Project Proposal: Accessible Weight Scale for Seated Users

By James I. Johnson
Patrick Tshilenge
Gregory Whitehouse

Client Contact:
Dr. John D. Enderle, Ph.D
University of Connecticut
Bronwell Building, Room 217C
260 Glenbrook Road
Storrs, Connecticut 06269-2247
Phone: (860) 486-5521
Fax: (860) 486-2500
Email: jenderle@bme.uconn.edu

Table of Contents

Executive Summary

This document is a proposal for the design and construction of an accessible weight scale for seated users. The introduction contains background information on our clients, the purpose of this project, and information on similar devices from past projects, current products and patents. The project description section provides an overview and detailed description of the project and how it will be implemented. The budget section contains a detailed account of the projected price of all of the components that will be needed to construct the accessible weight scale. The conclusion section gives a summary of the project and highlights the important points that make this product unique.

1 Introduction

1.1 Background (client and disability)

The majority of the clients for the Accessible Weight Scale for Seated Users typically has difficulty standing unaided and may have limited arm strength in either the right or left arm as well as limited eye sight. The users are generally older and would therefore prefer a simple easy to use scale that will not confuse them or demand a strong memory. A more complete description of the clients was provided by the RERC-AMI and is shown below.

1. Phylis is an active 77-year-old woman with rheumatoid arthritis that has caused diminished hand strength, joint stiffness, and pain. Phylis also has age-related macular degeneration and hearing loss, but she is determined to remain active and independent. Although she is outgoing and bold in general,

she is easily intimidated by many of the high-tech gadgets her grandchildren use; she prefers simple interfaces.

2. Aaron is a 23-year-old man, a returning Iraq war veteran, with an arm amputation above the elbow, chronic neck pain and recurring headaches. Although Aaron sometimes wears a prosthetic device with a pinching mechanism, most often he improvises and uses one hand to complete tasks. He takes a number of medications, mostly for pain management.
3. Keisha is an 84-year-old woman who recently had a stroke, causing hemiplegia on her right side that has affected the function of her dominant hand. She has also experienced some memory loss after the stroke, so she appreciates the reminders her family provides her. Before the stroke, Keisha had minor hearing loss, and it has continued to worsen in recent years due to aging. Although she wears a hearing aid every once in a while if she's going out, at home and at most other times she does not use it. She also has occasional challenges with incontinence.
4. Jerry is an 82-year-old man with Parkinson's disease, which causes him to have tremor, rigidity, and decreased range of motion; he also has difficulty with urinary control. Jerry has recently started experiencing symptoms of Dementia, but with the help of his family he is determined to remain in his own home as long as possible.
5. Jamie is a 42-year-old woman with a T11 spinal cord injury. She mainly uses a manual wheelchair and is a serious wheelchair basketball athlete. She would like to have better control of her urinary function while participating in athletic activities.
6. Betty is a 65-year-old woman who has limited and asymmetrical lower extremity range of motion due to a bad hip. She also has limited strength in her right leg due to decreased use of her right leg because of the pain caused by her hip.
7. Violet is a 32-year-old woman of short stature who is on blood pressure medication. She is also a mother of 3, and is very active within her family and community.
8. Paul is a 43-year-old man with diabetes. The diabetes has caused neuropathy in his hands and feet, which eventually necessitated two below-the-knee amputations, and some loss of vision.

1.2 Purpose of the project

There are many people in the United States who have difficulty standing because of obesity, old age, rheumatoid arthritis, amputation, etc. These Americans may also have trouble exercising, maintaining their weight and monitoring their weight. These people are expected to come into the hospital to weigh themselves or purchase expensive and bulky weight scales that require the help of another person to operate.

The purpose of our project is to design and build an inexpensive, comfortable, easy-to-use, easy-to-sanitize, weight scale for seated users that will allow our clients to

conveniently and easily measure their weight several times a day without the aid of another person.

