Casing | 1 | Casing for computer | Wood | $2,000.00 |
| newegg.com | N82E16883114077 | eMachines ET1831-01 Celeron 420 | 1 | - 3gb ram<br>- Celeron Processor<br>-VGA port | N/A | $354.23 |
| dell.com | N764H | Dell Refurbished S2209W 21.5-inch Full HD Widescreen Flat Panel | 1 | - 21.5" screen size monitor<br>- VGA connection | N/A | $157.58 |
| newegg.com | N82E16812119035 | Rosewill 6 ft. VGA Extension Coaxial cable | 1 | Connects PC to monitor | N/A | $5.99 |
| xtremegame-room.com | hp-58-9610-L | Red Convex Arcade Push Button | 1 | Reset button | Nylon Plastic | $2.90 |
| newegg.com | N82E16836113024 | ALTEC LANSING BXR1220 2.0 Speaker System | 1 | Speakers for Kiosk | N/A | $31.59 |
| | * estimate cost | | | | Total: | $4,744.17 |

Table 18. Cumulative Energy Display Costs

| Vendor | Part # | Part Name | Quantity | Description or size | Material | Price |
|---|---|---|---|---|---|---|
| Signs Direct | sd-7x80-S-OUT-RED | Ultra-Glow-2™ Semi-Outdoor Red 26.75" LED Sign | 1 | -26.75"x4.13"x2" -Scrolling characters 2" high -tallies up total energy used by kids | N/A | $184.11 |
| iii design | N/A | Sticker for accumulator | 1 | Background for accumulator | N/A | Included in Kiosk Design |
| Steve Gonzales | N/A | Brackets and screws | 4 | Holds border onto accumulator | steel | Included in Kiosk Design |
| Steve Gonzales | N/A | Border for accumulator | 1 | Place to put sticker for accumulator | wood | Included in Kiosk Design |
| Steve Azeka | N/A | *Microprocessor | 1 | interface to input energy totals (best case) | N/A | $200.00 |
| Newegg.com | N82E16834131048R | SAMSUNG N130-13B Slate Blue Intel Atom N270 | 1 | interface to input energy totals (worst case) | N/A | $251.99 |
| | * estimate cost | | | | Total: | $636.10 |

*Maintenance and Repair:*
Should any problems arise from the belt or pedometer, short of replacing the battery, both components can be replaced easily. The low price of the belt and pedometer make it more economical to just buy a new pedometer/belt rather than to take care of it. We recommend that the pedometer be replaced every year to ensure the best accuracy in counting steps since the spring life within the pedometer only lasts for a year. In any case, to replace the pedometer, take the pedometer off the belt and replace with another pedometer. Same goes for the belt. Replacement pedometers will be purchased from Bodytronics while materials for replacement belts will be purchased from NW Backpack Specialties. Finally, the team will consider making extra button blockers if they need to be replaced.

The frame of the kiosk will protect the computer from wear and tear. Since the computer will not be connected to the internet, viruses will not contaminate the computer. Therefore, the team suspects that any problems will come from a programming error or in correct input. In any case, to repair the programming a simple reboot of the computer should fix these problems. The kiosk keypad should be able to withstand any wear and tear since it is indestructible.

The scrolling LED display and the computer attached to it will be handled by staff only. Therefore, it will require very low maintenance since visitors in the museum will be unable to tamper with them. Technical problems such as a programming error or incorrect input are anticipated for the LED display and computer. These problems could be corrected by simply correcting the input. For a worst case scenario, a simple reboot should return the system to normal.

## Program

*Program Structure*

The program structure is reminiscent of a simple power point presentation. The foundations of each step can be seen in the Sample Presentation Flow Chart. The primary differences are going to be in the interactive experience and the random slides that offer a unique experience. The first slide is the welcome screen that states the title and sponsor of the exhibit. The next two slides require you to enter in personal information about the number of steps you have taken at the exhibit and your age. The final slides are categorized under four separate categories (small applications, food, large applications, and power applications) that are randomly chosen from an archive of eight slides per category. At the end is a credit with all of the senior project group member's names. This will then automatically continue back to the home screen.

*Program Flow Control*

The program will only continue during allotted times to prevent the children from continually pressing the button and speeding through the program unintentionally. The allotted time will begin after the audio narration. After the specified time the user will have the ability to enter in information, clear the information, return back to the home screen or continue to the next slide. If the user enters in a value of zero or fails to enter a value, the program will not continue until the user enters a correct value.

*Customized Output Text Values*

Each slide following the entry of steps and age will have a customized text value specific to the child's inputs. The number will be calculated based on user inputs and given constants associated with each slide. The units associated with each slide are seconds, quantities of a unit, or number of kids. Each time the user goes through the program a new set of values will be required to be entered.

*Audio Narration*

During each stage a narration will automatically play to explain the information on the screen and provide needed instructions. As stated before, the child will no be able to access any other information during this time. The ability to continue and play the right clip will depend on the random slide chosen during the program. An example, the hotdog audio with the appropriate time restriction for the narration will need to be applied during the hotdog visual slide. This will also require the correct hotdog output value to accompany it.

## Keypad

*Hardware System Overview*

A child at the exhibit needs to be able to enter information and control the program through the kiosk. The two primary inputs available for the exhibit are the keypad and the wall outlet. The keypad will enable the child to interact with the program (Figure 29). The wall outlet will provide the needed power to run the internal systems. The output of the system goes to a computer (Figure 29) that will read the signals produced by the internal systems. The two internal systems include the encoder and power supply (Figure 29). The encoder is what enables the input from the keypad to output a code that can be interpreted by the computer (ASCII). The power supply is what translates the power provided by the museum to the needed power of the encoder.

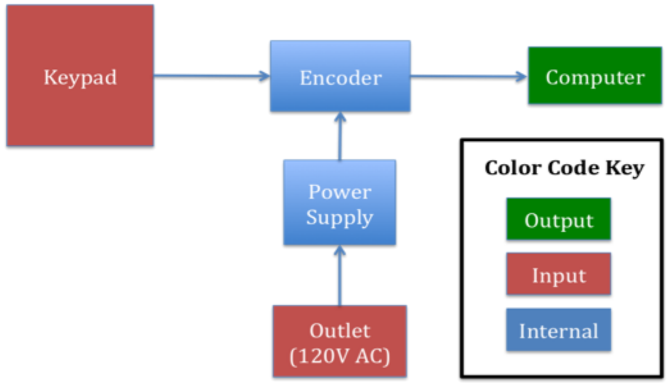


Figure 29. Hardware System Overview

*Software System Overview*
The signal produced by the encoder needs a way of being interpreted by the Energy of Motion Program (Figure 30). The encoder produces a signal that abides by the ASCII convention. Thus, each button on the keypad produces a different ASCII code. The redirection software (Figure 30) is what enables the ASCII code to be mapped as a keyboard event. The end functionality resembles a keypad found on a computer keyboard. When you press the number "1" on the kiosk keypad, the computer will recognize and interpret the action as the number "1". Additionally, the software will allow us to remap different commands from the kiosk keypad to alternate representative computer keyboard commands. This will be particularly useful for the next, cancel and home key buttons.

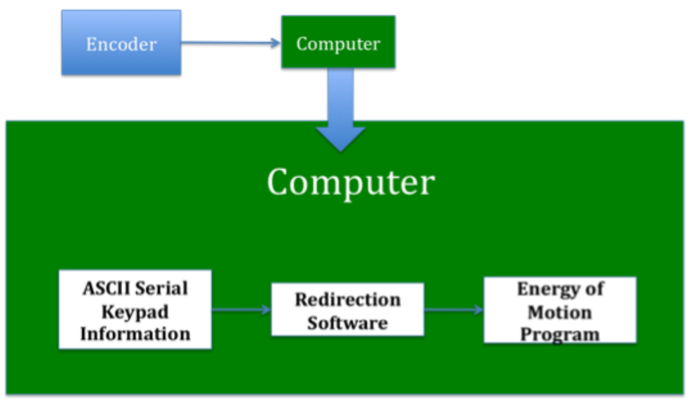


Figure 30 Software System Overview

## Audio
As indicated in the requirements section, we needed an amplifier and speaker combination to produce a 60 dB sound level. With the given budget for the amplifier aimed at under $100, the RX-4109 (Figure 31) was our initial choice for amplifier/receiver. After reviewing the specifications seen in Figure 32, we concluded the amplifier/receiver could produce and exceed the needed sound levels with a max of 95 dB ("Line(CD,TAPE, AUX)"). Additionally, the power allocated to each speaker needs to be taken into account.

Figure 31. RX-4109(A)

■ AMPLIFIER SECTION
- Power output, stereo mode, 8 Ω THD 0.08 %, 20 Hz~20 kHz .......... 2X100 W
- Total harmonic distortion, 8 Ω 100 W, 20 Hz~20 kHz .......... 0.04 %
- Intermodulation distortion
  60 Hz : 7 kHz= 4 : 1 SMPTE, 8 Ω 100 W .......... 0.02 %
- Input sensitivity, 47 kΩ
  Phono(MM) .......... 2.5 mV
  Line(CD,TAPE,AUX) .......... 200 mV
- Signal to noise ratio, IHF "A" weighted
  Phono(MM) .......... 70 dB
  Line(CD,TAPE,AUX) .......... 95 dB
- Frequency response
  Phono(MM), RIAA, 30 Hz~20 kHz .......... ±3 dB
  Line(CD,TAPE,AUX), 20 Hz~100 kHz .......... ±3 dB
- Output level
  TAPE/AUX OUT, 2.2 kΩ.......... 200 mV
- Bass/Treble control, 100 Hz/10 kHz .......... ±10 dB

Figure 32. Specifications for the RX-4109

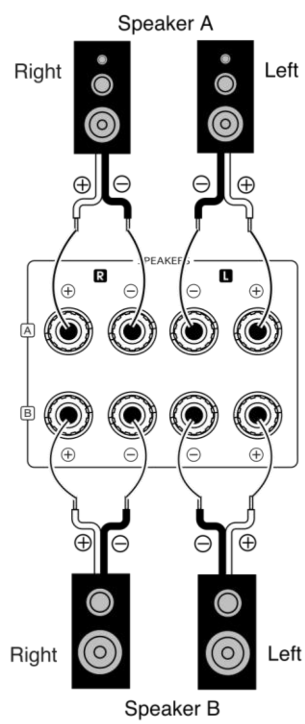



Figure 33. Output Speakers

The audio produced for the exhibit consists of two speakers. Thus, the two speakers will need to be connected to the set of speakers labeled "Speaker A" as shown in Figure 33. The connecting wires between the

amplifier/receiver and speakers are standard speaker wires that are bare on both ends and shielded in-between.

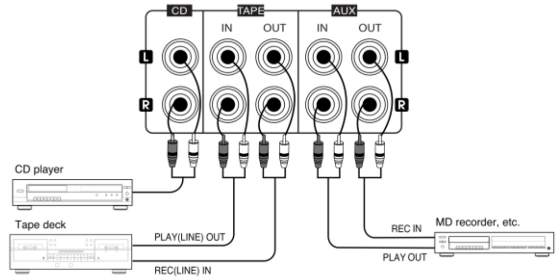



Figure 34. Input Speakers

The audio from the program will be outputted to a standard 3.5 mm headphone jack. This is the most common audio output found on desktop computers. The audio standard for amplifier's auxiliary input is RCA (Figure 34). This conversion of wire types can be achieved through a male 3.5 mm to RCA Y-cable. Each RCA channel will then need to be wired respectively to the speakers through the amplifier.

**Chapter 6 Building**

*Energy Belts*

The energy meters, composed of a pedometer and belt, were purchased by Missy Reitner-Cameron, the graphic editor for the project. A total of 500 pedometers and belts were ordered. 250 blue pedometers were ordered to resemble the colors of PG&E and the other 250 pedometers were red to resemble Thoma Electric, the two sponsors of the exhibit. In addition, labels with the names “PG&E” and “Thoma Electric” were placed on the blue and red pedometers, respectively. One hundred and fifty energy belts required assembly and more than 250 blue and red pedometers were assembled for the museum. The rest were kept by the museum to be stored for replacements once the assembled pedometers broke or needed to be replaced.


Figure 35. Picture of Thoma (Top) and PG&E (Bottom) pedometers

*Energy Meter Assembly – Belt and Pedometer Attachment*

The pedometers were fixed to the energy belt using pop rivets, shown in Figure 23, through the clip, belt and into the rear casing of the pedometer.  The rivets were aluminum and have 1/8” (3mm) diameter and ½” (12mm) grip range. This was done to ensure that the pedometer would not fall off of the user during his/her visit to the museum and to decrease the possibility of failure of the pedometer clip.  Detailed assembly instructions can be found in the Appendix of this document.

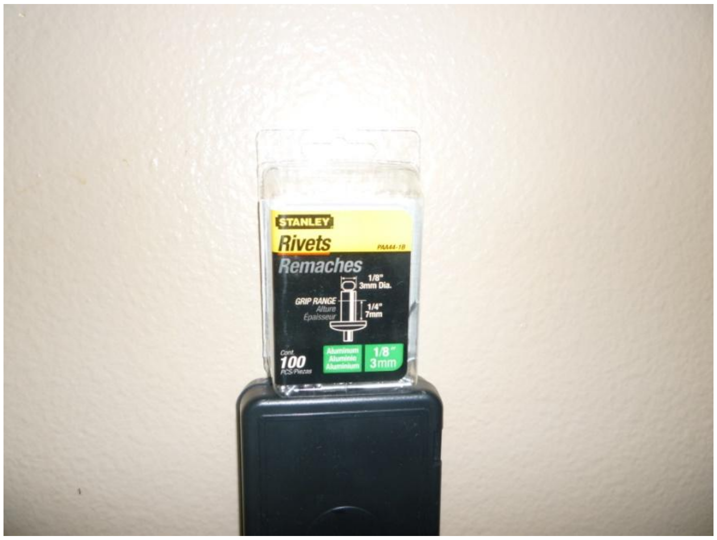



Figure 36. Rivets

The rivet gun shown below was purchased to rivet the belts to the back plate of the pedometer. Instructions on how to rivet the pedometers and belts were given to the museum staff. The staff needs to know the process of riveting the belts and pedometers, since they will have to do so once the assembled pedometers need to be replaced. The senior project team will have completed the exhibit by then.

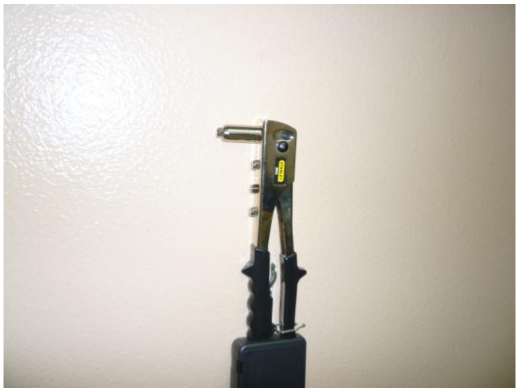


Figure 37. Rivet Gun

*Energy Meter Assembly – Button Blocker Attachment*

The next step was to affix the button blocker to the front casing of the pedometer. The button blockers were the bottom half of OSH screw caps, which could be glued around the reset button of the pedometer to allow resetting of the device with a tool and prevent the users from accidentally resetting them during their visit to the museum. Epoxy was used to attach the button blockers to each pedometer. Detailed assembly instructions for the button blockers can be found in the Appendix of this document.

*Kiosk*

The completed kiosk shown in Figure 40 is composed of the following parts:

- Plywood Frame
- Skin
- Computer and Monitor
- Keypad
- Speakers
- Plexiglass

Final detailed drawings of the kiosk were given to Steve Gonzalez for the construction of the kiosk casework. The entire structure was built using plywood and Lexan. Once the initial structure was built, it was brought to the museum for final sizing, and last minute modifications. Mr. Gonzalez then installed the front service door, the bracket for the monitor, and cut holes for the speakers and the keypad.

The finalized kiosk was then primed and brought to Big Images in San Luis Obispo, to install the skin graphics to the front face of the kiosk. Missy Reitner-Cameron of iii Designs oversaw the development of the graphics work for the kiosk exterior.

