Asäna

January 18, 2010

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440 Project Proposal for a Wireless Weight Distribution Scale

Dear Dr. Rawicz:

Our team at Asäna is proposing to build a Wireless Weight Distribution Scale for ENSC 440 in the document that follows. The importance of proper weight distribution in a standing position can be often overlooked unless it is directly affecting you. The proposed wireless weight distribution scale will allow the user to measure quantitatively how balanced their standing posture is.

The proposal will outline our goal with the weight distribution scale, along with the proposed design solution. To further strengthen this project, we have addressed the budgeting and funding of the parts required to proceed with development. Project scheduling and team organization will be an important factor to our success and we have also addressed this in our proposal. Our last supporting factor is that we have a wealth of knowledge from our sources of information discussed in this proposal.

Asäna consists of four engineering students all in their last year of studies, and all with co-op experiences. Our members Sam Leung, Sasan Naderi, Gurpal Sandhu, and Wil Gomez have worked together successfully in the past, and Asäna should be no different. For further inquiries about our company or this proposal, please reach us by email at ensc440-asana@sfu.ca, or by phone at 778.861.3371.

Sincerely,

Sam Leung

Sam Leung
Chief Executive Officer
Asäna

Enclosure: *Proposal for a Wireless Weight Distribution Scale*

Proposal for a

Wireless Weight Distribution Scale

Prepared for

Dr. Andrew Rawicz – ENSC 440
Steve Whitmore – ENSC 305
School of Engineering Science
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Project Members

Sam Leung
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Team Contact

ensc440-asana@sfu.ca

January 18, 2010

EXECUTIVE SUMMARY

From the very early stages of childhood to later stages of adulthood our bodies are constantly changing in physical form. These changes may be attributed to the environment we expose ourselves to, experiences we go through, or in some cases something much deeper such as a genetic disorder like scoliosis. They all can affect the ideal weight distribution for the human body which is necessary for maintaining a healthy (proper) standing posture.

Consider Bob a middle aged warehouse worker who has noticed some back pain that has gradually gotten worse over time. At first he thinks it's just from overusing his back at the workplace. Consulting with his family physician, he discovers that the problem is much greater than he expected. The doctors have concluded that he has spinal misalignment in his lower back. Further investigation is done to find the root cause and they find that Bob has a rare condition where one of his legs is slightly longer than the other. This caused Bob to develop poor standing posture that caused an uneven weight distribution in his body. Over time the weight imbalance took a toll on his back leaving it misaligned. Had Bob received some sort of indication letting him know of his rare condition earlier on, Bob could have taken action to remediate his problem before it had negatively affected his life.

Our objective is to design and develop a tool that will measure weight distribution in both the coronal and sagittal planes. The measurements captured can be used for applications such as developing prosthetics, tracking the rehabilitation progress for injured patients and even preventing situations like the one described above.

The three main goals for the project are as follows:

- To create a scale capable of measuring weight distribution of a person in a standing posture
- To interface wireless transmission capabilities to the scale to be able to send data measurements to a computer for analysis purposes
- To make software for the computer allowing it to analyze and store the measurements taken in an appropriate fashion

The team involved in this project consists of four engineering students with varying backgrounds in software, hardware, wireless communications, and project management. We have all previously worked in hi-tech companies, thus exposing us to projects of much larger scale than the one we are proposing. Nevertheless we plan to take careful consideration when scheduling and budgeting with the whole entirety of the project. All things considered we propose a completion time of 3 months at an approximate cost of $690. In that timeline we will develop a fully working prototype along with full documentation noting all our design specifications.

Table of Contents

Revision History

TABLE 1: REVISION HISTORY

Version	Date	Summary of Changes
1.0	11/01/2010	Initial draft created
1.1	15/01/2010	Rough draft completed
1.2	17/01/2010	Modifications to layout and formatting made. Addition of executive summary, company logo.
1.3	18/01/2010	Editing completed and references added. Final review and acceptance by all team members

1. Introduction

The human body weight can be described in ways beyond a single number, leading to a source of abundant and valuable information describing the health and overall well-being of the human body. Body weight distribution among the two contact points bearing the load can provide awareness to possible health risks associated with lifestyle, illnesses, genetic disorders, injuries, etc.