1.3 Previous work done by others

A similar RERC project was completed in the spring of 2005 by a group of UConn seniors. The device was an accessible weight scale for in home use. The device was a platform that the user could wheel their wheel chair onto in order to measure their weight. The scale features a wireless design that allows for an easily accessible hand display. The scale is able to measure up to 500 lbs in less than thirty seconds with a weight resolution of 0.5lbs. Some difficulties with this design is that it has a fairly long and complicated operating procedure; requiring the user to determine the units they want the measurement in prior to turning on the device. Also the user has to tare the weight scale with the wheel chair on the scale in order to receive their weight measurement.[1]

1.3.1 Products

There are no toilet seat scales currently available on the market for seated users. However, there are many other scales designed to be used by seated users. Most of the scales available on the market do not meet the specifications of our device. For example, when searching the ABELDATA website for a similar product to the accessible weight scale for seated users, the Sitting Scale (MODEL 6461) is found. This scale is capable of measuring a seated user's weight at an accuracy of 1 lb with a capacity of only 250 lbs. The device does not support the user's feet, which means the user will have to keep their feet elevated on their own in order to achieve an accurate measurement. The device is also not capable of storing past readings and because the display for the user's weight is in the rear of the scale, this device requires the aid of another person to use. The Sitting Scale has a price of only $200, but does not come close to meeting the specifications of the accessible weight scale for seated users.[2]

Figure 1 Sitting Scale (MODEL 6461)

There are scales currently on the market that are able to operate within the specifications of this project. One such scale is the Model 595KL Digital Chair Scale produced by Healthometer. This scale has similar specifications to our device being able to measure a maximum capacity of 600lbs to an accuracy of within one fifth of a pound.

[1] http://www.bme.uconn.edu/sendes/Spring05/Team2/Index.htm

[2] http://www.abledata.com/abledata.cfm?pageid=113583&top=0&productid=81062&trail=0

The scale is designed similar to a wheelchair that requires the assistance of another person to move and is not capable of storing past readings. The device is also rather expensive at retail price of $1,169.[3]

Figure 2 Healthometer Model 595KL Digital Chair Scale

A similar product to the Healthometer model is the Detecto Model 6876 Euro Chair scale w/ Flip-Seat. This scale has a capacity of 600lbs with an accuracy of one fifth of a pound and is capable of measuring the Body Mass Index of the user. The Detecto model also does not store readings, is bulky and requires the assistance of another individual to read the LCD screen. This device is also rather expensive with a retail price of $1,749.[4]

Figure 3 Detecto Model 6876 Euro Chair Scale w/ Flip-Seat

1.3.2 Patent Search Results

A search of United States patents of similar devices to the accessible weight scale for seated users resulted in United States Patent 20070061953. This patent is for a toilet seat cover scale. The patent does not say whether it provides leg support to aid the user in keeping their feet off the floor and does not seem to provide any support for a person with limited leg strength to get onto the scale. The device also does not appear to store past readings so that the user can monitor their weight closely. [5]

[3] http://www.northshorecare.com/chair-healthometer-scale.html

[4] http://www.northshorecare.com/detecto-chair-scale.html#

[5] http://www.freepatentsonline.com/20070061953.html

2 Project Description

2.1 Objective

The objective for this project is to create an accessible weight scale for seated users; allowing a person with limited mobility to easily and conveniently monitor their weight independently. The scale will be incorporated into a toilet seat for maximum convenience and comfort. The device will have several components including a hand held console for user interface, sensors attached to the bottom of a toilet seat and a circuit compartment that can be stored behind or next to the toilet. In designing the weight scale it is important to keep in mind the specific needs of the clients. Some of the limitations that our clients have are limited strength in one or both legs, limited strength in one arm or hand, limited eye sight, and poor memory.

Some seated weight scales require that the user keeps their feet off the ground in order to take an accurate measurement. The fact that many of our clients have limited strength in their legs, the seated weight scale will have leg support in order to make sure that all of the weight is accounted for in the measurement. Also the device will have hand rails to make it easier for the user to get on and off of the device.

The accessible weight scale will make use of a hand held console that will allow the user to independently take their own weight measurements without the aid of another person. Because some of the users have limited eyesight, the LCD display will be relatively large and easy to read. Also, because some of our clients have limited mobility or arm strength on one of their sides the console will be light weight and come with Velcro straps that can be attached to the console and another accessible mounting surface. This will allow the user to choose a place that is most convenient place in their bath room to mount the console, where it can be easily read and used.