Figure 38: Initial Naked Kiosk structure

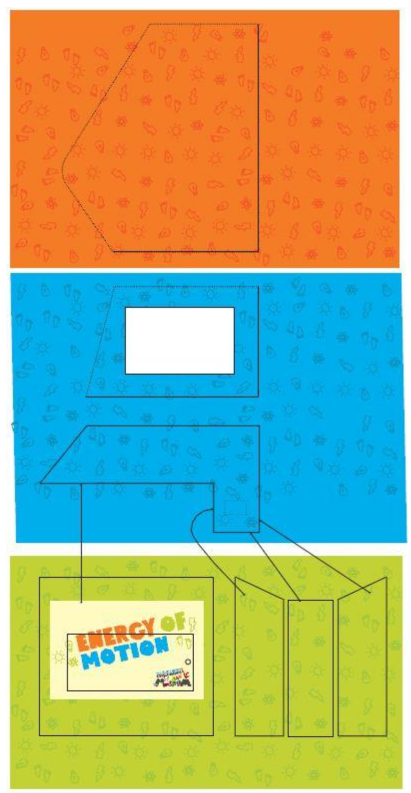



Figure 39: Early Skin Graphic Concept

Once the kiosk was skinned, it was returned to the museum for final assembly and testing. The computer, monitor, speakers, keypad and stereo amplifier were installed. A Lexan cover was added to the keypad platform to protect the skin from delamination and damage. Similar aluminum guards were cut, painted and fixed around the monitor to protect the skin from damage.


Figure 40: Completed Kiosk

*Energy Software*
Programming and implementation of the kiosk energy software was done primarily by Steve Azeka using Adobe Flash. He has included detailed information regarding the programming aspects of this project in his report, see attached.

All computer graphics and artwork for the energy software was done by iii Designs, a local graphics art company, with guidance from the Energy of Motion senior project team. Final artwork can be found in the Appendix of this document.

*Cumulative Energy Display*
To build the Cumulative Energy Display (CED), we purchased a Scrolling LED display that came with software for programming the display. The display is mounted behind the front desk of the museum with a border placed around the display, shown below, by iii Designs.


Figure 41: Cumulative Energy Display Border

The staff will collect the pedometer from the user after their visit to the museum is done. An Excel spreadsheet was provided by the team so the staff can easily compute average energy expenditure when the energy belts are returned. The CED will display total energy expenditure in watt-hours over the lifespan of the exhibit.

## Program

*Construction*

When following the development plan, there were several areas that took longer to construct then planned. One of the key functions of the program is the ability to prevent the child from continuing before the narration ends. This took a couple of weeks to implement and required "out of the box" methods to solve. Additional areas were faster to code like the implementation of the random function and incorporation of audio.

*Integration*

The final program was exported using the publishing feature in flash. The file extension was of .exe file type as to work with Windows XP computers. The .exe file and all accompanying audio were transferred to the desktop computer and then placed in the kiosk. Attached to the computer were the encoder, audio and monitor.

## Keypad

*Construction*

Being able to connect all the different parts required several different data sheets and online research. The power supply needed custom cables with additional crimps. The encoder serial interface also needed customized cables in order to transfer data. All of the different components needed to fit into the kiosk (Figure 42 and Figure 43). Additionally, the testing programs needed to be created.

Figure 42: Encoder with Wires


Figure 43: Keypad Integrated into Kiosk

*Integration*
After all of the individual components were functional, the system was assembled as a whole. The most difficult part of the system is the wiring and the ability for it to fit in the kiosk. Particular wires required extension and needed to avoid particular areas of the kiosk (especially flammable regions). The keypad needed to be customized to fit flush with the kiosk front. This needed to account for the encoder size and wiring.

## Audio
*Construction*
The construction of the exhibit followed the diagram similar to Figure 15. The amplifier and wiring were contained within the housing of the kiosk. The speakers were exposed on the top portion of the

exhibit. Because the speakers were originally white, we needed to spray paint the outer surface with a coat of black flat spray paint. This resulted with paint covering the audio connectors, which needed to be sanded down. Once placed in the kiosk (Figure 44) everything was wired and then mounted into place.

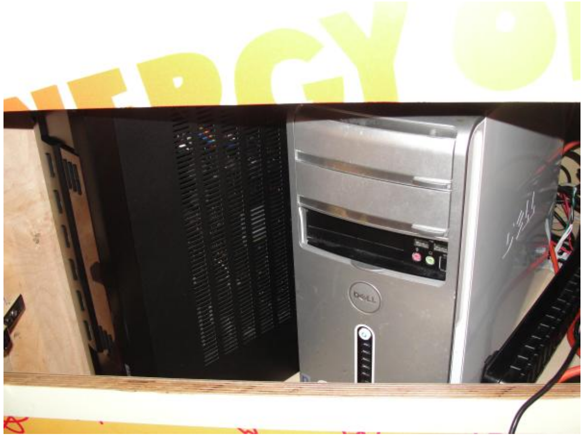


Figure 44: Amplifier in Kiosk

## Chapter 7 Testing

A survey was created to determine whether the exhibit appealed to the public. The survey asked 13 questions: 3 on the energy meters, 6 on the kiosk, 2 on eating habits, and 2 involving the overall look of the exhibit and improvements to the kiosk. The first 12 questions were based on a rating scale from 1 to 10, with 10 meaning highly agree and 1 meaning highly disagree. From May 28 to May 31, 13 surveys were collected from the museum. From the 13 surveys, it was observed that the people who were filling them out were the parents. Therefore, the input from the surveys would imply the parent's perspective and not a child's perspective, which was the design intent. The 13 surveys were averaged and the following conclusions were drawn from them.

<u>Energy Meters:</u>

The aesthetics portion of the energy meters had a score of 7 out of 10. This means that people were satisfied with the look of the energy meter. Some reasons why the aesthetics received 7 out of 10 are because the users may not have liked the black trim of the energy meters, the belt may have been hard to adjust, or people may have thought the energy meter was inaccurate. Generally speaking, adults take fewer steps than children.

Ease of use scored 8 out of 10, so most people found the energy meter easy to use. It seems people were able to put on the energy belt and read the number with almost no instruction. The energy meter was designed this way so the user would easily be able to strap it around their waist and read the number.

Problems with the energy belt scored 4 out of 10, so less than half of the people experienced some problems with the energy meter. From the experience at the museum, some people who used the exhibit gave the energy meter back with the button blocker removed or had the energy meter on their waist upside down, leading to an inaccurate count. Also, the energy meter has an automatic shutoff and people would complain that the energy had turned off. Prior knowledge of how to use and attach the pedometer before use would tremendously help the users have a better and positive experience with the exhibit.

<u>Kiosk:</u>

When asked if the kiosk was enjoyable, people agreed on an 8 out of 10 scale. The kiosk was designed to be used by both children and adults. The kiosk was designed for parents and children to use the kiosk together and enjoy finding out what they could do with the energy they produced at the museum. With that in mind, people seem to enjoy what they see at the kiosk.

The ease of use of the Kiosk scored 7 out of 10. This meant that people were satisfied with the ease of use of the kiosk. During the testing, some people had a hard time inputting their age and number of steps. The program would sometimes skip asking for the number of steps and return to the home screen. Overall, people seemed capable of inputting their age and steps with few problems.

Comprehending the kiosk was rated 9 out of 10. The information on the kiosk was presented through audio as well as in text. This would allow children who cannot read an opportunity to hear the presentation. Everything was enunciated clearly in the audio, and presented in an enthusiastic mood in

order for children to be excited and intrigued to the kiosk and energy.

The children were able to learn about energy and where it comes from, which can be seen from the following 2 questions, in which people scored 8 out of 10 when asked where energy comes from, and a score of 7 out of 10 when asked if they learned more about energy. When asked if the exhibit was fun, people scored 8 out of 10, which shows people enjoyed the kiosk. Since the kiosk was originally designed for both children and parents, conversations about energy and their experience at the exhibit may have initiated. During the testing, parents and children seemed to have really enjoyed the exhibit, indicating that they were having fun using the kiosk.

Goals:

Two questions asked children about changing their eating habits and exercise more after learning about the food in energy. When asked if they would eat healthier, people scored 8 out of 10. This shows children learned about the nutritious foods, such as oranges, apples and bananas and would most likely eat healthier foods since they are good for them. When asked if they would exercise more, people scored 7 out of 10. This also indicates that people learned more about fatty foods like pizza and cookies, and although they are high sources of energy, they could be bad for you if you eat too many.

Improvements:

Not many suggestions were made to improve the kiosk. One person suggested that the information should relate to all ages. Another suggested commented on some problems with the program. For example, one person said that they were unable to input their steps and age into the kiosk. One person suggested that more activities be added into the kiosk. But mainly, people commented on the visuals and the look of the kiosk, acknowledging that they liked the kiosk. Even though these improvements were helpful, the only ones that could be implemented would be to fix all the possible bugs in the problem so that the program will flow smoothly.

Overall, when asked if they liked the exhibit, people scored 9 out of 10. This means that the exhibit appealed to the public. When designing the kiosk, general assumptions were made about the user, about what foods they like and what they like to do. Based on the score, our design of the exhibit matched the considerations and needs of the users.

Even though these conclusions were drawn from only 13 surveys, it would have been beneficial to obtain at least 200 surveys to see how the public likes the exhibit. However, due to lack of time and busyness of the museum, only 13 surveys could be filled out. Also, it was hard to obtain a survey from the staff about the ease of use and maintenance of the kiosk. However, when the kiosk was installed, the cumulative energy display was not ready to be put up. Up to this time, the cumulative energy display is still not up and therefore, a survey could not be conducted on the ease of use of the cumulative energy display. However, when the cumulative energy display does go up, manuals on how to use the cumulative energy display have been given to the staff so that if they experience any problems, they can refer to those manuals.

Average Survey Results

**SLO Children's Museum** | **Survey Questions** | **Energy-of-Motion Exhibit**

How old are you?

On a scale from 1 to 10, please CIRCLE your answer.
(1 - Highly Disagree, 5 - Agree, 10 - Highly Agree)

1. I liked how the exhibit looked:

1 2 3 4 5 6 7 8 **9** 10

**Belts**

1. I liked the energy belts:

1 2 3 4 5 6 **7** 8 9 10

2. It was easy to find out how many steps I took:

1 2 3 4 5 6 7 **8** 9 10

3. I had problems with the energy meter:

1 2 3 **4** 5 6 7 8 9 10

**Kiosk**

1. I enjoyed the exhibit:

1 2 3 4 5 6 7 **8** 9 10

2. It was easy to use the exhibit:

1 2 3 4 5 6 **7** 8 9 10

3. It was easy to understand the exhibit:

1 2 3 4 5 6 7 8 **9** 10

4. I know where energy comes from:

1 2 3 4 5 6 7 **8** 9 10

5. I felt I learned a lot from this exhibit

1 2 3 4 5 6 **7** 8 9 10

6. This exhibit was fun

1 2 3 4 5 6 7 **8** 9 10

**Goals**

1. I will eat healthier food:

1 2 3 4 5 6 7 **8** 9 10

2. I will exercise more:

1 2 3 4 5 6 **7** 8 9 10

**Improvements**

1. "How would you improve this exhibit?"

## Program

*Team Testing*

The first testing stage is in front of team members and the advisor. Having others look at the program to obtain a general feel for the program is important. They can contribute different perspectives and try different paths in the code that would not have normally been explored. After suggestions and problems are worked out the next stage of testing can be explored.

*Software and Hardware Testing*

Being able to transfer the program from Mac OS X to Windows XP is imperative in order for the system to work as a whole. All the software functionality needs to be tested in the new Windows environment. The key components to look out for are the key mappings and timing function. Ensuring the keypad and encoder are behaving as specified when the dedicated keys are pressed can test the key mappings. Additionally, the timing can be tested by comparing the slide change with the narration while pressing the continue button. If the slide continues before or after the specified time then the timing is off.

*Kiosk Testing*

The best test is to place the program before a group of children. The program will need to be introduced to the rigor of children's testing. For the first few days of the exhibit opening, the kiosk will need to be watched for any sort of problems. Additionally, the staff members will need a place to collect any additional problems that may arise.

*Testing Results*

The initial testing showed numerous problems with different parts of the code. The first problem existed with the time delay of the second input. Since both of the inputs existed within the same slide, the focus for the second input needed to be unfocused. The solution was to place the inputs on two different slides. After introducing the program to the team members they made a few suggestions. The primary one was the reduction of inputs in order to simplify the program for the children. When the program was tested in the museum the children found some bugs with the home button. All of the variables would not clear after the button was pushed. Problems that need to be addressed for future versions are the bilingual incorporation and the home button.

## Keypad

*System Power Test*

The correct power provided by the power supply (Figure 45) will be crucial in the functionality of the encoder. If the power supply produces too much power, the encoder will be damage. If the power supply produces too little power, the encoder will not have enough energy to operate. The power provided by the wall outlet is 120V AC. The power supply will need to convert the power to DC. To ensure the correct conversion of power, the power supply will be tested with a standard multimeter. The system power test needs to be implemented before all others because it enables the functionality of the other components.

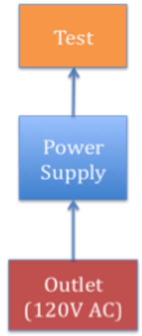


Figure 45 – Power System Test

*Encoder Output Test*
After the power supply is confirmed as being functional, the encoder needs to be tested (Figure 46). Ensure the encoder is connected to the computer after the wiring of the keypad and power supply. To be able to recognize the initial ASCII code produced by the encoder, the built in software (HyperTerminal) provided by Windows XP will be utilized.

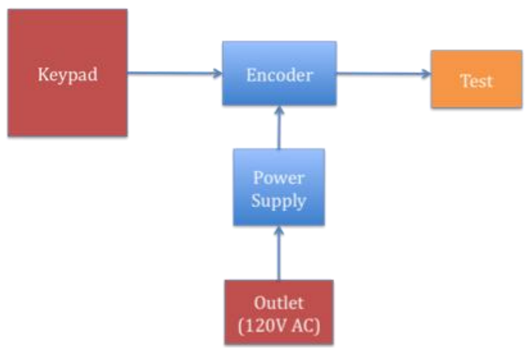


Figure 46 – Encoder Output Test

HyperTerminal will enable us to see the connection between the encoder and the computer. Figure 47 demonstrates the different settings associated with the encoder. The settings to be mindful of when configuring HyperTerminal are the “Connect using” and the “Bits per second” drop options. The “Connect using” refers to the port you choose to connect your encoder to. The “Bits per second” is set using the encoder switches.

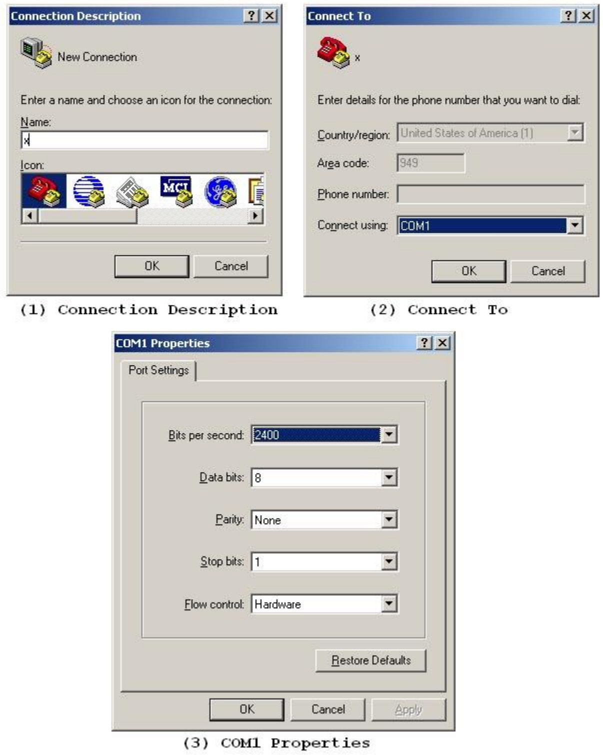



Figure 47 – HyperTerminal Setup
(http://www.colinfahey.com/phone_interface/phone_interface_en.html)

*Bill Redirect Output Test*

The most important part of the interface is the Bill Redirect Output. This is what enables the connection of the output of the encoder to communicate with the program. This will also enable the change of any reserved ASCII characters. A simple program can be created in order to display the output of the keys in the Action Script 3 language. This is the final stop between the keypad and the program (Figure 48).