Posture is defined by the weight distribution and center of balance of the human body. Changes in posture can result in weight fluctuation throughout the day and also over time. By measuring weight distribution in the coronal and sagittal planes, we are given better insight to posture. Health conditions such as scoliosis, muscle atrophy, and lower back pains associated with posture can be linked to weight distribution. Also, sports rehabilitation can benefit from studying weight distribution to better treat postsurgical orthopedic and non-surgical rehabilitation patients. Measuring and recording the human weight and its distribution can assist in sports rehabilitation and provide analysis of health conditions associated with posture.

The Wireless Weight Distribution Scale uses a wireless transmitter to send collected data from the digital scale to a personal computer for post analysis. The scale collects the overall weight and its distribution from load cells positioned in each quadrant of the scale. As such, this information can be monitored and tracked on a personal computer.

This proposal will outline the design solution and system overview of the Wireless Weight Distribution Scale. Funding, budgeting, scheduling, and addressing the sources of information will assess the feasibility of the Wireless Weight Distribution Scale.

2. System Overview

Figure 1 shows how the Wireless Weight Distribution Scale will operate. The scale itself will be similar in dimensions and structure to a regular digital scale. However, it performs more complex tasks like determining the user's balance through weight distribution calculations and transmitting all obtained information wirelessly to a local PC for analysis.

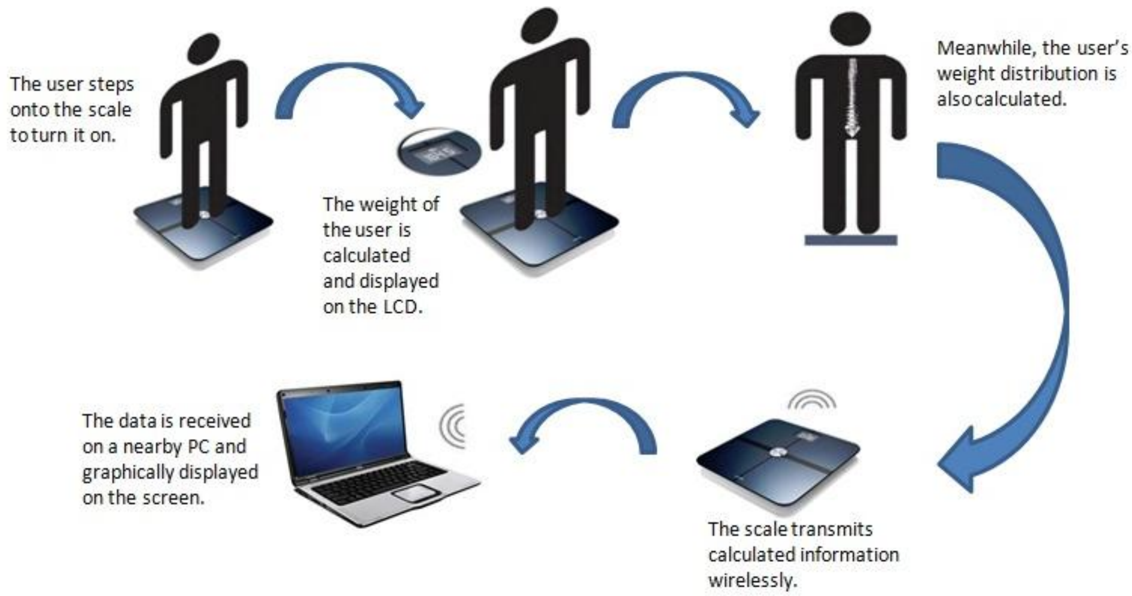


FIGURE 1: SYSTEM OPERATION

The data received by the PC is displayed graphically on the screen and compiled into a graph consisting of past data points. This is automatically done by our application which allows the user to monitor their health information and easily identify any existing trends.

Figure 2 shows the system block diagram which illustrates how the components of the Wireless Weight Distribution Scale operate.