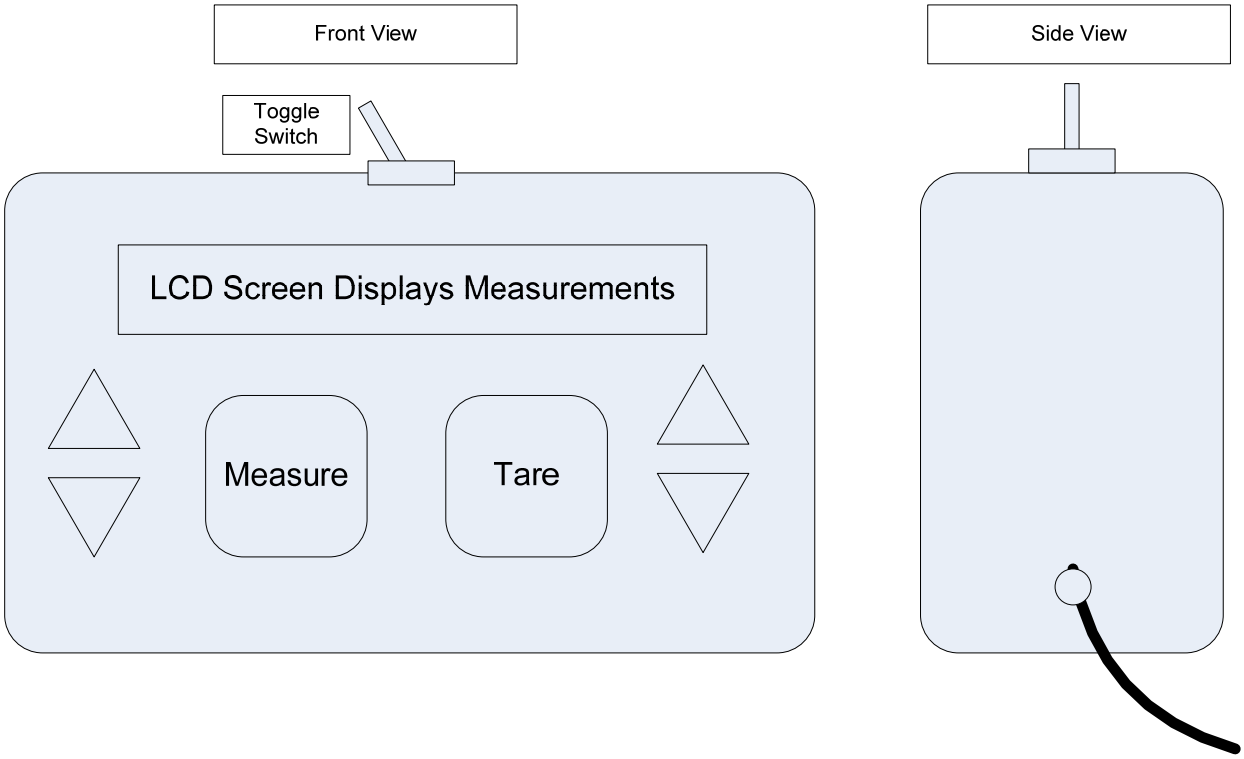
Another important design consideration will be keeping the number of user inputs low. The device should not require the user to do much more than push a few buttons in order to take the readings and to view past readings. A simple interface is paramount to allowing the user to use the device conveniently and without the aid of another person. A block diagram of the operation procedure for the device is provided in the methods section of this report.

In addition to the other requirements for this device, it is important to take into consideration that the device will be used in a bathroom. The fact that the device will be used in the bathroom means that the device will have to be resistant to water and humidity. Also, the device should be relatively aesthetically pleasing. Most people like to have nice looking bathrooms and a device that is not aesthetically pleasing would be detrimental to the user's desire for a clean looking bathroom. To accomplish this, the sensors for the scale will be attached to the bottom of a toilet seat. The sensors will then be connected to a separate console that can be stored behind or next to the toilet. This console will contain the majority of the wires and electrical components that make up the device.

2.2 Methods

The accessible weight scale will have three main components, the handheld console, the toilet seat and the circuit compartment. The first component is a lightweight handheld console, which will act as the user interface for the device. It will display the readings for the user on the LCD screen. As stated previously, the LCD screen will have large and easy to read characters to aid users with limited eyesight. There will be a toggle switch located at the top of the hand held device allowing the patient to easily turn the device on and off. There is also a clearly labeled measure button, that when pressed will take a new measurement. There is also a "Tare" button that will be used to tare the device prior to the user getting onto the seated scale. The triangular up and down buttons will allow the user to scroll through previous readings. These buttons are on both the right and left hand side of the console in case some users have difficulty using one of their hands. The device will come with Velcro straps allowing the user to decide where they would like to mount the hand held console. The Velcro should be attached to the back side of the device. From the side view in Figure 4 it is possible to see where the handheld console will be connected to the electrical component compartment.