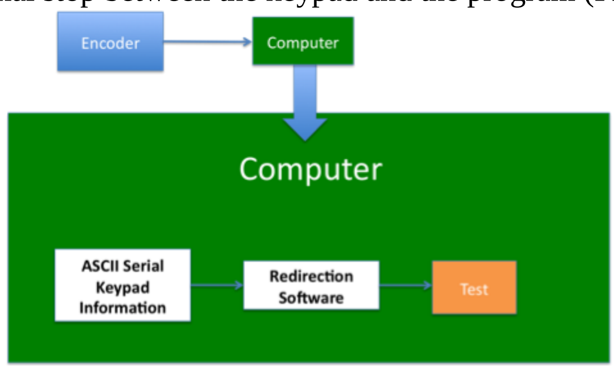



Figure 48 - Bill Redirect Output Test

*Test Results*

The test results of the power supply resulted in an output voltage of 4.98 V. This was measured using a standard multimeter. The output of the encoder originally gave the wrong keyboard mapping. The encoder was then replaced with a new one and all the keys mapped. This could have been attributed to faulty wiring on the end of the manufacturer. After receiving the new encoder the keys could be

remapped through the Bill Redirect program.

### Audio

The overall system is simple enough to test all at once. The block diagram (Figure 49) demonstrates the different segments and the end results that the speakers should produce. If there are any problems at any particular point the segment should be isolated and independently tested. The volume on both the amplifier and computer need to be adjusted accordingly in order to produce the desired sound level.

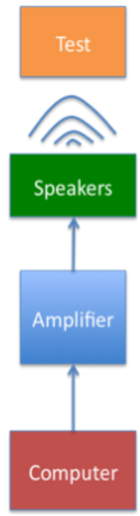



Figure 49 - Audio Testing Block

*Test Results*

After setting up the audio system in the kiosk we realized the audio wires were not stripped enough. This prevented the speakers from obtaining the necessary signal from the amplifier. After further stripping we were able to obtain audio from both speakers. The volume needed to be adjusted from both the computer and the amplifier. The quality was best when the computer was outputting the highest volume and the amplifier were used for fine tune adjustment afterwards.

## Chapter 8 Project Management Plan

Table 2 lists the roles that each member was responsible for. Patrick Ligot was responsible for the scheduling of the project. He planed meetings and set deadlines for the project, kept the group on task and changed the schedule of the project when needed. Brian Mich will be responsible charge of the organization and documentation of the project. He will hold on to all documents and keep then organized. He will also go over each document and have decide whether or not the document is complete or ready to be turned in. Eric Sanchez will be responsible for communicating with our sponsor. He will inform the sponsor of our decisions to the project. He will also inform us of what the sponsor wants to add or take away from the project. Jaime Salazar will be responsible for the financing of the project. He will keep track of all purchases we make as well as keeping us within the proposed budget.

Table 19. Roles and responsibilities for each member

| Roles and Responsibilities | | | |
|---|---|---|---|
| Patrick Ligot | Brian Mich | Erik Sanchez | Jaime Salazar |
| Plan and Manage Time for project | Organization and Documentation | Communication with Sponsor | Financing |

Figure 1 shows our Gantt chart and our set dates and times for our project. All the diamonds mark due dates that we have to meet. All the bars indicate the time set aside for sub-projects, such as, such as building the kiosk or interviewing the children. These due dates and time allotted are subject to change.

## Chapter 9 Conclusions and Recommendations

The goals for the Energy of Motion Exhibit were to design an experience that children and parents alike would enjoy, while learning about energy. The exhibit had to be durable, safe, and low maintenance for the museum staff to operate. The surveys made for the children showed that it was very well like and the overall experience was positive.

There were low samples in to determine the overall experience of the children that visit the museum. However, the exhibit met the main goals from the beginning stages of the project. The overall experience of senior project was very helpful and will only aide in transitioning the senior project team to industry.

### Audio

The overall audio system was setup and functioned properly. The only change for the future I would recommend is to obtain a smaller amplifier. There was enough room in the kiosk for the full size receiver but additional functionality of the exhibit could have been added if the space was saved. Additionally, a single channel amplifier would have been acceptable while lowering the overall cost of the exhibit.

### Keypad

The keypad was the most diverse set of components out of any other system. Knowledge of code, wiring and power was required in order to complete the interface. After all of the individual components were functional the system provided to be a robust. The most time consuming portion of this project was waiting for the turnaround between broken and new parts. Additionally, the custom wires took a longer time to complete because of the crimping needed for several dozen ends.

### Program

This portion of the project was the most time consuming experience of senior project. It originally was created with several different functionalities but the requirements of the museum restricted the complexity of the program. The development process was a valuable experience in trying to strategies the different systems in order to complete the project on time. The finished product meets all the requested requirements and we are looking to continue improving the program in the future.

**References**


- http://www.pedometerswithattitude.com/p/672947/walking-style-pro-omron-pocket-usb-pedometer-hj720it-e2.html
  - Specifications for the Pro Omron Pocket USB Pedometer (Hj720IT E2).
- http://www.alibaba.com/product-gs/205772663/Top_view_USB_pedometers_download_data.html
  - Specifications for the M368F.
- http://shopper.cnet.com/health-monitors/hj-720itc-usb-pocket/4414-19390_9-34950669.html#info-5
  - Specifications for the Omron Hj-720itc Pocket Pedometer.
- http://www.alibaba.com/product-gs/229538912/USB_Pedometer.html
  - Specifications for the HNP-113.
- http://www.ecplaza.net/tradeleads/seller/4184662/mp3_pedometer.html
  - Specifications for the HoYou Electron MP3 Pedometer.
- http://www.ecplaza.net/tradeleads/seller/2682552/mp3_with_pedometer.html
  - Specifications for the Keysbond Ltd. MP3 with Pedometer.
- http://www.usbfever.com/index_eproduct_view.php?products_id=329
  - Specifications for Dream Cheeky USB Pedometer.
- http://slokidicalmass.blogspot.com/2009/05/arrive-early-to-decorate-your-bike-san.html
  - Title Page - San Luis Obispo Children's Museum Logo
- http://www.aqualeisure.com/store/product_info.php?cPath=26_41&products_id=109
  - Child Pedometer Picture
- http://www.wv-hsta.org/cdc_chc/walking_kcal_expenditure.htm
- http://www.brianmac.co.uk/energyexp.htm
- http://www.medindia.net/patients/calculators/ht_wt_chartResult.asp
- http://caloriecount.about.com/cc/search2.php?search_type=foods&searchpro=calories+in+an+apple&s_order=&page=1
- http://www.usda.gov
- http://www.ge.com
- http://www.colinfahey.com/phone_interface/phone_interface_en.html
- www.windpower.org
- Bourns Inc.

## Appendix A: Decision Matrices

Decision Matrix of Energy Meter

| | USB | | | Non USB (w/screen) | | |
|---|---|---|---|---|---|---|
| Description | Clip on Pants | Clip w/Belt | Belt w/"Pouch" | Clip on Pants | Clip w/Belt | Belt w/"Pouch" |
| Life Span (5) | 1 | 3 | 5 | 1 | 3 | 5 |
| Durability (5) | 1 | 2 | 5 | 1 | 2 | 5 |
| Aesthetics (5) | 3 | 2 | 4 | 3 | 2 | 4 |
| Maintenance (5) | 2 | 3 | 5 | 2 | 3 | 5 |
| Safety (5) | 4 | 4 | 5 | 4 | 4 | 5 |
| Learning Experience (5) | 2 | 2 | 2 | 4 | 4 | 4 |
| Interaction (5) | 2 | 2 | 2 | 4 | 4 | 4 |
| Simplicity (5) | 1 | 1 | 1 | 3 | 3 | 4 |
| Ease of Use (5) | 5 | 5 | 5 | 5 | 5 | 5 |
| Battery Life (5) | 3 | 3 | 3 | 3 | 3 | 3 |
| Cost (5) | 3 | 3 | 3 | 4 | 4 | 4 |
| Reliability (4) | 2 | 3 | 4 | 2 | 3 | 4 |
| Size (4) | 1 | 1 | 1 | 1 | 1 | 1 |
| Shape (3) | 1 | 1 | 1 | 1 | 1 | 1 |
| Exchangeable Parts (3) | 0 | 0 | 0 | 5 | 5 | 5 |
| Materials (2) | 4 | 3 | 2 | 4 | 3 | 2 |
| Water Proof (1) | 0 | 0 | 5 | 0 | 0 | 5 |
| Weight (1) | 1 | 1 | 1 | 1 | 1 | 1 |
| Sum = | 159 | 176 | 233 | 209 | 226 | 288 |

Decision Matrix of Kiosk

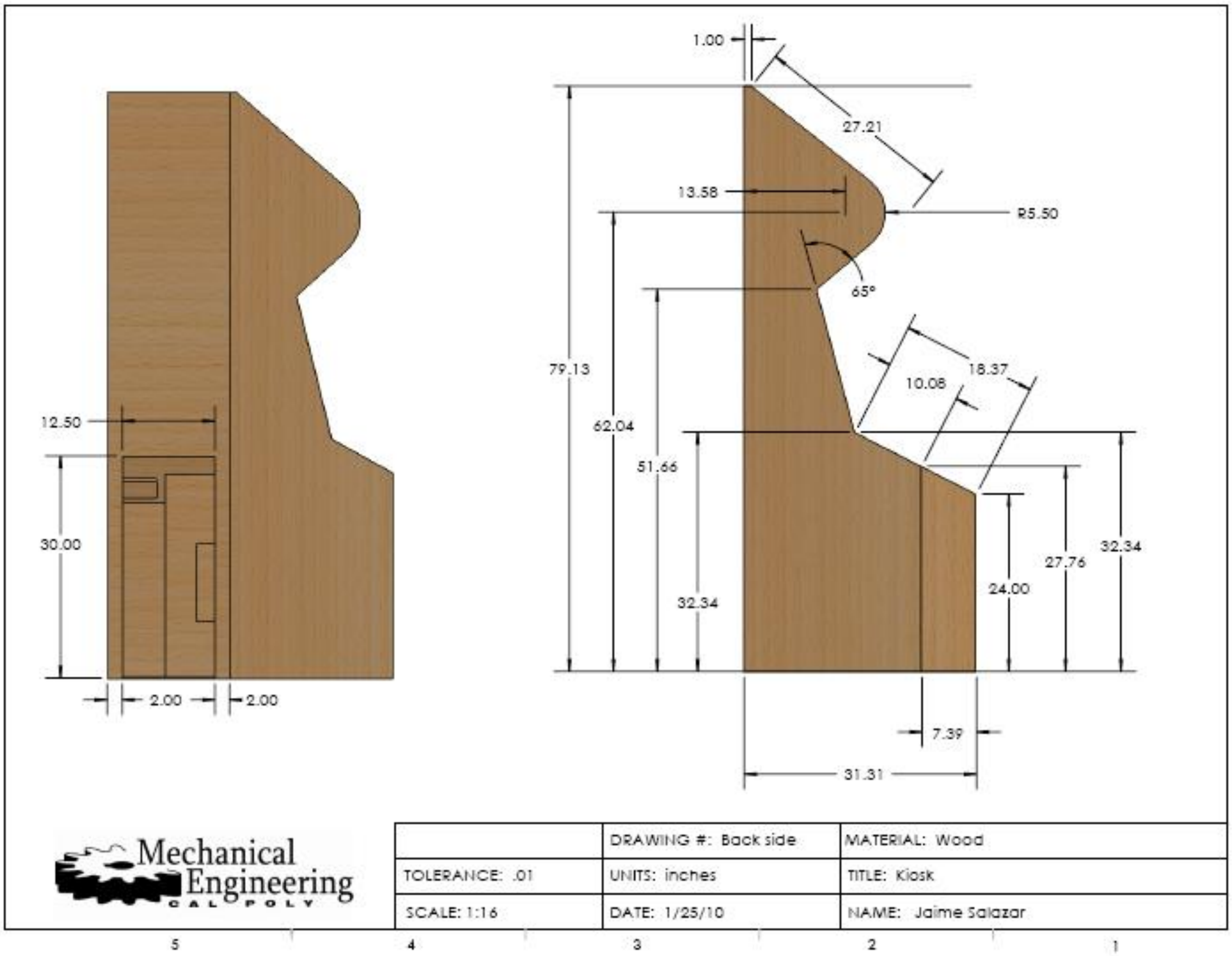
| Description | ATM Style | Arcade Style |
|---|---|---|
| Life Span (5) | 5 | 5 |
| Durability (5) | 5 | 5 |
| Aesthetics (5) | 3 | 5 |
| Maintenance (5) | 5 | 5 |
| Safety (5) | 5 | 5 |
| Learning Experience (5) | 4 | 5 |
| Interaction (5) | 3 | 5 |
| Simplicity (5) | 5 | 5 |
| Ease of Use (5) | 5 | 4 |
| Battery Life (5) | 5 | 5 |
| Cost (5) | 3 | 3 |
| Reliability (4) | 5 | 5 |
| Size (4) | 5 | 5 |
| Shape (3) | 5 | 5 |
| Exchangeable Parts (3) | 0 | 0 |
| Materials (2) | 3 | 2 |
| Water Proof (1) | 5 | 5 |
| Sum = | 306 | 324 |

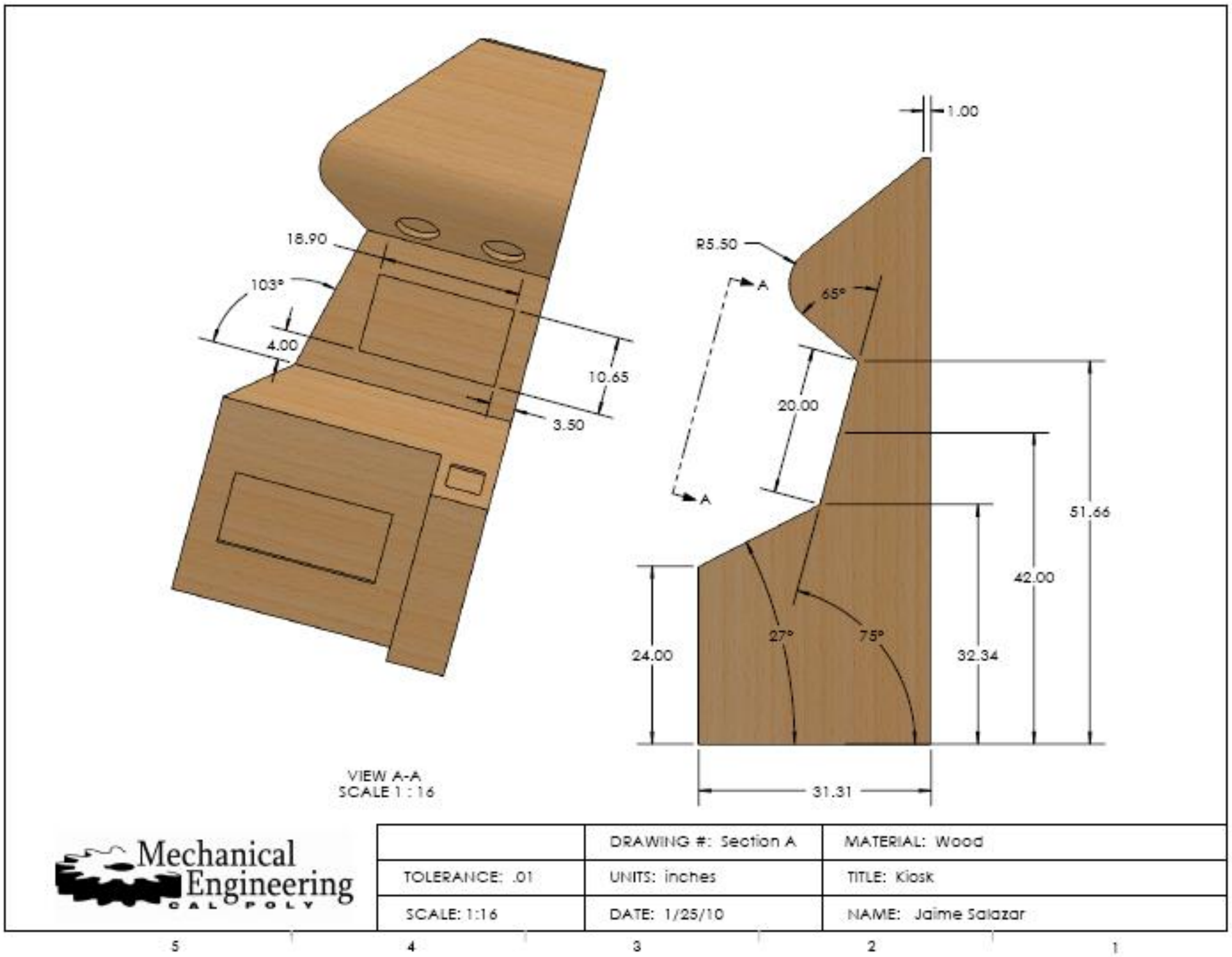
Decision Matrix of Cumulative Energy Display (CED)

| Description | LCD Display | Scrolling LED Display |
|---|---|---|
| Life Span (5) | 5 | 5 |
| Aesthetics (5) | 5 | 5 |
| Maintenance (5) | 3 | 5 |
| Safety (5) | 5 | 5 |
| Learning Experience (5) | 5 | 5 |
| Interaction (5) | 5 | 5 |
| Simplicity (5) | 4 | 4 |
| Ease of Use (5) | 3 | 5 |
| Battery Life (5) | 5 | 5 |
| Cost (5) | 2 | 4 |
| Reliability (4) | 4 | 4 |
| Size (4) | 5 | 5 |
| Shape (3) | 5 | 5 |
| Materials (2) | 3 | 3 |
| Sum = | 267 | 297 |