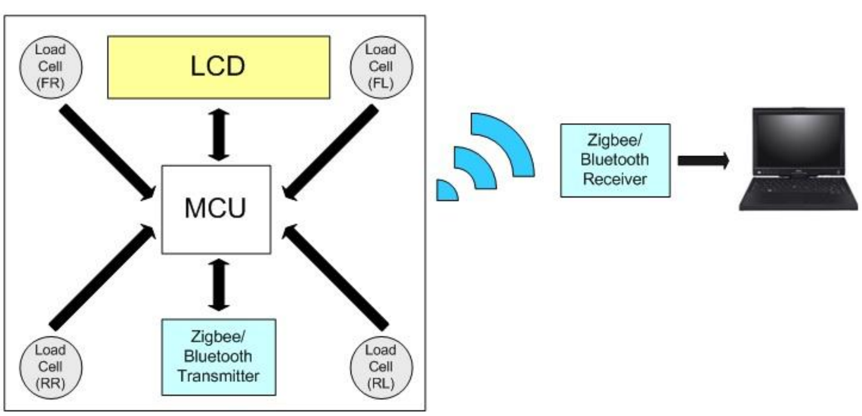


FIGURE 2: SYSTEM OVERVIEW

3. Possible Design Solutions

The proposed capabilities of the scale we plan to build comprises of various technologies and features that already exist in standalone scales with the exception of the ability to determine weight distribution. There have been a few examples of scales that can transmit data wirelessly but none using a low power protocol which we plan to use. Below is a summary comparing different approaches which outline their capabilities and limitations.

Pressure sensors can detect the weight distribution by determining the pressure applied against a liquid or gas. Differential pressure sensors specifically, measure weight by taking the difference between two pressures applied to a unit. They can take very accurate readings but have a disadvantage of being temperature dependant and of being difficult to integrate.

Strain gauge sensors can also be used to determine weight. They work by measuring the difference in resistance of a piece of metal when it's stressed from an applied force. They are cheap to make and take relatively accurate measurements. Some scales on the consumer market use this method to measure weight. By characterizing these strain gauge sensors with standardized weights to produce a voltage versus weight graph, we can predictably configure our scale to create accurate results.

Linear Variable Differential Transformer (LVDT) sensors are electrical transformers that can be used to measure linear displacement. The displacement of the measurement is determined from the movement of the armature, which is the magnetic core between the primary and secondary coils of the transformer. LVDT sensors provide high precision and accuracy. However they only support a small amount of weight which is not suitable for our application.

As mentioned previously there are scales already in the market that can transmit data wirelessly. They use Wi-Fi or Bluetooth as their wireless protocol, which has the advantage of sending data at a fast rate within a moderate range. An issue that is foreseeable is the power consumption of the device using said wireless protocols. In order to prolong the battery life of the device, our implementation will use a wireless protocol with lower power consumption.

4. Proposed Design Solution

Our design solution will record the overall weight and weight distribution of the user when standing on our digital scale. The user's weight distribution offers an insight to health issues associated with improper postures. Identifying the weight-distributed in the human body can add to the research of medical conditions such as scoliosis, muscle atrophy, obesity, and various lower back pains associated with posture. In addition to health risk issues, monitoring the weight distribution of injured athletes can assist in sports rehabilitation, such as postsurgical orthopedic rehab.

The product will integrate a wireless transmitter with a digital weight scale to send collected data to a personal computer for post analysis. The scale will collect the overall weight and weight distribution from four load cells positioned in each corner of the scale. The information from each cell will show how weight is distributed from the coronal and sagittal planes of the user. The information collected will be displayed on the weight scale. Additionally, the user can also track their record from a personal computer by transmitting data from the digital scale to the computer.

The measurement of the human body weight can be found in the common household bathroom scale. Already, there exist digital weight scales with WiFi that can send body weight data to an external device. In addition to weight scales, Nintendo Wii's balance board has provided users with fitness activities, including Yoga exercises focusing on the center of balance. Our design solution combines the WiFi capability of a digital weighing scale with a balance board to address overall weight and weight distribution. Our product will allow the user to view the information on the scale and on a personal computer containing records of the collected data.

The main constraint in completing this project would be its timeline. Thirteen weeks is allotted to completing this project from the initial design concept to the functioning prototype. The load cells will require fine-tuning to retrieve accurate readings of the overall weight and the weight distribution of the user. Moreover, the wireless transmission of the data will need to be error-free.

If more time is available, additional features can be added to the scale. These features will include the user's BMI and body-composition. Also, the post analysis performed by the application on the local PC will be upgraded to be richer in features such as supporting multiple users.

There is a wide range of information that can be retrieved by the weight of the human body. The Wireless Weight Distribution Scale will only focus on data pertaining to the overall weight and weight distribution of a single user.

5. Source of Information

There is a range of information sources that we have access to during our research and implementation stages. These sources include the obvious and most easily accessible such as the Internet to the more impervious like our contacts to medical professionals. We also have access to a variety of textbooks, research publications, hardware specifications datasheets and online forums at our disposable.