Figure 4 Preliminary Handheld Console



The second component of the device is the toilet seat. This part of the device will have the load cells on the bottom of the toilet seat. There will be four load cells used in order to evenly distribute the weight of the user onto the load cells. Their relative positions on the bottom of the toilet seat will have to be determined in order to ensure that the weight is distributed as evenly as possible. Load cells are measuring devices that

transform applied forces into an electrical output either analog or digital. For the accessible weight scale, the cells will measure the compression force. When a force is applied on the load cell it deforms the strain gage inside the load cell. The deformation, which is also called strain, is then measured and converted into an electrical signal. Four load cells of capacities of more then 200lbs will be used on the toilet. The total weight capacity for the device will be greater than 500lbs. There will be wires that will connect the load cells on the bottom of the toilet seat. These wires will connect with the electrical component compartment next to the toilet. These wires should not be loose. They will either be drawn through the toilet in the final design or secured in such a way as to not be dangerous for the user. Figure 5 shows how the wires will be connected to the load cells and the electrical component compartment.

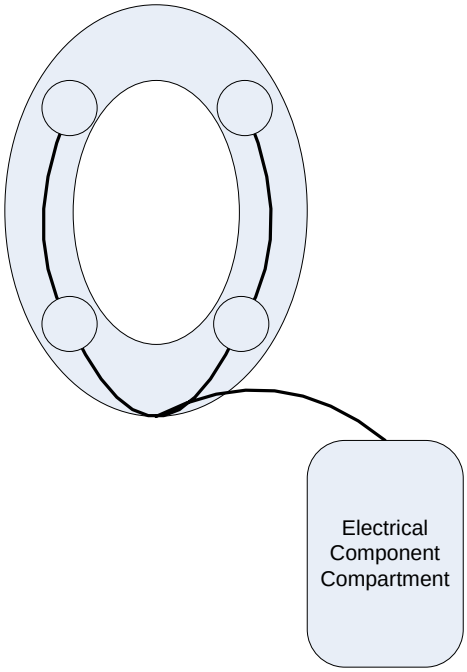


Figure 5 Toilet Seat Wiring

Figure 6 shows the total accessible weight scale system. The toilet seat will also have handrails and leg support attached to it in order to provide the support that the user needs to get on and off the device. The foot support will be attached directly to the toilet seat in order to ensure that all of the user's weight is distributed onto the toilet seat. The handheld component of the device can be attached to the side of the toilet and the electrical component compartment can be stored next to the toilet.

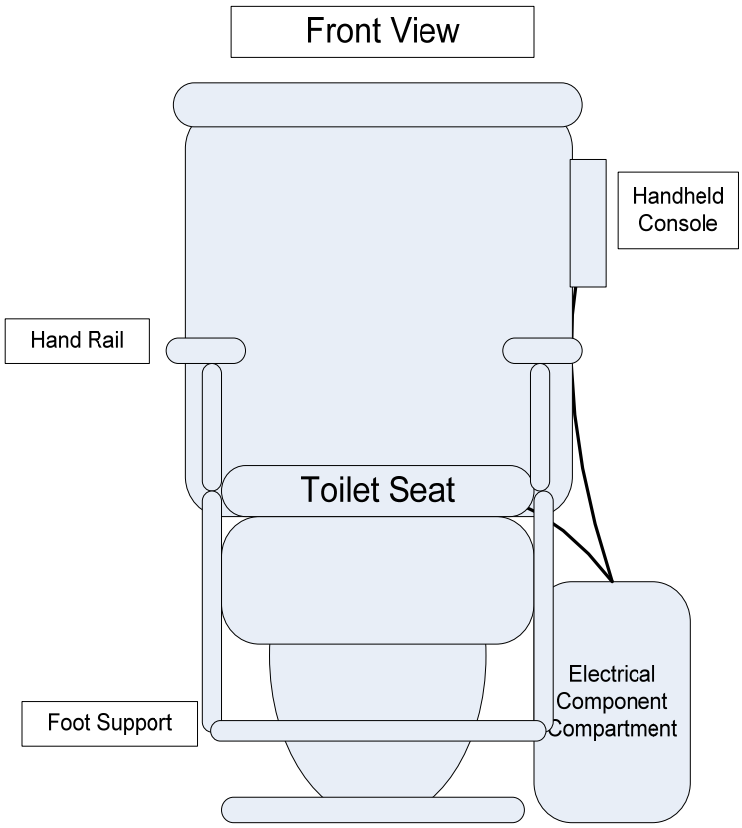


Figure 6 Toilet Seat Scale

The electrical component compartment will act as the bulk of the device. It will take the user inputs from the hand held console and signal the load cells to take a measurement when necessary. The electrical component compartment will have a PCB board with a microprocessor. The microprocessor is the command center of the device. It does most of the crucial functions. First the microprocessor receives the electrical signal from the load cell and it transforms it to mass measurements in pounds and kilograms using conversion equations programmed directly into the microprocessor. The microprocessor will then send the information to the LCD. The microprocessor will also have to have a certain amount of memory. The microprocessor will be able to store up to 10 or 20 previous readings. The entire measurement process will have to be completed within 10 seconds, starting from when the user presses the measurement button and ending when the values are displayed on the LCD screen. The device will be powered by a battery, probably a lithium battery, which will also be stored from within the electrical component compartment.