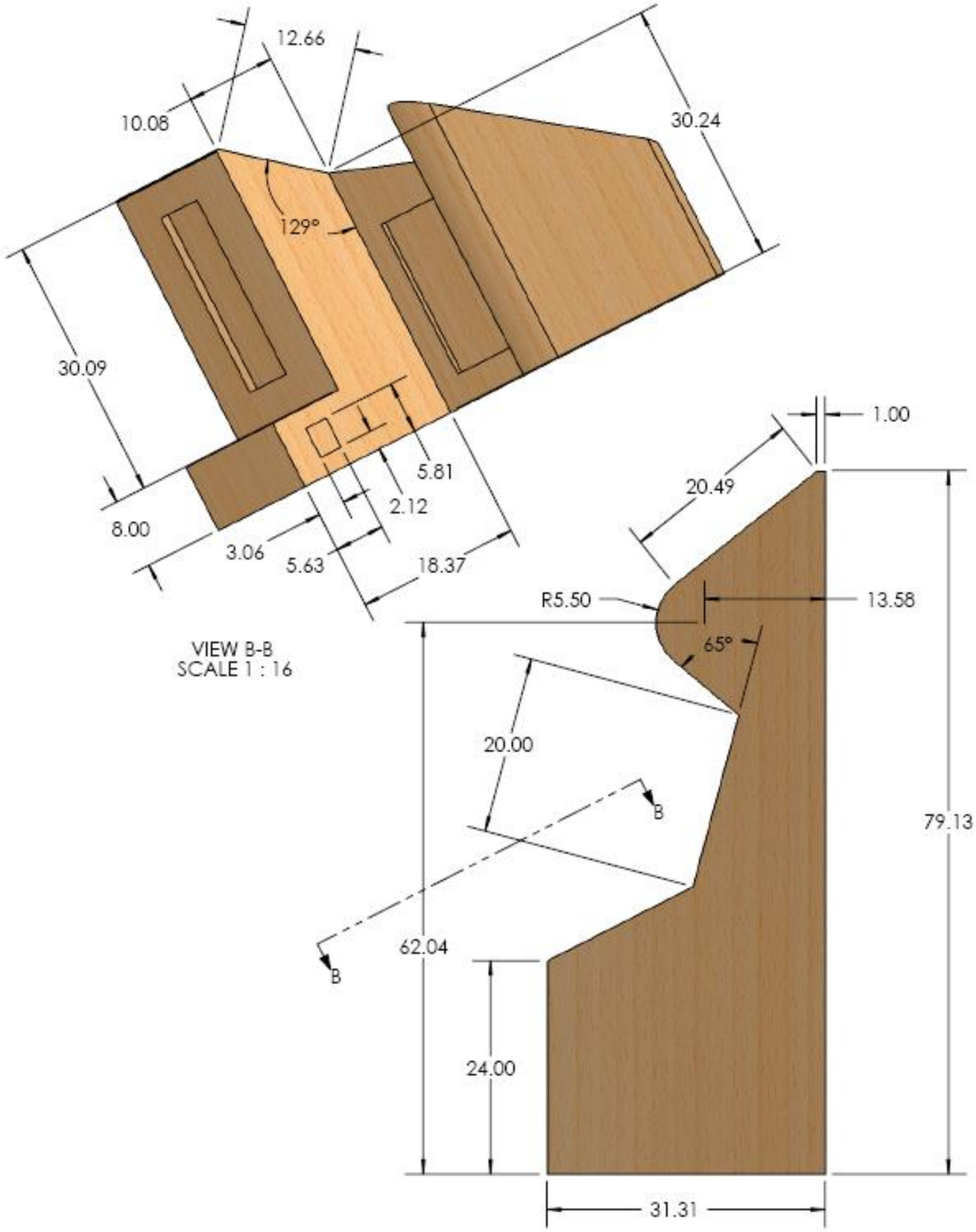
**Appendix B: Detailed Drawings**

Drawings of Pedometer, Belt, and Kiosk

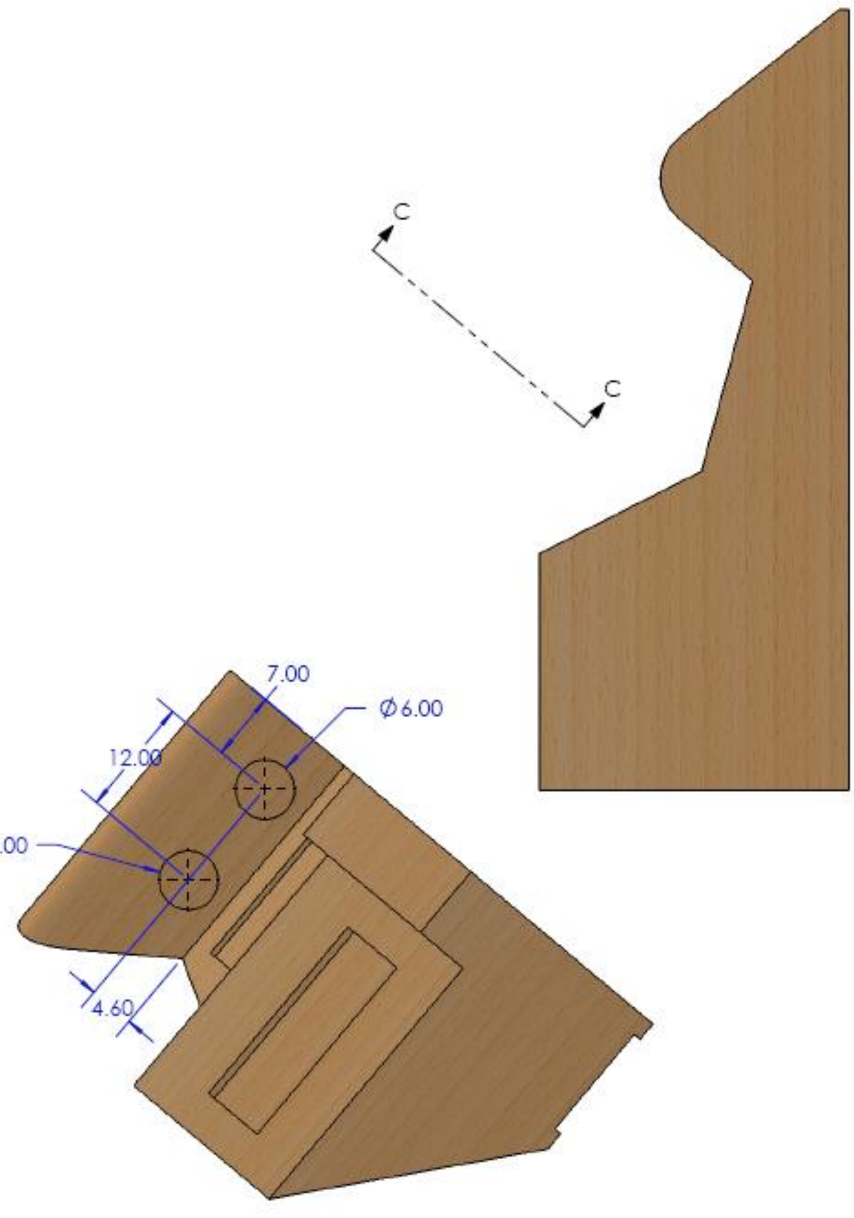




18.90
103°
4.00
10.65
3.50
1.00
R5.50
A
65°
20.00
A
51.66
42.00
24.00
27°
75°
32.34
31.31
VIEW A-A
SCALE 1 : 16
Mechanical Engineering
CAL POLY
DRAWING #: Section A
MATERIAL: Wood
TOLERANCE: .01
UNITS: inches
TITLE: Kiosk
SCALE: 1:16
DATE: 1/25/10
NAME: Jaime Salazar
5
4
3
2
1



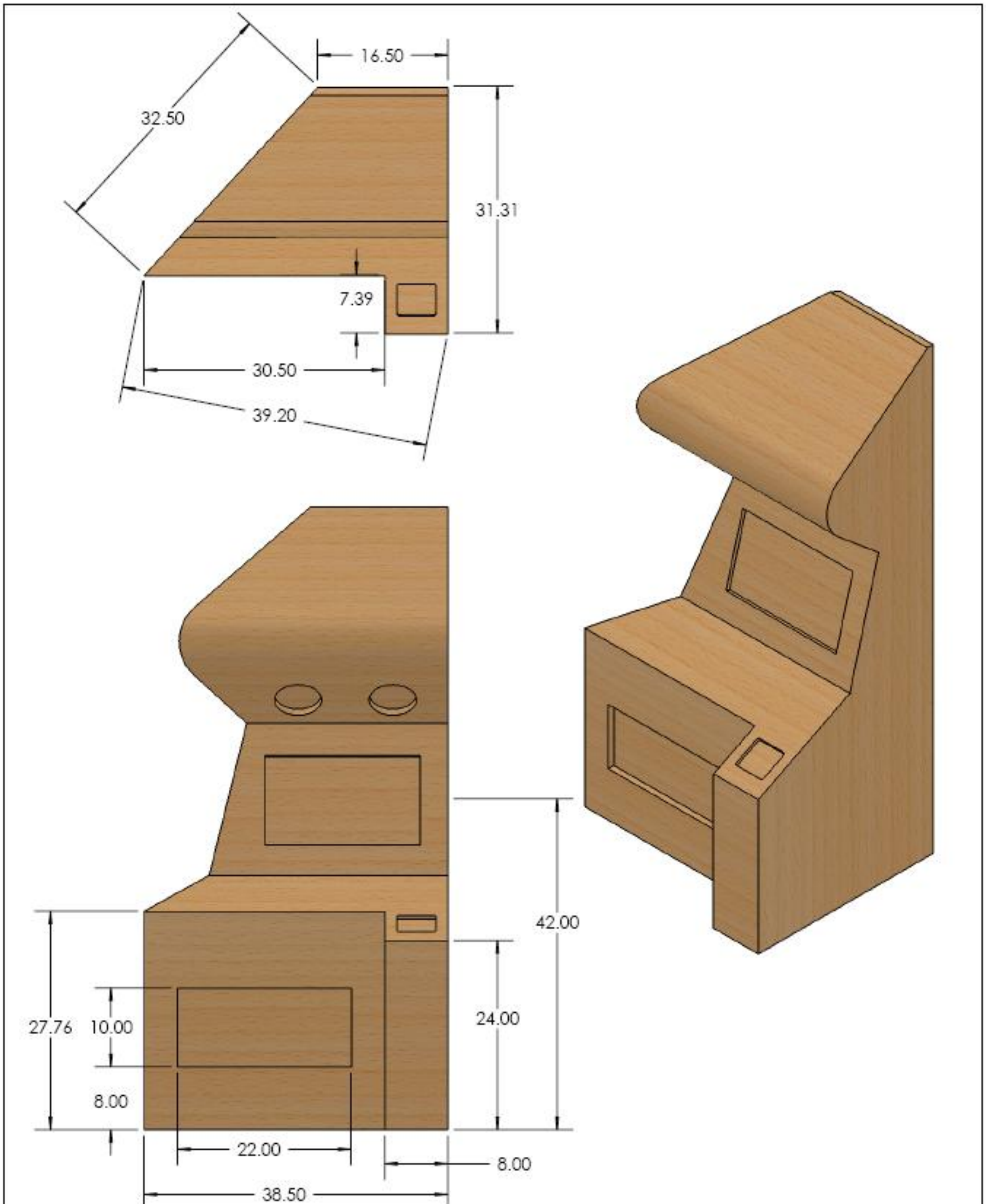

| | | | |
|---|---|---|---|
| Mechanical Engineering CAL POLY | | DRAWING # Section B | MATERIAL: Wood |
| | TOL: .01 | UNITS: inches | TITLE: Kiosk |
| | SCALE: 1:16 | DATE: 1/25/10 | NAME: Jaime Salazar |



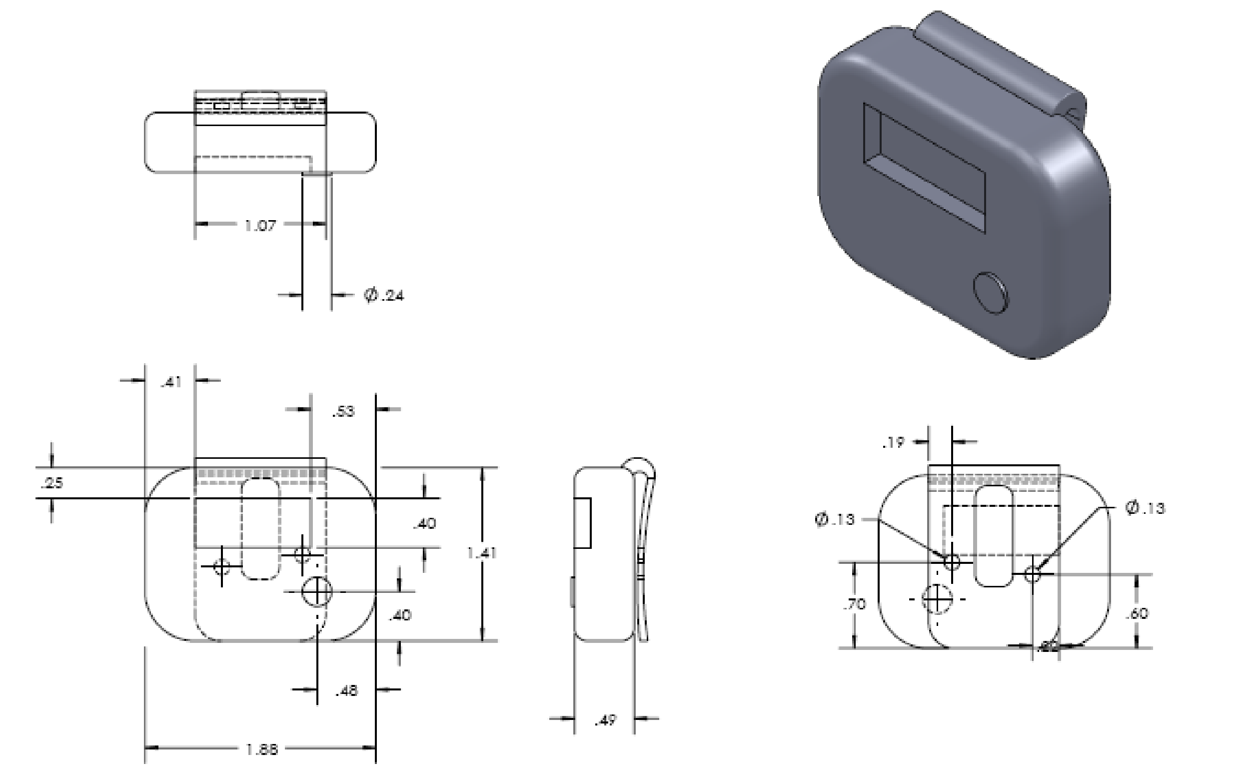

VIEW C-C
SCALE 1 : 16

Mechanical Engineering CAL POLY

| | | |
|---|---|---|
| | DRAWING # Section C | MATERIAL: Wood |
| TOL: .01 | UNITS: inches | TITLE: Kisosk |
| SCALE: 1:16 | DATE: 1/25/10 | NAME: Jaime Salazar |




| Mechanical Engineering CAL POLY | | DRAWING # | MATERIAL: Wood |
|---|---|---|---|
| | TOL: .01 | UNITS: inches | TITLE: Kiosk |
| | SCALE: 1:16 | DATE: 1/25/10 | NAME: Jaime Salazar |