Our group has direct contact with a plethora of informative sources related to human biology and medicine. These include contacts with a practicing and retired family physician, a medical student currently studying to become an orthopedic surgeon, various student contacts in the kinesiology department of SFU and UVIC, and a personal trainer.

In terms of support for technical design and troubleshooting problems, we can rely on several faculty members at SFU who specialize in biomedical research, most notably Dr. Andrew Rawicz. For the bio-mechanical aspect of our project we have contacted Tony Leyland who is a senior lecturer for the department of kinesiology at SFU. Lastly, our teaching assistant Ali Ostadfar can provide help regarding the mechanical aspect of our project, as he has previous mechanical engineering experience.

Also, two of our group members were directly involved in wireless projects at BCIT under the guidance of Bob Gill and Bob Nicholson, who have agreed to provide technical support should the need arise.

6. Budgeting and Funding

Budgeting

The costs for the materials needed to design and implement the Wireless Weight Distribution Scale are outlined in Table 2.

TABLE 2: COST OF PARTS

Equipment List	Estimated Cost ($CND)
Load Cells (4): AnyLoad 202WA @ 60 per cell	240.00
Zigbee Development Kit with Receiver/Transceiver pair	200.00
Microcontroller	120.00
LCD Development Kits: LCD-08884	80.00
Casing	50.00
Total Cost	690.00

Funding

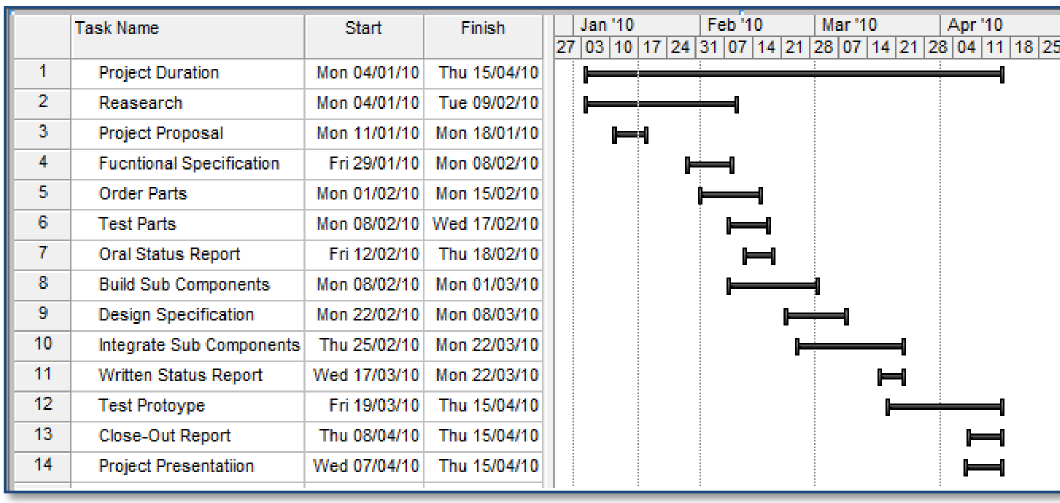
To alleviate the financial burden of designing and implementing the Wireless Weight Distribution Scale prototype from the employees of Asäna, we have applied for funding from the Engineering Science Student Endowment Fund (ESSEF). The total amount that we have applied for is the same that is estimated in our budget. Depending on the funding that is provided from the ESSEF, we may also apply for financial assistance from the Wighton Engineering Development Fund.

In the event that our financial resources fall short to the demands of the project, the employees of Asäna have agreed to divide any debt incurred equally amongst each other. It is the responsibility of the CFO to keep an accurate account of all expenditures in order to operate within the originally planned budget to the best of our abilities.