Operation Procedure

Figure 7 shows a block diagram of the operation procedure for the accessible weight scale for seated users below. The user inputs are shown in rectangles with

rounded edges and the actions completed by the accessible weight scale are shown in rectangular boxes with sharp edges.

To operate the device the user will pick up the hand held console and press turn the analog switch to the “ON” position. The user will then press the “Tare” button on the hand held console. The device will then take a reading, which will be used to differentiate between the weight of the user and the weight of the seat. Next the LCD screen interface will display the message “Please be seated on the scale and press the measure button when ready.” The user now has two choices. He or she can get on the scale and take a measurement or they can view past measurements by pressing the scroll up or down key.

To take a new measurement the user will get on the scale and press the “Measure” button. At this point the sensors under the seat will send the reading to the microprocessor which will subtract the current weight from the one measured prior to the user getting on the device. This will be the measurement of the user’s weight, which will be converted into kilograms and pounds, stored in the memory, and displayed for the user on the LCD screen. The user now has the option of turning off the device or viewing past measurements.

The user can scroll through past measurements by pressing the up or down arrow on the user interface. These weights will be displayed in both kilograms and pounds. Figure 7 shows the block diagram of the process outlined above.

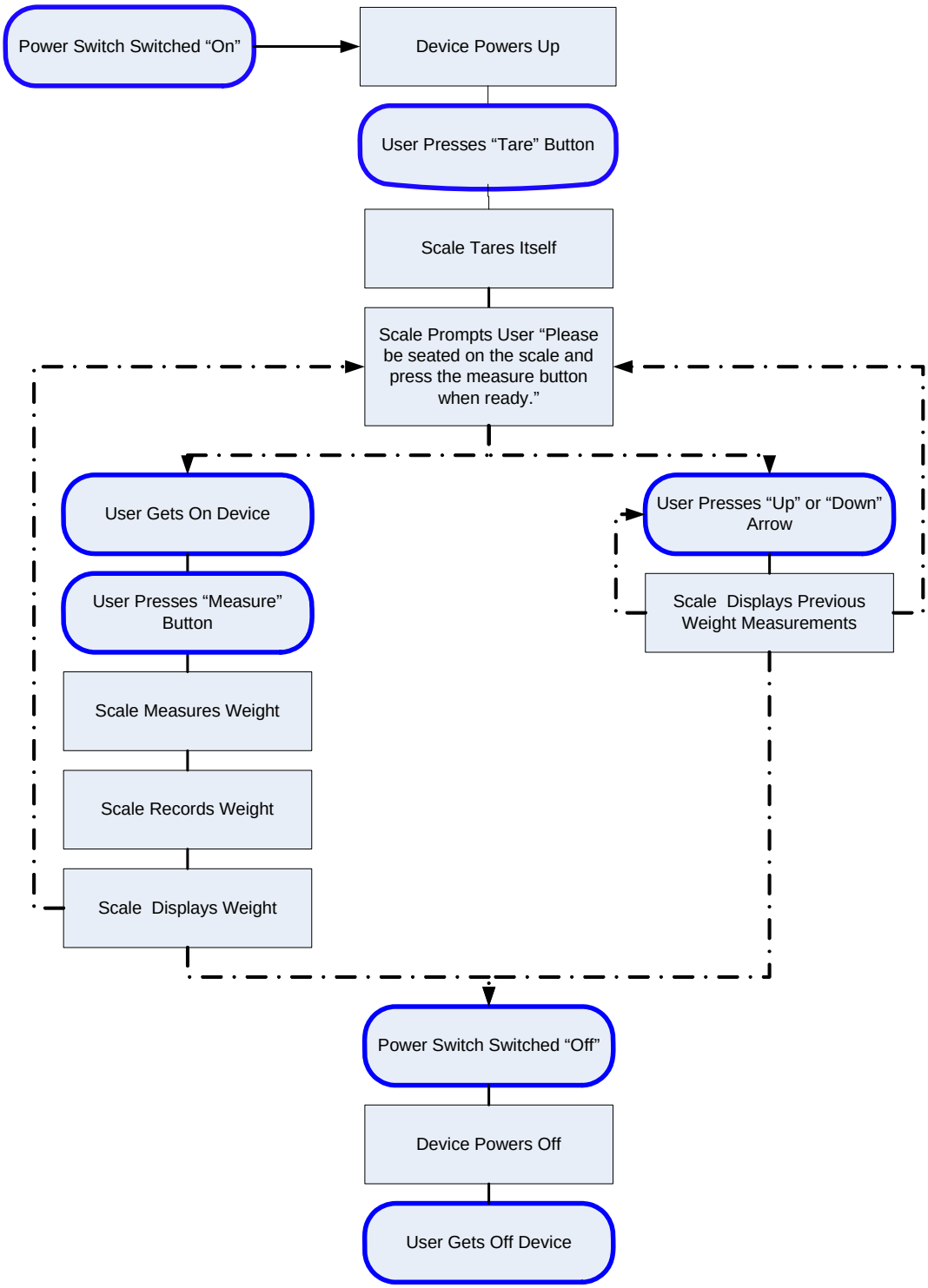


Figure 7 Block Diagram of Scale Operation

3 Budget

The total budget for the project is $2000 as provided by the RERC. One aim of the project is to keep it convenient and cost effective while meeting all of the needs of the clients outlined in the background section. Keeping the product cost effective will require as low of a production cost as possible. The following table contains the materials/products that the design team intends to use in order to produce the Accessible Weight Scale for Seated Users.

Product	Cost
Toilet Seat	$50 - $100 (due to choice of either standard toilet seat or raised with possible handrails)
Support Handles	$100
Electrical Components	$100
LCD Screen	$10
Buttons/Toggle Switch	$20
Casing Enclosure	$20 - $50 (Could be machined at low or no cost)
PIC Microprocessor	$5
Lithium Batteries	$20 - $30
PCB Board	$205
Strain Gauges/Weight Sensors	$300 (Waiting for official quote)
TOTAL	$920

Table 1: Breakdown of Budget