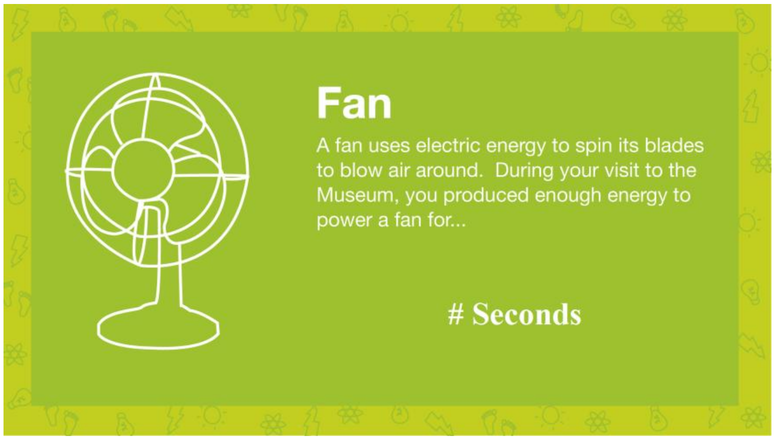

Mechanical Engineering
CAL POLY

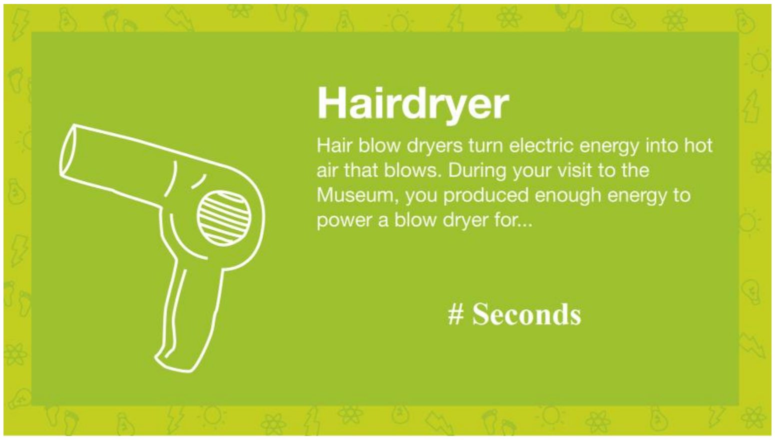
| | | |
|---|---|---|
| | DRAWING #: | MATERIAL: plastic |
| TOLERANCE: .01 | UNITS: inches | TITLE: Pedometer |
| SCALE: 1:1 | DATE: 1/25/2010 | NAME: Jaime Salazar |

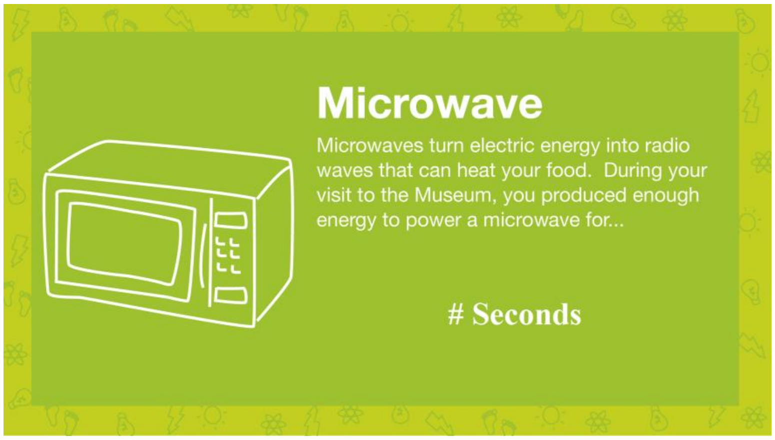
5 4 3 2 1

**Appendix C: Application Screenshots**

Small Scale Applications:



## Radios

Radios convert electric energy into sound waves in the form of music or talk radio. During your visit to the Museum, you produced enough energy to power a radio for...

**# Seconds**

## Toaster

Toasters turn electric energy into heat in order to toast your bread. During your visit to the Museum, you produced enough energy to power a toaster for...

**# Seconds**

## Cell Phones

Cell phones are powered by electric energy stored in batteries. During your visit to the Museum, you produced enough energy to talk on a cell phone for...

**# Seconds**

## Laptop Computer

Laptop computers are powered by electric energy stored in batteries. During your visit to the Museum, you produced enough energy to power a laptop for...

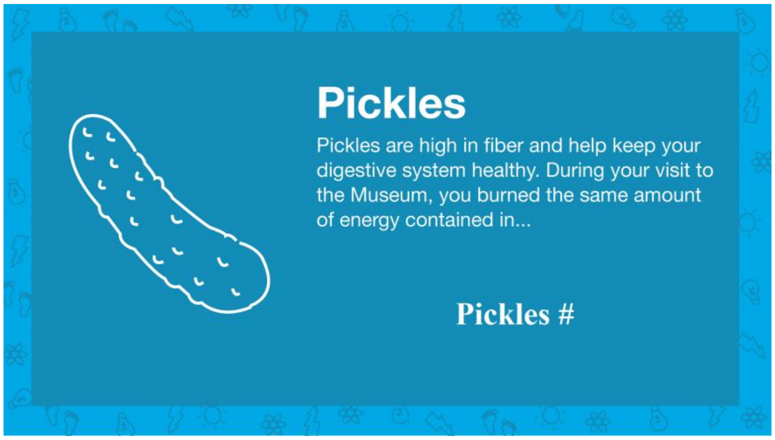
**# Seconds**

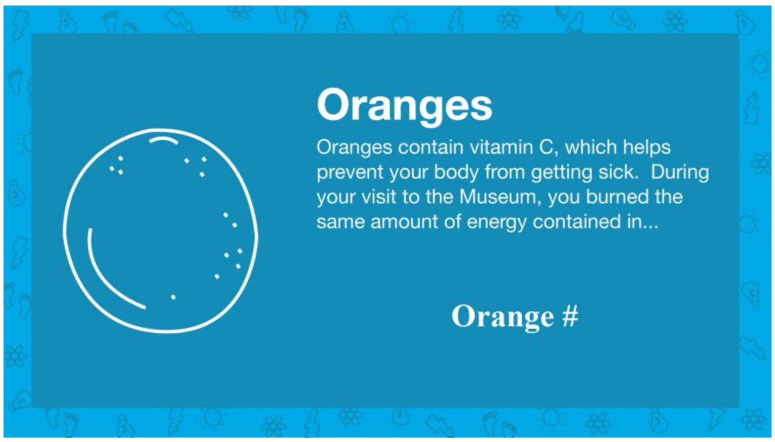
## Light Bulb

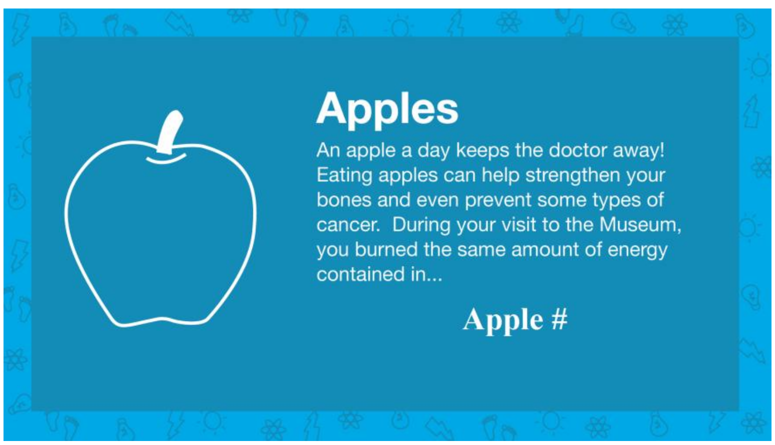
Light bulbs use electrical energy to create visible light. During your visit to the Museum, you produced enough energy to power an average light bulb for...

**# Seconds**

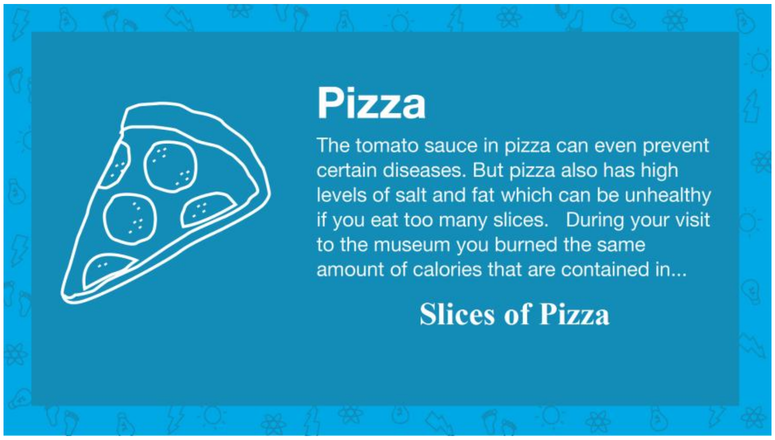
Food Applications




Bananas
Bananas contain many vitamins and potassium, which help keep your muscles strong and your body working smoothly. During your visit to the museum, you burned the same amount of energy contained in...
Banana #


Pizza
The tomato sauce in pizza can even prevent certain diseases. But pizza also has high levels of salt and fat which can be unhealthy if you eat too many slices. During your visit to the museum you burned the same amount of calories that are contained in...
Slices of Pizza


Hot Dogs
Hot dogs have high levels of salt and fat, which can cause health problems if you eat too many. During your visit, you burned the same amount of calories contained in...
Hot Dog #

## Cookies

Chocoloate chip cookies are a sweet snack that should not be eaten too often because they are high in fat and sugar, which can hurt your body and teeth. During your visit to the Museum, you burned the same amount of energy contained in...

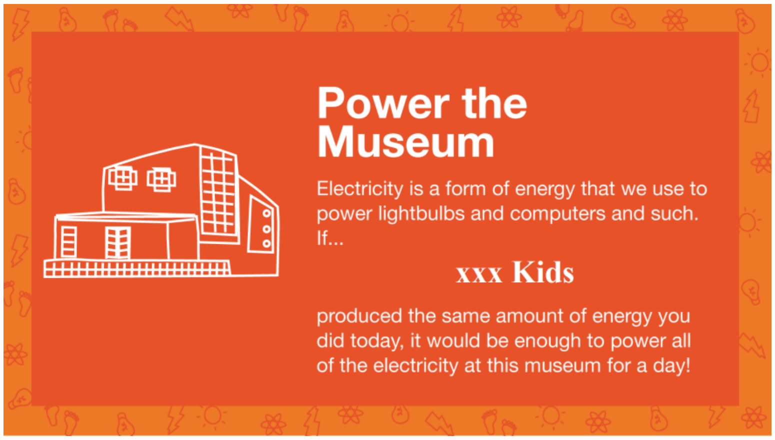
**Cookie #**

## Peanuts

Peanuts are rich in proteins, minerals and vitamins that can help you grow up strong. During your visit to the Museum, you burned the same amount of energy contained in...

**Peanut #**

Large Scale Applications





## Heat a Hot Tub

It takes a lot of energy to heat a hot tub. If...

**xxx Kids**

produced the same amount of energy you did today, it would be enough to heat a hot tub!

## Drive a Car from San Luis Obispo to Avila Beach

The distance from San Luis Obispo to Avila Beach is about 9 miles. If...

**xxx Kids**

each produced the same amount of energy you did today, altogether they could drive a car from San Luis Obispo to Avila Beach.

## Mow a Lawn

Imagine mowing a lawn the size of a basketball court. If...

**xxx Kids**

produced the same amount of energy you did today, it would be enough to mow a lawn that big.

## Train Ride from San Luis Obispo to Disneyland

Trains are big and need lots of energy to move. If...

**xxx Kids**

produced the same amount of energy you did today, it would be enough to power a train from San Luis Obispo to Disneyland!

## Plane from San Luis Obispo to San Francisco

Airplanes have to use a lot of energy to take off and fly. If...

**xxx Kids**

produced the same amount of energy you did today, it would be enough to power an airplane from San Luis Obispo to San Francisco.

Power Plant Applications

## Wind Power

A wind turbine converts the power of wind into energy. Wind farms (a farm of wind turbines) produce 100 megawatts, or 100,000 kilowatts! If...

**xxx Kids**

produced the same amount of energy you did today, it would be enough to generate the energy in a wind turbine.

## Solar Power

Solar energy is the Earth's most available energy source. Most solar power plants produce about 5 megawatts, or 5,000 kilowatts! If...

**xxx Kids**

produced the same amount of energy you did today, it would be enough to generate the energy in a solar power plant.

## Hoover Dam

Hydropower is when the power of water is turned into energy. Hoover Dam is a type of hydro power plant that can produce 2 gigawatts, or 2 million watts! If...

**xxx Kids**

produced the same amount of energy you did today, it would be enough to generate the energy in at Hoover Dam.

## Petroleum

Petroleum comes from crude oil, which is found deep beneath the earth's surface. Petroleum power plants produce about 550 megawatts, or 550,000 kilowatts! If...

**xxx Kids**

produced the same amount of energy you did today, it would be enough to generate the energy in at petroleum power plant.

## Geothermal

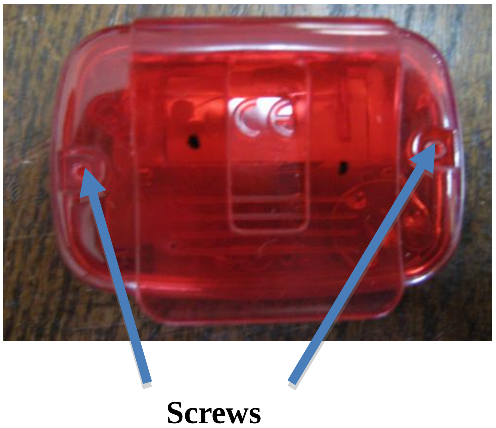
Geothermal energy is power from heat stored in the earth. Most geothermal power plants produce about 80 megawatts, or 80,000 kilowatts! If...

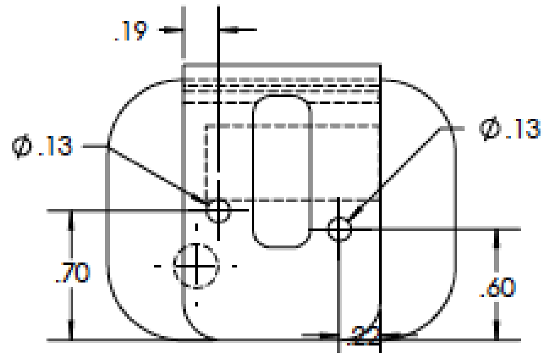
**xxx Kids**

produced the same amount of energy you did today, it would be enough to generate electricity produced by geothermal energy.