7. SCHEDULE

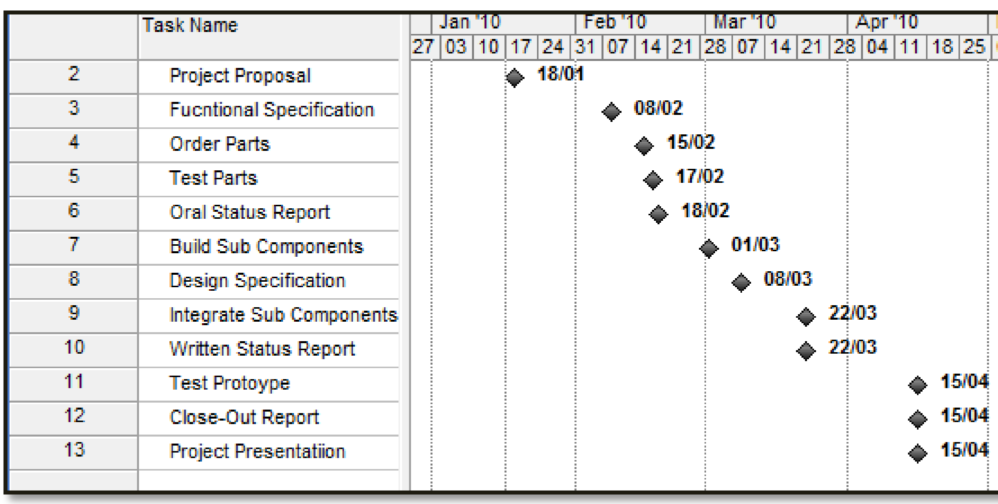
Below is a Gantt chart and Milestone table summarizing the important dates for our project. It has a start date of January 4th with an approximate completion date of April 15th. Each task has been given an appropriate timeline to meet our original requirements. There are some overlaps in the dates but that should not affect our final completion date as some tasks complement each other. Any changes to the dates below will be noted and included in the final report.

TABLE 3: GANTT CHART



	Task Name	Start	Finish
1	Project Duration	Mon 04/01/10	Thu 15/04/10
2	Reasearch	Mon 04/01/10	Tue 09/02/10
3	Project Proposal	Mon 11/01/10	Mon 18/01/10
4	Fucntional Specification	Fri 29/01/10	Mon 08/02/10
5	Order Parts	Mon 01/02/10	Mon 15/02/10
6	Test Parts	Mon 08/02/10	Wed 17/02/10
7	Oral Status Report	Fri 12/02/10	Thu 18/02/10
8	Build Sub Components	Mon 08/02/10	Mon 01/03/10
9	Design Specification	Mon 22/02/10	Mon 08/03/10
10	Integrate Sub Components	Thu 25/02/10	Mon 22/03/10
11	Written Status Report	Wed 17/03/10	Mon 22/03/10
12	Test Protoype	Fri 19/03/10	Thu 15/04/10
13	Close-Out Report	Thu 08/04/10	Thu 15/04/10
14	Project Presentatiion	Wed 07/04/10	Thu 15/04/10

TABLE 4: MILESTONES



	Task Name	Milestone
2	Project Proposal	18/01
3	Fucntional Specification	08/02
4	Order Parts	15/02
5	Test Parts	17/02
6	Oral Status Report	18/02
7	Build Sub Components	01/03
8	Design Specification	08/03
9	Integrate Sub Components	22/03
10	Written Status Report	22/03
11	Test Protoype	15/04
12	Close-Out Report	15/04
13	Project Presentatiion	15/04

8. TEAM ORGANIZATION

Our team at Asäna comprises of four Engineering Science students all in their final year of studies. Led by Sam Leung, his team consisting of Wil Gomez, Sasan Naderi, and Gurpal Sandhu have proven to be a successful group of engineers in past projects and studies in previous courses. All our team members have had work terms in large companies such as RIM, Broadcom, and Dolby Canada where they have individually played an important role as a co-op to their hiring companies. From their diverse background in engineering, each team member will bring in their unique skills to designing and prototyping the Wireless Weight Distribution Scale.

Realizing that most meetings are not as productive as one would think, our group has not scheduled meetings at a constant interval. Rather, meetings are set based on the need to have one, especially two weeks before any document submissions are due. Each meeting will be "open floor" where items to be discussed are itemized on the meeting agenda to ensure that all topics of concern are covered. Besides meetings in person, we have already successfully conducted meetings over the telephone, and also group instant messaging online for short discussions. Asäna contains members that have endured and resolved group dynamics issues in the past which can guarantee results when working towards the same goal.

With a group of four, we plan to have two micro-streams working simultaneously on different tasks for the same component. This will allow an increase in productivity, while also preventing team members from missing out on information about product development. Two members of the team are currently attending school part time with no other outside commitments, while the other two members are enrolled in a manageable course load, also with no other outside commitments. Stress due to work overload should not be an issue for our team.

