April 22, 2010

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

Re: ENSC 440 Post Mortem for a Wireless Weight Distribution Scale

Dear Dr. Rawicz:

The following document contains the post mortem for Asäna's Wireless Weight Distribution Scale. The scale will be used to measure the user's body weight and center of balance. This information can be used for a wide range of health related applications. For example, a recovering stroke patient needs to relearn how to stand with an even weight distribution between both feet. The scale will wirelessly send the collected information to a nearby computer for data storage and analysis.

Details in the current status of the prototype, deviations from our original specifications, budget and timeline differences, and future plans for potential are included in this post mortem document. Finally, each member of our team will describe their personal contributions to our project.

Asäna consists of four engineering students: Sam Leung, Sasan Naderi, Gurpal Sandhu, and Wil Gomez. For further inquiries about our company, 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: *Post Mortem for a Wireless Weight Distribution Scale*

Post Mortem for a

Wireless Weight Distribution Scale

Prepared for

Dr. Andrew Rawicz – ENSC 440
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April 22, 2010

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REVISION HISTORY

TABLE 1: REVISION HISTORY

Version	Date	Summary of Changes
1.0	15/04/2010	Initial template created
1.1	19/04/2010	Rough draft completed
1.3	21/04/2010	Finished editing
1.4	22/04/2010	Completed formatting

1. INTRODUCTION

Through countless hours of hard work during the past thirteen weeks, the Asana team members have completed their work on the Wireless Weight Distribution Scale. This document will assess the work that was done to accomplish their goals, and it will include personal experiences during the workings of the project from Sam Leung, Wil Gomez, Sasan Naderi, and Gurpal Sandhu.

2. CURRENT STATE OF PROTOTYPE

The Asana team developed a Wireless Weight Distribution Scale, which measured the total weight and weight distributed among the coronal and sagittal planes of the user. These measurements were then wirelessly transmitted to a local computer for post-analysis. Figure 1 shows the system's block diagram illustrating the contribution of each component to the scale's operation.

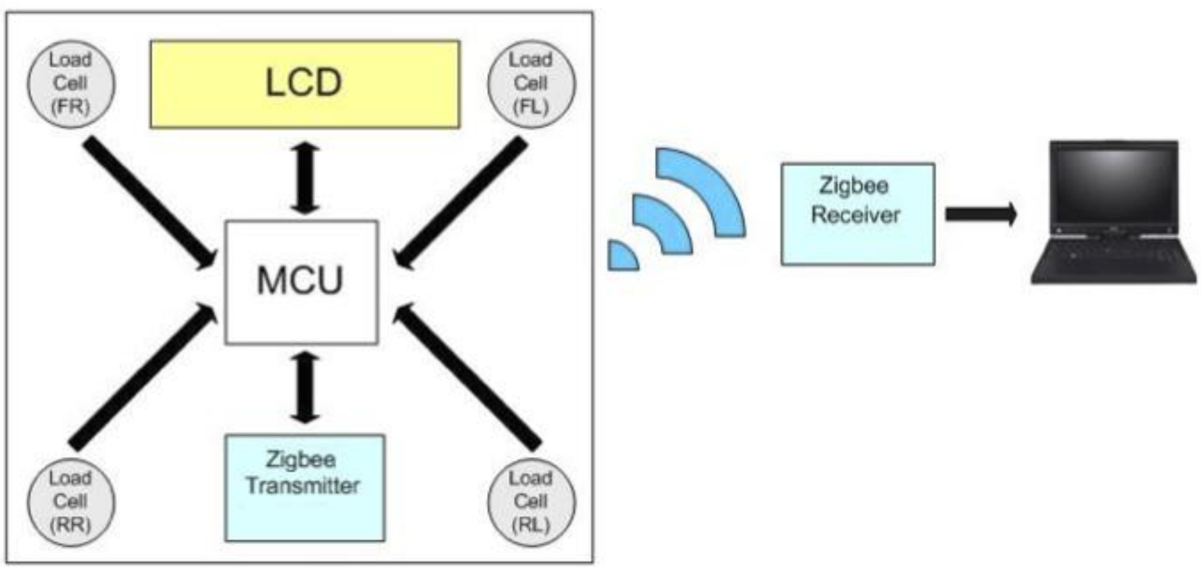


FIGURE 1: SYSTEM OVERVIEW

Referring to Figure 1, the load cells located in each corner of the scale collected the user's weight measurements. The microcontroller (MCU) would process these measurements to determine the user's total weight and center of balance. The LCD would display the results for the user, and finally, the Zigbee module would transmit these results to the PC. From the PC, the user can view their previous and newly obtained results using a simple and intuitive GUI application. Figure 2 below describes this process in a functional block diagram.