**Appendix D: Pedometer Assembly – Pedometer and Belt Attachment**

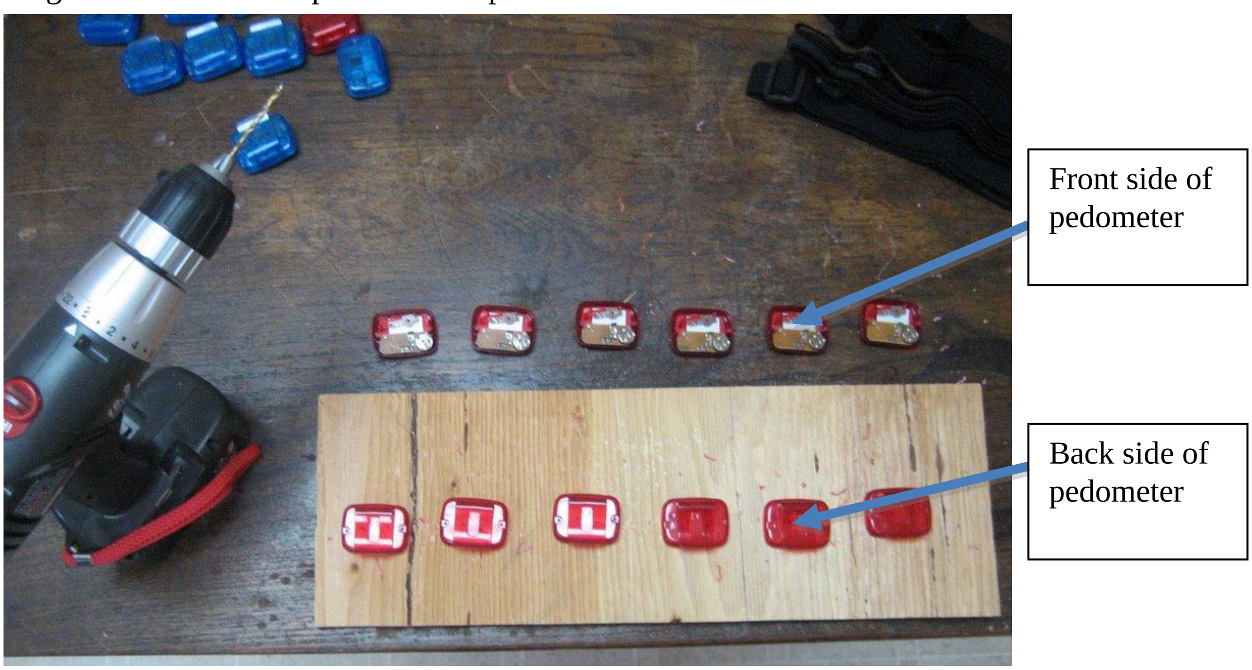
1) First mark the pedometer where the holes are going to be made with a black sharpie. Make sure there aren't any components directly behind the holes you marked. The model shown below on the right is a rough estimate of where the holes should be made.




2) Unscrew the screws (two) on the backside of the pedometer with a Phillips screwdriver. The two screws are pointed out above. **Note: Keep the screws.**

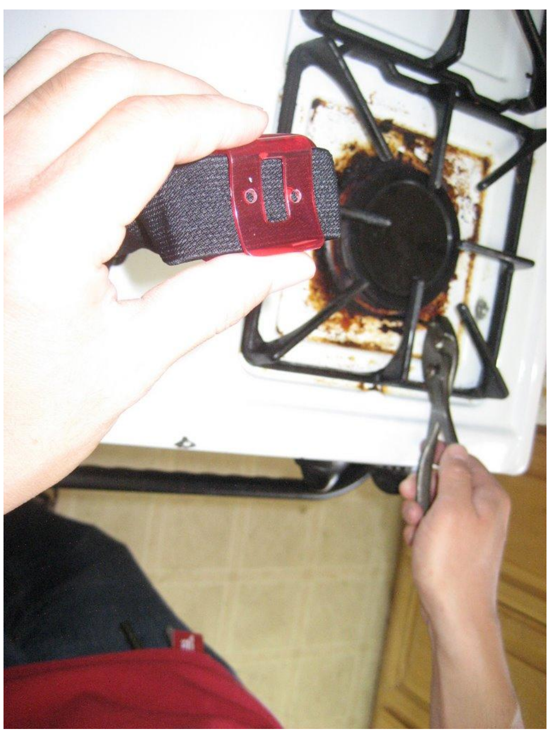
3) Now separate the backside and front side of the pedometer**. Note: Make sure when you pull apart the pedometer that the front side (the side with the screen) faces down on the table, or else components of the pedometer will come loose and fall out**. **Also keep each backside with its corresponding front side.** Place the backside of the pedometer the way indicated in the picture below. (We used a piece of wood since we did not want to screw into the table or damage the drill bit). Now place the 1/8-inch diameter bit into the drill. This is the size of the holes you will be making on the backside of pedometer. A pilot hole is not needed.

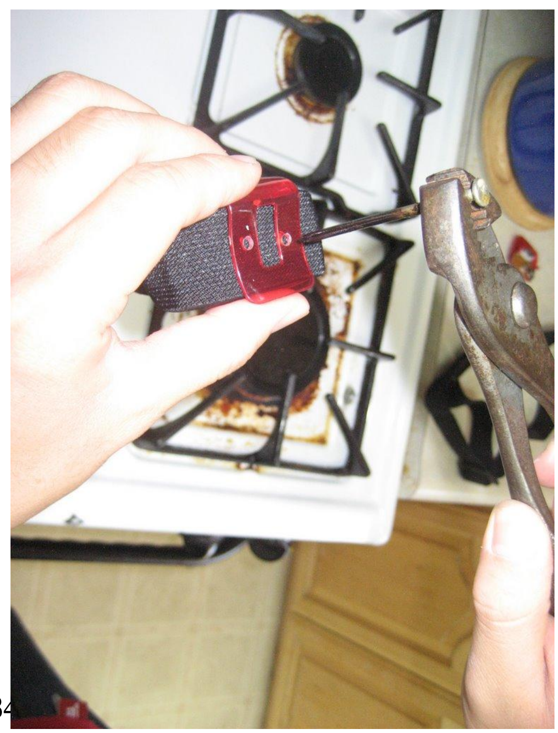


4) Drill a hole into the backside of the pedometer where the two marks were made in Step 1. Go through both surfaces (clip end and backside). The picture below on the right illustrates what the pedometer backside should look like after the holes are made.

5) Slide a belt on the backside of the pedometer. (The belt will be between the clip and backside surface of the pedometer) The location of the backside of the pedometer on the belt is very important. **Notice the pictures below and the direction of belt clip with the back side of pedometer.** There is an approximate distance of three inches between the pedometer backside and the belts clip.

6) Once the proper location of the backside portion of the pedometer has been determined on the belt, you will need to start heating the 1/8-inch diameter nail provided (We used a gas stove for the purpose of heating the nail). Use a pair of pliers to hold the hot nail. Once the nail reaches an orange/yellow color, you will drive the hot nail thought the holes you made with the drill, and melt through the belt. Make sure there is no debris left in the hole. **Note: it is extremely important to maintain the holes concentric once the hole has been made in the belt**. The pictures below demonstrate what is done in this section.





**7)** Now you will insert a rivet in each hole like shown below on the left (the flanges of the rivet should be in contact with a backside of the pedometer). **Note: the hole for the rivet should have a snug fit when inserting the rivet. If the hole is too small or it is too hard to insert the rivet all the way through the hole, you should heat the nail up again and widen the hole by melting a little bit of the plastic and belt.** Once the rivets are in place, you will use the rivet gun to snap on the rivet. Insert the back end of the rivet into the hole of the front of the rivet gun, shown in the picture below **Note: If you have never used a rivet gun before please read the rivet gun user's manual before use**. Repeat this process for the second hole.

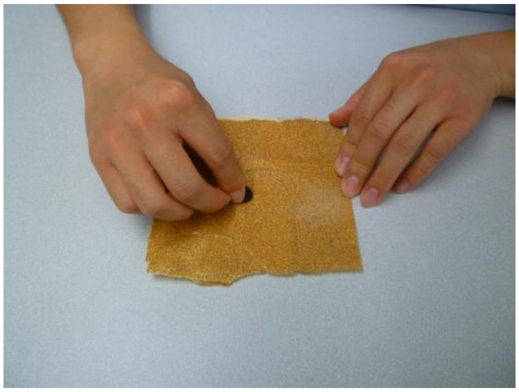

8) After snapping the rivets, there will be a remaining piece left over. You will not need this so you can throw it away. The rivet is now fastened into the back side of the pedometer. You will now assemble the pedometer back together using the screws you removed in Step 2, with its corresponding front side**.** It is easier to keep the front side facing the same was as Step 3, and adjust the back side of the pedometer until the holes from the back side are concentric to those of the front side. This way the screws you removed earlier will tighten up nicely. **Note: there are delicate and fragile parts on the front side of the pedometer. Please be careful when flipping or moving the front side of the pedometer, because there is a hairline spring that keeps the lever arm up. With out the hairline spring the pedometer will not work properly.** The pictures below should demonstrate the final looking pedometer, when assembled properly.

**Appendix E: Pedometer Assembly – Button Blocker Attachment**

Once the pedometer and belts have been attached, the button blockers need to be glued on top of the top of the bottom with epoxy to prevent children from re-setting the pedometer. Pictures of the button blockers and epoxy are shown below.



The button blockers, above, are screw caps purchased from a local hardware store. After opening the bag, the screw caps need to be sanded. Only the portion of the screw cap with a hole in the middle will be sanded. This will give it a stronger hold once it is glue to the pedometer.



After sanding, the screw cap should look like the picture below. Notice the screw cap portion with the hole is no longer smooth.

Next, squeeze some epoxy into paper plate or something that you can throw away. **Note: Epoxy has a strong odor and must be used very carefully. Inhaling too much epoxy can be dangerous and may cause nose bleeds.** Mix the epoxy together and place a little bit of epoxy around the “rough” button blocker only. The epoxy dries in about 5-10 minutes, so make sure you only use what you plan think you will need in that time frame. Carefully place the button blocker on top of the gray button on the pedometer. Make sure it is properly attached and let it dry for about an hour. Once it is dry, cut the portion of the screw cap that is not glued with a sharp razor knife like the one shown below. The screw caps are attached to each other by a thin piece of plastic and must be cut here. Discard the remaining screw cap portion. The button blocker assembly is now complete.

Once the epoxy is dry, the energy meter is complete and ready to use. A complete set of instructions of assembling an energy belt is attached.

**Appendix F: Putting on the Energy Belt**

1) Take a pedometer out of the box.

2) Take a pen and press the reset button to reset the pedometer.

3) Place the pedometer on the waist with the logo right side up.

    a. Adjust the belt length to fit snug on waist.

**Appendix G: Replacing front plate of Pedometer**

The front side of the pedometer needs to be replaced if the battery seems to be dead or the front plate of the pedometer has been damaged.

1. You will need to first remove the screws from the old pedometer and new one, using a Phillips screwdriver. **Note: You should be careful when separating the front side and the backside of the pedometer. The best way to do this is two set both pedometers on the screen side, unscrew the screws and then separate, that way no components of the pedometer fall out. Also, keep the screws**.
2. Now you will carefully swap backsides of pedometers. To do this, the pedometers must now be separated. You will now grab the backside with the belt attached to it, and combine it with the front side of the new pedometer. Make sure the holes for the screws are concentric and screw on the screws you removed in step one, either set of screws will do. Fasten the screw to a tight fit. Make sure front and backside of pedometers are tightly sealed with one another, and you're done. The pictures below should help with what was done in these two steps

**Appendix H: Restarting the Program**

Program Troubleshooting:

If experiencing any problems with the program, restarting the computer might help to solve the problems. In order to start the program:

1) Press Alt+F4 to close the "Energy of Motion" program.

2) Go to the start menu.

3) Select "Turn off the computer" or "Shut Down"

4) Select "Restart"

5) Wait for the computer to restart and for the "Energy of Motion" program to start up.

6) In the "Energy of Motion" program, go to view.

7) Select "Full Screen"

Once these steps are completed, the program should run fine.

**Appendix I: Starting the Kiosk Program**

Starting up the Program:

1) Turn on computer
    a. "Energy of Motion" program should already start up once computer is fully booted.
2) Select "View"
3) Select "Full Screen"
4) Press the power button on the stereo amplifier.

The "Energy of Motion" Logo should only be displayed if done correctly.

## Appendix J: Using the Cumulative Energy Display (LED Sign)

1) Turn on the computer

2) Open up Multimedia Sign on Desktop

3) Type total amount of kid energy found in “Total Kid Energy” excel file.

4) Select “Download”

Number should appear on Cumulative Energy Display

**Appendix K: Using "Total Kid Energy" Excel File**

1) Open up "Total Kid Energy" Excel File on computer.
2) Input number of steps on pedometer in cell B7.

Total Kid Energy will be found in green cell titled "Total Kid Energy for Today"

To input more pedometers:

1) Insert a row between Row 7 and Row 8.
    a. To insert a row, right click on Row 8.
    b. Select Insert. A row should now be inserted between Row 7 and Row 8.
2) Input number of steps on pedometer in Cell B8.
    a. To input another pedometer, repeat steps 1 and 2.

## Appendix L: User Surveys

SLO Children's Museum | Survey Questions | Energy-of-Motion Exhibit

How old are you?

On a scale from 1 to 10, please CIRCLE your answer.
(1 - Highly Disagree, 5 - Agree, 10 - Highly Agree)

1. I liked how the exhibit looked:

1 2 3 4 5 6 7 8 9 10

**Belts**

1. I liked the energy belts:

1 2 3 4 5 6 7 8 9 10

2. It was easy to find out how many steps I took:

1 2 3 4 5 6 7 8 9 10

3. I had problems with the energy meter:

1 2 3 4 5 6 7 8 9 10

**Kiosk**

1. I enjoyed the exhibit:

1 2 3 4 5 6 7 8 9 10

2. It was easy to use the exhibit:

1 2 3 4 5 6 7 8 9 10

3. It was easy to understand the exhibit:

1 2 3 4 5 6 7 8 9 10

4. I know where energy comes from:

1 2 3 4 5 6 7 8 9 10

5. I felt I learned a lot from this exhibit

1 2 3 4 5 6 7 8 9 10

6. This exhibit was fun

1 2 3 4 5 6 7 8 9 10

**Goals**

1. I will eat healthier food:

1 2 3 4 5 6 7 8 9 10

2. I will exercise more:

1 2 3 4 5 6 7 8 9 10

**Improvements**

1. "How would you improve this exhibit?"