We have a team with diverse backgrounds and the ability to cut tension with a unique sense of humor. Our past team project ventures together have given us a clear understanding to how each group member works to ensure productivity. We strongly believe that our group can make Asäna a successful company by producing an excellent product.

9. Company Profile

Sam Leung – Chief Executive Officer (CEO)
Sam is in his final year of his undergraduate studies for a Computer Engineering degree. His program has allowed him to learn and practice both hardware and software development. Past co-op experiences include working as a system engineering assistant for Mobidia, and also as a research and development software engineer for Dolby Canada. He is experienced in programming using C/C++, and designing electronic circuits. Sam has a history of leading other projects in school for his team to produce excellent results in an efficient and organized manner.

Wil Gomez – Chief Technical Officer (CTO)

Wil is in his final stages of Computer Engineering at Simon Fraser University. As the CTO of the company his main focus will be to assure proper design when planning the system architecture. Throughout the execution of the project he will make sure that the original design goals are being met within the proposed timeline. Wil's previous experience includes one work term with Getronics as a field technician. He also completed two terms at Research In Motion as an embedded software developer. There he was able to really enrich some key skills such as programming in C, and writing drivers and API's for taking control of various IC peripherals. He also has excellent analytical and problem solving skills which will greatly benefit the success of team Asäna.

Sasan Naderi – Chief Financial Officer (CFO)
Sasan is a fifth year Electronics Engineering undergraduate student at Simon Fraser University. He has a very diverse background stemming from his Technologists Diploma from BCIT in the field of Telecommunications and Wireless networks. Since transferring to SFU, Sasan has continuously demonstrated a thorough and rigid work ethic which has catapulted him straight to the top of his class. He continues to excel in all aspects of academia and has obtained co-operative experiences in large electronic corporations such as Broadcom. He strongly believes that the best way to solve a problem is with persistence and patience. He looks forward to his time and dedication spent at Asäna.

Gurpal Sandhu – Chief Operations Officer (COO)
Gurpal Sandhu is a fourth year student at Simon Fraser University majoring in Electronics Engineering. Prior to attending SFU, Gurpal completed two diplomas in engineering technology at BCIT in the fields of Computer Control and Electrical Power and Industrial Control. At BCIT, Gurpal managed a group project for Mobile Safety Monitoring Incorporated regarding the implementation of RFID tag systems for employees working in hazardous environments. Additionally, he had voluntarily participated in a BCIT Open-House project involving the simulation of a micro-scaled version of the BC Transit Skytrain system. Gurpal has previously completed a co-op term with Broadcom, where he gained valuable experience with scripting and testing of VoIP networks and communication systems.

10. Conclusion

Asäna is comprised of talented engineering students devoted to help people find their correct center of balance. Whether someone is recovering from a leg injury or suffering from scoliosis, our scale will aid those in search for a healthy standing posture. Also, because of this device's simplicity, it is a very easy to use tool for people to use outside of the medical field. Replacing your bathroom scale with our product will give you peace of mind knowing your body is balanced the way it should be.

If mass produced, our scale can surely climb into an affordable price range, and the ease of operation allows for one more health check in the comfort of your own home. There is no other similar product out-of-the-box available on the market, and our elegant design will make it very attractive to those who value their health, and also to those in the medical field.

Our schedule for this project is very realistic, and is very feasible with our team member's course load this term. Our goal and design are well defined, and we have the support of professors and knowledgeable peers to support us complete this project in a timely manner.

11. References

1. RDP Group, "How it works – LVDT", 2006, http://www.rdpe.com/displacement/lvdt/lvdt-principles.htm

2. Anyload Transducer Co. Ltd, "Load Cell Products", 2009, http://www.anyload.ca

3. R. Manske, "Postsurgical orthopedic sports rehabilitation: knee & shoulder", 2006, http://tinyurl.com/yzy6vwl

4. L. Meller-Gattenyo, "Postural control in standing among adolescents with Idiopathic Scoliosis", January 15, 2009, http://www.scoliosisjournal.com/content/4/S1/O22

5. Guo X, Chau WW, Hui-Chan CW, Cheung CS, Tsang WW, and Cheng JC, "Balance control in adolescents with idiopathic scoliosis and disturbed somatosensory function", June 15, 2006, http://www.ncbi.nlm.nih.gov/pubmed/16778672

6. Wikipedia, "Muscle Atrophy", January 13, 2009, http://en.wikipedia.org/wiki/Muscle_atrophy