As with any engineering design project, there will be challenges faced during the design that will require changes to the project; therefore, the budget will be subject to change as the design team modifies and/or updates the design. Also, it is expected that the total production cost will be greater than the cost of the actual product to ensure that the optimal prototype is produced. It is estimated that the overall cost of the finished product will be $920, which is significantly lower than the allotted $2000 and will allow for minor errors and changes as the product is made. The cost of the finished product will be the overall cost of the prototype. Therefore, the cost of the product after the finished prototype will be 35% of the prototype cost, making the product an estimated $350. This is a very marketable price for such a convenient and useful device, especially when compared to other or similar products on the market. The estimated overall cost of the finished accessible weight scale falls into the 35% of the total prototype costs.

4 Conclusion

The accessible weight scale for seated users project is quite a unique one and is being designed in order to provide a convenient way for people with disabilities to weigh themselves during the day. The product is unique because it is integrated into a toilet seat and will be able to keep the user stable with handles or handrails. It will be as user-friendly as possible in order to comply with the needs of the client list and to keep it highly convenient. The accessible weight scale will have to be aesthetically pleasing and will be such that it can be used in both home settings and clinical settings. Keeping the

product battery powered will also be convenient for users as there will be no power supply to get in the way. The design team will produce a product that can essentially raise the standard of living for people in wheelchairs and people with disabilities.

Although there are already toilet seats with handrails for disabled users in the market, accessible weight scales integrated into toilet seats are not currently available. There are, as shown earlier, chair weight scales which can be helpful for disabled users; however, they have costs greater than one thousand dollars and do not provide the convenience that the toilet seat weight scale will provide. There is also a sitting scale, as formerly shown, that has a price of $200, but does not offer the specifications and capabilities that the accessible weight scale for seated users offers. The cost of the accessible weight scale will be cheaper than the currently available weight scales for disabled users, save the sitting scale, which is beneficial to the customer who purchases the product. Furthermore, due to the originality of the product, and the lack of a toilet seat scale in the market, there should not be any market issues. The budget has been projected to be well within the allotted $2000; therefore, there should not be any budget issues, and the design team will be able to produce the optimal prototype. The accessible weight scale for seated users will utilize biomedical engineering principles and technology to provide a product that will enhance the standard of living for disables persons, as well as provide convenience in the home and clinical settings.