## Appendix M: Energy of Motion Code

```
/*
//		Energy of Motion Exhibit
//		Version: 19
//		Date: June 1, 2010
//		By: Steven Azeka
*/

/*
//		Stops the program from running through all the
//		slides at the beginning.
*/
stop();

/*
//		Import files to have needed access to different functions
*/
import flash.utils.*;
import flash.events.TimerEvent;


/*
//		Timer Variables
//		Provides the delay for different slides
//		Timer( # ms)
*/
var myTimerHome:Timer = new Timer(15000);		// Home Screen
var myTimerFinal:Timer = new Timer(7000);		// Final Screen
var myTimerAge:Timer = new Timer(8000);			// Age Entry Screen
var myTimerStep:Timer = new Timer(12000);		// Step Entry Screen
var myTimer1:Timer = new Timer(8000);			// Small Apps Screen
var myTimer2:Timer = new Timer(9000);			// Small Apps Screen
var myTimer3:Timer = new Timer(10000);			// Small Apps Screen
var myTimer4:Timer = new Timer(10000);			// Small Apps Screen
var myTimer5:Timer = new Timer(9000);			// Small Apps Screen
var myTimer6:Timer = new Timer(8000);			// Small Apps Screen
var myTimer7:Timer = new Timer(9000);			// Small Apps Screen
var myTimer8:Timer = new Timer(9000);			// Small Apps Screen
var myTimer9:Timer = new Timer(10000);			// Food Screen
var myTimer10:Timer = new Timer(11000);// Food Screen
var myTimer11:Timer = new Timer(12000);// Food Screen
var myTimer12:Timer = new Timer(15000);// Food Screen
var myTimer13:Timer = new Timer(17000);// Food Screen
var myTimer14:Timer = new Timer(11000);// Food Screen
var myTimer15:Timer = new Timer(16000);// Food Screen
var myTimer16:Timer = new Timer(11000);// Food Screen
var myTimer17:Timer = new Timer(10000);// Large Apps Screen
var myTimer18:Timer = new Timer(9000);			// Large Apps Screen
var myTimer19:Timer = new Timer(10000);// Large Apps Screen
var myTimer20:Timer = new Timer(9000);			// Large Apps Screen
var myTimer21:Timer = new Timer(12000);// Large Apps Screen
var myTimer22:Timer = new Timer(9000);			// Large Apps Screen
var myTimer23:Timer = new Timer(11000);// Large Apps Screen
var myTimer24:Timer = new Timer(12000);// Large Apps Screen
var myTimer25:Timer = new Timer(19000);// Power Apps Screen
var myTimer26:Timer = new Timer(19000);// Power Apps Screen
var myTimer27:Timer = new Timer(19000);// Power Apps Screen
var myTimer28:Timer = new Timer(21000);// Power Apps Screen
var myTimer29:Timer = new Timer(20000);// Power Apps Screen
var myTimer30:Timer = new Timer(20000);// Power Apps Screen
var myTimer31:Timer = new Timer(21000);// Power Apps Screen

var i:Number = 0;
var j:Number = 0;
var energy:String = "";
var stepsAnswerbox:String = "";
var ageAnswerbox:String = "";
```

```
// Small Scale Applications
var fan:String = "";
var hair:String = "";
var micro:String = "";
var radio:String = "";
var toast:String = "";
var cell:String = "";
var laptop:String = "";
var bulb:String = "";

// Food Energy
var peanutsfoodflag:Boolean = true;
var chipfoodflag:Boolean = true;
var hotdogfoodflag:Boolean = true;
var pizzafoodflag:Boolean = true;
var picklefoodflag:Boolean = true;
var orangefoodflag:Boolean = true;
var applefoodflag:Boolean = true;
var bananafoodflag:Boolean = true;

var foodflag:String = "";
var pickle:String = "";
var orange:String = "";
var apple:String = "";
var banana:String = "";
var pizza:String = "";
var hotdog:String = "";
var chip:String = "";
var peanuts:String = "";

// Large Scale Applications
var museum:String = "";
var	marathon:String = "";
var	rocket:String = "";
var	hottub:String = "";
var	car:String = "";
var	lawnmower:String = "";
var	train:String = "";
var	plane:String = "";

// Power
var wind:String = "";
var sun:String = "";
var dam:String = "";
var gas:String = "";
var geo:String = "";
var coal:String = "";
var nuc:String = "";

/*
//	Random Variables
//	Provides random variables for random selection of slides
//	randomNumber(min #, max #)
*/
var randomizor1 = randomNumber(1,8);
var randomizor2 = randomNumber(9,16);
var randomizor3 = randomNumber(17,24);
var randomizor4 = randomNumber(25,31);

var rand1 = 0;
var rand2 = 0;
var rand3 = 0;
var rand4 = 0;



function calculations()
{
	var bsteps:Number = int(stepsAnswerbox);
	var cage:Number = int(answerBox1.text);
```

```
/*
// Calculation of Agerage Weight and Age
*/

var aweight:Number = 0;
var dfeet:Number = 0;

if (cage <= 2)
{
		aweight = 26;
		dfeet = 2.69;
}
else if (cage == 3)
{
		aweight = 32;
		dfeet = 2.92;

}
else if (cage == 4)
{
		aweight = 36;
		dfeet = 3.20;
}
else if (cage == 5)
{
		aweight = 41;
		dfeet = 3.44;
}
else if (cage == 6)
{
		aweight = 45;
		dfeet = 3.64;
}
else if (cage == 7)
{
		aweight = 51;
		dfeet = 3.82;
}
else if (cage == 8)
{
		aweight = 56;
		dfeet = 3.96;
}
else if (cage == 9)
{
		aweight = 63;
		dfeet = 4.23;
}
else if (cage == 10)
{
		aweight = 72;
		dfeet = 4.37;
}
else if (cage == 11)
{
		aweight = 79;
		dfeet = 4.53;
}
else if (cage == 12)
{
		aweight = 88;
		dfeet = 4.69;
}
else if (cage == 13)
{
		aweight = 98;
		dfeet = 4.91;
}
else if (cage == 14)
```

```
{
        aweight = 109;
        dfeet = 5.13;
}
else if (cage == 15)
{
        aweight = 118;
        dfeet = 5.24;
}
else if (cage == 16)
{
        aweight = 125;
        dfeet = 5.28;
}
else if (cage == 17)
{
        aweight = 132;
        dfeet = 5.55;
}
else if (cage == 18)
{
        aweight = 135;
        dfeet = 5.57;
}
else if (cage == 19)
{
        aweight = 139;
        dfeet = 5.60;
}
else
{
        aweight = 142;
        dfeet = 5.60;
}

// Energy (Watt-hour) = Weight (lb) x Height (ft) x (# of steps)/19244
var fwatth:Number = int ((aweight*bsteps*dfeet)/19244); // Watt-Hours
var fkcal:Number = ((aweight*bsteps*(dfeet))/22375);
energy = String(fwatth);

/*
//      Small Scale Application
*/
var k:Number = int ((fwatth/88)*(60*60));
if (k < 1)
{
        fan = String("1");
}
else
{
        fan = String(k);
}

var m:Number = int ((fwatth/1000)*(60*60));
if (m < 1)
{
        toast = String("1");
        hair = String("1");
        micro = String("1");
}
else
{
        toast = String(m);
        hair = String(m);
        micro = String(m);
}

var n:Number = int ((fwatth/15)*(60*60));
if (n < 1)
{
```

```
        radio = String("1");
}
else
{
        radio = String(n);
}

var o:Number = int ((fwatth/26.4)*(60*60));
if (o < 1)
{
        cell = String("1");
}
else
{
        cell = String(o);
}

var p:Number = int ((fwatth/45)*(60*60));
if (p < 1)
{
        laptop  = String("1");
}
else
{
        laptop  = String(p);
}

var q:Number = int ((fwatth/60)*(60*60));
if (q < 1)
{
        bulb  = String("1");
}
else
{
        bulb  = String(q);
}


/*
//      Food Energy
*/

// Pickle
var k2:Number = int (fkcal/16);
if (int(fkcal/16) == 0)
{
        k2 = (fkcal/16) * 100;

        if (int (k2) < 1)
        {
                pickle = String ("1");
        }
        else
        {
                pickle = String (roundDecimal(k2, 0));
        }
        picklefoodflag = false;
        }
else
{
        picklefoodflag = true;
        k2 = int (fkcal/16);
        pickle = String (k2);
}

// Orange
var m2:Number = int (fkcal/69);
if (int(fkcal/69) == 0)
{
        m2 = (fkcal/69) * 100;
```

```
		if (int (m2) < 1)
		{
			orange = String ("1");
		}
		else
		{
			orange = String (roundDecimal(m2, 0));
		}
		orangefoodflag = false;
		}
else
{
		orangefoodflag = true;
		m2 = int (fkcal/69);
		orange = String (m2);
}

// Apple
var n2:Number;
if (int(fkcal/116) == 0)
{
		n2 = (fkcal/116) * 100;
		if (int (n2) < 1)
		{
			apple = String ("1");
		}
		else
		{
			apple = String (roundDecimal(n2, 0));
		}
		applefoodflag = false;
}
else
{
		applefoodflag = true;
		n2 = int (fkcal/116);
		apple = String (n2);
}

// Banana
var o2:Number = int (fkcal/105);
if (int(fkcal/105) == 0)
{
		o2 = (fkcal/105) * 100;
		if (int (o2) < 1)
		{
			banana = String ("1");
		}
		else
		{
			banana = String (roundDecimal(o2, 0));
		}
		bananafoodflag = false;
}
else
{
		bananafoodflag = true;
		o2 = int (fkcal/105);
		banana = String (o2);
}

// Pizza
var p2:Number = int (fkcal/324);
if (int(fkcal/324) == 0)
{
		p2 = (fkcal/324) * 100;
		if (int (p2) < 1)
		{
			pizza = String ("1");
		}
```

```
		else
		{
			pizza = String (roundDecimal(p2, 0));
		}
		pizzafoodflag = false;
		}
	else
	{
		pizzafoodflag = true;
		p2 = int (fkcal/324);
		pizza = String (p2);
	}

	// Hotdog
	var q2:Number = int (fkcal/137);
	if (int(fkcal/137) == 0)
	{
		q2 = (fkcal/137) * 100;
		if (int (q2) < 1)
		{
			hotdog = String ("1");
		}
		else
		{
			hotdog = String (roundDecimal(q2, 0));
		}
		hotdogfoodflag = false;
	}
	else
	{
		hotdogfoodflag = true;
		q2 = int (fkcal/137);
		hotdog = String (q2);
	}

	// Chip
	var r2:Number = int (fkcal/78);
	if (int(fkcal/78) == 0)
	{
		r2 = (fkcal/78) * 100;
		if (int (r2) < 1)
		{
			chip = String ("1");
		}
		else
		{
			chip = String (roundDecimal(r2, 0));
		}
		chipfoodflag = false;
	}
	else
	{
		chipfoodflag = true;
		r2 = int (fkcal/78);
		chip = String (r2);
	}

	// Peanuts
	var s2:Number = int (fkcal/6);
	if (int(fkcal/6) == 0)
	{
		s2 = (fkcal/6) * 100;
		if (int (s2) < 1)
		{
			peanuts = String ("1");
		}
		else
		{
			peanuts = String (roundDecimal(s2, 0));
		}
```

```
                peanutsfoodflag = false;
        }
else
{
        peanutsfoodflag = true;
        s2 = int (fkcal/6);
        peanuts = String (s2);
}

/*
// Large Scale Application
*/

var k3:Number = int(154000/fwatth);
if (k3 < 1)
{
        museum = String("1000000000");
}
else
{
        museum = String(k3);
}

var m3:Number = int(2878/fkcal);
if (m3 < 1)
{
        marathon = String("1000000000");
}
else
{
        marathon = String(m3);
}

var n3:Number = int(27800000000/fwatth);
if (n3 < 1)
{
        rocket = String("1000000000");
}
else
{
        rocket = String(n3);
}

var o3:Number = int(186000/fwatth);
if (o3 < 1)
{
        hottub = String("1000000000");
}
else
{
        hottub = String(o3);
}

var p3:Number = int(22600/fwatth);
if (p3 < 1)
{
        car = String("1000000000");
}
else
{
        car = String(p3);
}

var q3:Number = int(2050/fwatth);
if (q3 < 1)
{
        lawnmower = String("1000000000");
}
else
{
```

```
		lawnmower = String(q3);
}

var r3:Number = int(4800000/fwatth);
if (r3 < 1)
{
		train = String("1000000000");
}
else
{
		train = String(r3);
}

var s3:Number = int(195000/fwatth);
if (s3 < 1)
{
		plane = String("1000000000");
}
else
{
		plane = String(s3);
}


/*
//		Power
*/
var a4:Number = int(100000000/fwatth);
if (a4 < 1)
{
		wind = String("1000000000");
}
else
{
		wind = String(a4);
}

var b4:Number = int(5000000/fwatth);
if (b4 < 1)
{
		sun = String("1000000000");
}
else
{
		sun = String(b4);
}

var c4:Number = int(2078000000/fwatth);
if (c4 < 1)
{
		dam = String("1000000000");
}
else
{
		dam = String(c4);
}

var d4:Number = int(550000000/fwatth);
if (d4 < 1)
{
		gas = String("1000000000");
}
else
{
		gas = String(d4);
}

var e4:Number = int(80000000/fwatth);
if (e4 < 1)
{
```

```
			geo = String("1000000000");
		}
		else
		{
			geo = String(e4);
		}

		var f4:Number = int(1000000000/fwatth);
		if (f4 < 1)
		{
			coal = String("1000000000");
		}
		else
		{
			coal = String(f4);
		}

		var g4:Number = int(2000000000/fwatth);
		if (g4 < 1)
		{
			nuc = String("1000000000");
		}
		else
		{
			nuc = String(g4);
		}
}

function smallScaleApps()
{
		if (rand1 == 1)
		{
			if (int(fan) == 1)
			{
				EnergyNumber.text = String(fan + " Second");
			}
			else
			{
				EnergyNumber.text = String(fan + " Seconds");
			}
		}
		if (rand1 == 2)
		{
			if (int(hair) == 1)
			{
				EnergyNumber.text = String(hair + " Second");
			}
			else
			{
				EnergyNumber.text = String(hair + " Seconds");
			}

		}
		if (rand1 == 3)
		{
			if (int(micro) == 1)
			{
				EnergyNumber.text = String(micro + " Second");
			}
			else
			{
				EnergyNumber.text = String(micro + " Seconds");
			}
		}
		if (rand1 == 4)
		{
			if (int(radio) == 1)
			{
				EnergyNumber.text = String(radio + " Second");
			}
```

```
			else
			{
				EnergyNumber.text = String(radio + " Seconds");
			}
		}
		if (rand1 == 5)
		{
			if (int(toast) == 1)
			{
				EnergyNumber.text = String(toast + " Second");
			}
			else
			{
				EnergyNumber.text = String(toast + " Seconds");
			}
		}
		if (rand1 == 6)
		{
			if (int(cell) == 1)
			{
				EnergyNumber.text = String(cell + " Second");
			}
			else
			{
				EnergyNumber.text = String(cell + " Seconds");
			}
		}
		if (rand1 == 7)
		{
			if (int(laptop) == 1)
			{
				EnergyNumber.text = String(laptop + " Second");
			}
			else
			{
				EnergyNumber.text = String(laptop + " Seconds");
			}
		}
		if (rand1 == 8)
		{
			if (int(bulb) == 1)
			{
				EnergyNumber.text = String(bulb + " Second");
			}
			else
			{
				EnergyNumber.text = String(bulb + " Seconds");
			}
		}
}

function foodEnergy()
{
		if (rand2 == 9)
		{
			if (picklefoodflag == false)
			{
				EnergyNumber.text = String(pickle + "% of a Pickle");
			}
			else if (picklefoodflag == true && int(pickle) == 1)
			{
				EnergyNumber.text = String(pickle + " Pickle");
			}
			else
			{
				EnergyNumber.text = String(pickle + " Pickles");
			}
		}
		if (rand2 == 10)
		{
```

```
		if (orangefoodflag == false)
		{
			EnergyNumber.text = String(orange + "% of an Orange");
		}
		else if (orangefoodflag == true && int(orange) == 1)
		{
			EnergyNumber.text = String(orange + " Orange");
		}
		else
		{
			EnergyNumber.text = String(orange + " Oranges");
		}
	}
	if (rand2 == 11)
	{
		if (applefoodflag == false)
		{
			EnergyNumber.text = String(apple + "% of an Apple");
		}
		else if (applefoodflag == true && int(apple) == 1)
		{
			EnergyNumber.text = String(apple + " Apple");
		}
		else
		{
			EnergyNumber.text = String(apple + " Apples");
		}
	}
	if (rand2 == 12)
	{
		if (bananafoodflag == false)
		{
			EnergyNumber.text = String(banana + "% of a Banana");
		}
		else if (bananafoodflag == true && int(banana) == 1)
		{
			EnergyNumber.text = String(banana + " Banana");
		}
		else
		{
			EnergyNumber.text = String(banana + " Bananas");
		}
	}
	if (rand2 == 13)
	{
		if (pizzafoodflag == false)
		{
			EnergyNumber.text = String(pizza + "% of a Slice");
		}
		else if (pizzafoodflag == true && int(pizza) == 1)
		{
			EnergyNumber.text = String(pizza + " Slice");
		}
		else
		{
			EnergyNumber.text = String(pizza + " Slices");
		}
	}
	if (rand2 == 14)
	{
		if (hotdogfoodflag == false)
		{
			EnergyNumber.text = String(hotdog + "% of a Hot Dog");
		}
		else if (hotdogfoodflag == true && int(hotdog) == 1)
		{
			EnergyNumber.text = String(hotdog + " Hot Dog");
		}
		else
		{
```

```
				EnergyNumber.text = String(hotdog + " Hot Dogs");
			}
		}
		if (rand2 == 15)
		{
			if (chipfoodflag == false)
			{
				EnergyNumber.text = String(chip + "% of a Cookie");
			}
			else if (chipfoodflag == true && int(chip) == 1)
			{
				EnergyNumber.text = String(chip + " Cookie");
			}
			else
			{
				EnergyNumber.text = String(chip + " Cookies");
			}
		}
		if (rand2 == 16)
		{
			if (int(foodflag) == 1)
			{
				EnergyNumber.text = String(peanuts + "% of a Peanut");
			}
			else if (int(foodflag) == 0 && int(peanuts) == 1)
			{
				EnergyNumber.text = String(peanuts + " Peanut");
			}
			else
			{
				EnergyNumber.text = String(peanuts + " Peanuts");
			}
		}
}

function largeScaleApps()
{
		if (rand3 == 17)
		{
			if (int(museum) == 1)
			{
				EnergyNumber.text = String(museum + " Kid");
			}
			else
			{
				EnergyNumber.text = String(museum + " Kids");
			}
		}
		if (rand3 == 18)
		{
			if (int(marathon) == 1)
			{
				EnergyNumber.text = String(marathon + " Kid");
			}
			else
			{
				EnergyNumber.text = String(marathon + " Kids");
			}
		}
		if (rand3 == 19)
		{
			if (int(rocket) == 1)
			{
				EnergyNumber.text = String(rocket + " Kid");
			}
			else
			{
				EnergyNumber.text = String(rocket + " Kids");
			}
		}
```

```
	if (rand3 == 20)
	{
		if (int(hottub) == 1)
		{
			EnergyNumber.text = String(hottub + " Kid");
		}
		else
		{
			EnergyNumber.text = String(hottub + " Kids");
		}
	}
	if (rand3 == 21)
	{
		if (int(car) == 1)
		{
			EnergyNumber.text = String(car + " Kid");
		}
		else
		{
			EnergyNumber.text = String(car + " Kids");
		}
	}
	if (rand3 == 22)
	{
		if (int(lawnmower) == 1)
		{
			EnergyNumber.text = String(lawnmower + " Kid");
		}
		else
		{
			EnergyNumber.text = String(lawnmower + " Kids");
		}
	}
	if (rand3 == 23)
	{
		if (int(train) == 1)
		{
			EnergyNumber.text = String(train + " Kid");
		}
		else
		{
			EnergyNumber.text = String(train + " Kids");
		}
	}
	if (rand3 == 24)
	{
		if (int(plane) == 1)
		{
			EnergyNumber.text = String(plane + " Kid");
		}
		else
		{
			EnergyNumber.text = String(plane + " Kids");
		}
	}
}

function powerApps ()
{
	if (rand4 == 25)
	{
		if (int(wind) == 1)
		{
			EnergyNumber.text = String(wind + " Kid");
		}
		else
		{
			EnergyNumber.text = String(wind + " Kids");
		}
	}
```

```
		if (rand4 == 26)
		{
			if (int(sun) == 1)
			{
				EnergyNumber.text = String(sun + " Kid");
			}
			else
			{
				EnergyNumber.text = String(sun + " Kids");
			}
		}
		if (rand4 == 27)
		{
			if (int(dam) == 1)
			{
				EnergyNumber.text = String(dam + " Kid");
			}
			else
			{
				EnergyNumber.text = String(dam + " Kids");
			}
		}
		if (rand4 == 28)
		{
			if (int(gas) == 1)
			{
				EnergyNumber.text = String(gas + " Kid");
			}
			else
			{
				EnergyNumber.text = String(gas + " Kids");
			}
		}
		if (rand4 == 29)
		{
			if (int(geo) == 1)
			{
				EnergyNumber.text = String(geo + " Kid");
			}
			else
			{
				EnergyNumber.text = String(geo + " Kids");
			}
		}
		if (rand4 == 30)
		{
			if (int(coal) == 1)
			{
				EnergyNumber.text = String(coal + " Kid");
			}
			else
			{
				EnergyNumber.text = String(coal + " Kids");
			}
		}
		if (rand4 == 31)
		{
			if (int(nuc) == 1)
			{
				EnergyNumber.text = String(nuc + " Kid");
			}
			else
			{
				EnergyNumber.text = String(nuc + " Kids");
			}
		}
}

stage.addEventListener(KeyboardEvent.KEY_DOWN,checkKeysDown);
```

```
function checkKeysDown(event:KeyboardEvent):void
{
		if (event.keyCode == 39)
		{
			i++;

			if (i == 1)
			{
				gotoAndStop("Entry");


				answerBox2.restrict = "0-9";
				answerBox2.text = "";

				StepEntry.text = ("");

				var musicintro:Sound = new Sound(new URLRequest("Welcome.mp3"));
				var sc5:SoundChannel = musicintro.play();

				myTimerStep.addEventListener(TimerEvent.TIMER, stepfunc);
				myTimerStep.start();


				StepEntry.text = ("");

				answerBox2.restrict = "0-9";
				answerBox2.text = "";

			}
			if (i == 2)
			{
				stepsAnswerbox = answerBox2.text;
				var stepCheck:Number = int(answerBox2.text);
				if (int(stepCheck) == 0)
				{
					answerBox2.text = "";
					i = 1;
				}
				else
				{

				gotoAndStop("Entry2");
				AgeEnter.text = ("");
				answerBox1.restrict = "0-9";
				answerBox1.text = "";

				var musicage:Sound = new Sound(new URLRequest("Age.mp3"));
				var sc6:SoundChannel = musicage.play();
				myTimerAge.addEventListener(TimerEvent.TIMER, agefunc);
				myTimerAge.start();
				}
			}

			if (i==3)
			{
				var ageCheck:Number = int(answerBox1.text);
				if (int(ageCheck) == 0)
				{
					answerBox1.text = "";
					i = 2;
				}
				else
				{
					calculations();

					rand1 = randomizor1;
					gotoAndStop("Slide" + rand1);

					var music1:Sound = new Sound(new URLRequest(rand1 + ".mp3"));
```

```
			var sc1:SoundChannel = music1.play();

			smallScaleApps();
			if (String(rand1) == "1")
			{
				myTimer1.addEventListener(TimerEvent.TIMER, smallfunc);
				myTimer1.start();
			}
			else if (String(rand1) == "2")
			{
				myTimer2.addEventListener(TimerEvent.TIMER, smallfunc);
				myTimer2.start();
			}
			else if (String(rand1) == "3")
			{
				myTimer3.addEventListener(TimerEvent.TIMER, smallfunc);
				myTimer3.start();
			}
			else if (String(rand1) == "4")
			{
				myTimer4.addEventListener(TimerEvent.TIMER, smallfunc);
				myTimer4.start();
			}
			else if (String(rand1) == "5")
			{
				myTimer5.addEventListener(TimerEvent.TIMER, smallfunc);
				myTimer5.start();
			}
			else if (String(rand1) == "6")
			{
				myTimer6.addEventListener(TimerEvent.TIMER, smallfunc);
				myTimer6.start();
			}
			else if (String(rand1) == "7")
			{
				myTimer7.addEventListener(TimerEvent.TIMER, smallfunc);
				myTimer7.start();
			}
			else
			{
				myTimer8.addEventListener(TimerEvent.TIMER, smallfunc);
				myTimer8.start();
			}
		}
	}
	if (i == 4)
	{
		rand2 = randomizor2;
		gotoAndStop("Slide" + rand2);

		var music2:Sound = new Sound(new URLRequest(rand2 + ".mp3"));
		var sc2:SoundChannel = music2.play();

		foodEnergy();

		if (String(rand2) == "9")
		{
			myTimer9.addEventListener(TimerEvent.TIMER, foodfunc);
			myTimer9.start();
		}
		else if (String(rand2) == "10")
		{
			myTimer10.addEventListener(TimerEvent.TIMER, foodfunc);
			myTimer10.start();
		}
		else if (String(rand2) == "11")
		{
			myTimer11.addEventListener(TimerEvent.TIMER, foodfunc);
			myTimer11.start();
		}
```

```
		else if (String(rand2) == "12")
		{
			myTimer12.addEventListener(TimerEvent.TIMER, foodfunc);
			myTimer12.start();
		}
		else if (String(rand2) == "13")
		{
			myTimer13.addEventListener(TimerEvent.TIMER, foodfunc);
			myTimer13.start();
		}
		else if (String(rand2) == "14")
		{
			myTimer14.addEventListener(TimerEvent.TIMER, foodfunc);
			myTimer14.start();
		}
		else if (String(rand2) == "15")
		{
			myTimer15.addEventListener(TimerEvent.TIMER, foodfunc);
			myTimer15.start();
		}
		else
		{
			myTimer16.addEventListener(TimerEvent.TIMER, foodfunc);
			myTimer16.start();
		}

	}
	if (i == 5)
	{
		rand3 = randomizor3;
		gotoAndStop("Slide" + rand3);

		var music3:Sound = new Sound(new URLRequest(rand3 + ".mp3"));
		var sc3:SoundChannel = music3.play();

		largeScaleApps();


		if (String(rand3) == "17")
		{
			myTimer17.addEventListener(TimerEvent.TIMER, largefunc);
			myTimer17.start();
		}
		else if (String(rand3) == "18")
		{
			myTimer18.addEventListener(TimerEvent.TIMER, largefunc);
			myTimer18.start();
		}
		else if (String(rand3) == "19")
		{
			myTimer19.addEventListener(TimerEvent.TIMER, largefunc);
			myTimer19.start();
		}
		else if (String(rand3) == "20")
		{
			myTimer20.addEventListener(TimerEvent.TIMER, largefunc);
			myTimer20.start();
		}
		else if (String(rand3) == "21")
		{
			myTimer21.addEventListener(TimerEvent.TIMER, largefunc);
			myTimer21.start();
		}
		else if (String(rand3) == "22")
		{
			myTimer22.addEventListener(TimerEvent.TIMER, largefunc);
			myTimer22.start();
		}
		else if (String(rand3) == "23")
		{
```

```
				myTimer23.addEventListener(TimerEvent.TIMER, largefunc);
				myTimer23.start();
			}
			else
			{
				myTimer24.addEventListener(TimerEvent.TIMER, largefunc);
				myTimer24.start();
			}

		}
		if (i == 6)
		{
			rand4 = randomizor4;
			gotoAndStop("Slide" + rand4);

			var music4:Sound = new Sound(new URLRequest(rand4 + ".mp3"));
			var sc4:SoundChannel = music4.play();

			powerApps();
			if (String(rand4) == "25")
			{
				myTimer25.addEventListener(TimerEvent.TIMER, powerfunc);
				myTimer25.start();
			}
			else if (String(rand4) == "26")
			{
				myTimer26.addEventListener(TimerEvent.TIMER, powerfunc);
				myTimer26.start();
			}
			else if (String(rand4) == "27")
			{
				myTimer27.addEventListener(TimerEvent.TIMER, powerfunc);
				myTimer27.start();
			}
			else if (String(rand4) == "28")
			{
				myTimer28.addEventListener(TimerEvent.TIMER, powerfunc);
				myTimer28.start();
			}
			else
			{
				myTimer29.addEventListener(TimerEvent.TIMER, powerfunc);
				myTimer29.start();
			}
		}

		if (i == 7)
		{
			gotoAndStop("End");
			myTimerFinal.addEventListener(TimerEvent.TIMER, endscreen);
			myTimerFinal.start();

		}
	}

}

function endscreen(event:TimerEvent):void
{
	myTimerFinal.stop();
	gotoAndStop("Home");
	i = 0;
	stage.focus = EnergyNumber;

}


// agefunc
function agefunc(event:TimerEvent):void
{
```

```
		myTimerAge.stop();
		stage.focus = answerBox1;
		AgeEnter.text = String("Enter your age:");
		returnHome();
		clearScreen();
}

// StepFunc
function stepfunc(event:TimerEvent):void
{
		myTimerStep.stop();
		stage.focus = answerBox2;

		StepEntry.text = ("Enter the number from your pedometer:");
		returnHome();
		clearScreen();

}

function returnHome():void
{
		stage.addEventListener(KeyboardEvent.KEY_DOWN,checkKeysHome);
		function checkKeysHome(event:KeyboardEvent):void
		{
				if (event.keyCode == 40)
				{

						gotoAndStop("Home");
						i = 0;
						stage.focus = EnergyNumber;

				}
		}
}

function clearScreen():void
{
		stage.addEventListener(KeyboardEvent.KEY_DOWN,checkKeysClear);
		function checkKeysClear(event:KeyboardEvent):void
		{
				if (event.keyCode == 37)
				{
						if (i == 1)
						{
								answerBox2.text = "";
								stage.focus = answerBox2;
						}
						else if (i == 2)
						{
								answerBox1.text = "";
								stage.focus = answerBox1;
						}
				}
		}
}

function smallfunc(event:TimerEvent):void
{
						if (String(rand1) == "1")
						{
								myTimer1.stop();
								returnHome();
						}
						else if (String(rand1) == "2")
						{
								myTimer2.stop();
								returnHome();
						}
						else if (String(rand1) == "3")
						{
```

```
				myTimer3.stop();
				returnHome();
			}
			else if (String(rand1) == "4")
			{
				myTimer4.stop();
				returnHome();
			}
			else if (String(rand1) == "5")
			{
				myTimer5.stop();
				returnHome();
			}
			else if (String(rand1) == "6")
			{
				myTimer6.stop();
				returnHome();
			}
			else if (String(rand1) == "7")
			{
				myTimer7.stop();
				returnHome();
			}
			else
			{
				myTimer8.stop();
				returnHome();
			}
	stage.focus = EnergyNumber;
}

function foodfunc(event:TimerEvent):void
{
	if (String(rand2) == "9")
	{
		myTimer9.stop();
		returnHome();
	}
	else if (String(rand2) == "10")
	{
		myTimer10.stop();
		returnHome();

	}
	else if (String(rand2) == "11")
	{
		myTimer11.stop();
		returnHome();
	}
	else if (String(rand2) == "12")
	{
		myTimer12.stop();
		returnHome();

	}
	else if (String(rand2) == "13")
	{
		myTimer13.stop();
		returnHome();

	}
	else if (String(rand2) == "14")
	{
		myTimer14.stop();
		returnHome();

	}
	else if (String(rand2) == "15")
	{
		myTimer15.stop();
```

```
                returnHome();

        }
        else
        {
                myTimer16.stop();
                returnHome();

        }
        stage.focus = EnergyNumber;
}

function largefunc(event:TimerEvent):void
{
        if (String(rand3) == "17")
        {
                myTimer17.stop();
                returnHome();

        }
        else if (String(rand3) == "18")
        {
                myTimer18.stop();
                returnHome();

        }
        else if (String(rand3) == "19")
        {
                myTimer19.stop();
                returnHome();

        }
        else if (String(rand3) == "20")
        {
                myTimer20.stop();
                returnHome();

        }
        else if (String(rand3) == "21")
        {
                myTimer21.stop();
                returnHome();

        }
        else if (String(rand3) == "22")
        {
                myTimer22.stop();
                returnHome();

        }
        else if (String(rand3) == "23")
        {
                myTimer23.stop();
                returnHome();

        }
        else
        {
                myTimer24.stop();
                returnHome();

        }
        stage.focus = EnergyNumber;
}
// Powerfunc
function powerfunc(event:TimerEvent):void
{
        if (String(rand4) == "25")
        {
                myTimer25.stop();
```

```
				returnHome();

		}
		else if (String(rand4) == "26")
		{
				myTimer26.stop();
				returnHome();

		}
		else if (String(rand4) == "27")
		{
				myTimer27.stop();
				returnHome();

		}
		else if (String(rand4) == "28")
		{
				myTimer28.stop();
				returnHome();

		}
		else if (String(rand4) == "29")
		{
				myTimer29.stop();
				returnHome();

		}
		else if (String(rand4) == "30")
		{
				myTimer30.stop();
				returnHome();

		}
		else if (String(rand4) == "31")
		{
				myTimer31.stop();
				returnHome();

		}
		stage.focus = EnergyNumber;
}

/**
* Generate a random number
* @return Random Number
* @error throws Error if low or high is not provided
*/
function randomNumber(low:Number=NaN, high:Number=NaN):Number
{
  var low:Number = low;
  var high:Number = high;

  if(isNaN(low))
  {
    throw new Error("low must be defined");
  }
  if(isNaN(high))
  {
    throw new Error("high must be defined");
  }

  return Math.round(Math.random() * (high - low)) + low;
}

/*
rounding function
*/
function roundDecimal(num:Number, places:Number):Number
{
return int( (num) * Math.pow(10, places) ) / Math.pow(10, places);
```