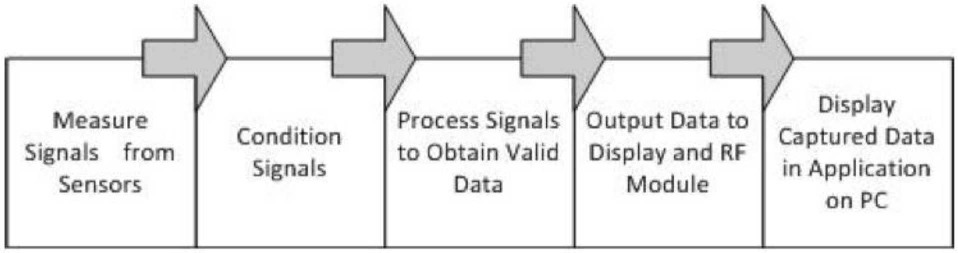


FIGURE 2: FUNCTIONAL BLOCK DIAGRAM OF SYSTEM OVERVIEW

In terms of operation, the scale was designed to require minimal input from the user. A grid was etched on to the surface of the scale to inform the user where to stand in order to obtain precise and accurate readings. The scale's sequence of operation is described below.

1. User steps on the scale to wake it up.
2. LCD informs the user that the scale is calibrating.
3. Buzzer alerts the user when the calibration has been completed.
4. LCD informs the user to step on the scale, remain still and look forward until the buzzer sounds.
5. The total weight is displayed for 3 seconds on the LCD. The weight displayed is either in kilograms or pounds depending on the position of the external unit switch.
6. The LCD now displays the user's center of balance for 3 seconds.
7. The wireless transmitter sends the results to the PC, and the LCD informs the user whether the transmission is successful or unsuccessful. The transmission is only unsuccessful when the scale is out of range from the PC or when the wireless receiver is not connected to the PC.
8. The scale returns to sleep.
9. From the PC, the user can view their results by running the GUI application. The GUI application allows the user to view the total weight (in kg or lbs), center of balance, and the percentage of weight distributed in each quadrant of the scale.

The primary objective of the scale was to collect and display the user's total weight and center of balance where the results were wirelessly transmitted to a PC for post analysis (GUI Application). This objective was met in the final prototype.

3. Deviations of Prototype

3.1. User Software

The user software did not differ too much from the design specifications. The biggest difference between the original specifications and the implementation is that the data is not separated into two tables, where one holds the unorganized, and the other holds the organized data entries. Instead, the implemented version has a single table for all entries, where new entries will have defaulted empty name and comment fields.

The ability to right click rows to show a menu strip was also taken out of the software during implementation simply due to the difficulty of such implementation. Instead, the software has a text box where a user can enter the ID of the entry they want to view in detail. Then by clicking on the *Entry Details* button, a window will pop up displaying all of the information for the selected entry.

Lastly, the entry details window does not have a *Delete* button as the design specifications show. This could most likely have been implemented if more time was given for the development of the software.

Other than the mentioned changes, along with some smaller cosmetic changes, the software follows the design specifications fairly closely, and the user software is very capable of fulfilling its intended purposes.

3.2. Wireless Communication

The ZigBee component was implemented to provide wireless communication between the PC and the scale. Initially, the ZigBee component consisted of two different modules; they were the Xbee 802.15.4 transceiver and the RZUSBSTICK receiver. This subsequently was changed to using two Xbee 802.15.4 transceivers where one was the transmitter and the other was the receiver.

3.2.1. Wireless Receiver

The purpose of the RZUSBSTICK was to provide a small and compact wireless receiver that would connect to a PC through the USB port and retrieve incoming wireless data. Unfortunately, this method was changed due to the fact that we lacked a JTAG programmer. As an alternative, another Xbee 802.15.4 transceiver was purchased along with its development board to function as the wireless receiver.

The wireless receiver was programmed using the C# serial API to receive data from the scale. As such, the user is required to launch a console application that will run the wireless receiver application in the Windows OS background. This deviated from the original plan of having a one-time plug and play setup, which we wanted to do by using the RZUSBSTICK. Nonetheless, the Xbee 802.15.4 receiver still served its purpose in retrieving incoming data from the transmitter.

3.2.2. Wireless Transmitter

The Xbee 802.15.4 module served its purpose by sending data to the PC and verifying the success of its transmission. However, we encountered difficulty with implementing the sleep mode operation, which increased the device's overall power consumption. Currently, the wireless transmitter draws 40 mA of current during standby which is unreasonable. A proposed solution was to hard-wire a digital pin to the transmitter's "Sleep Request" input pin. This would allow a digital write command from the microcontroller to disable or enable the transmitter. Unfortunately, due to time limitations, we were unable to implement this feature.

3.3. Arduino (MCU) Software

The LCD was intended to provide the user with results of their total weight, weight distribution, success of wireless transmission, and also operation instructions. In the end the LCD was capable of meeting all those requirements with the exception of showing total weight on the same screen as weight distribution. For the most part the LCD behaved as intended but at times it would reset or show random pixels on the screen. The exact reason behind this was not known but indicators pointed to the serial backpack interface that was used to control the LCD.

In terms of the MCU programming all requirements were met except for the power consumption while the scale was in sleep mode. It was intended for almost no power to be consumed during this mode but the MCU was not capable of shutting down all the peripherals as desired. This alone caused the scale to not reach its battery life requirements.

4. Future Plans

With any project carried out there can always be small refinements to further improve the overall success of a product. Many ideas come to mind for alternative solutions or features that could have been added through the development process of the scale. Below are some of these ideas outlining possible future plans.

4.1. Overall System

Taking a look at our first prototype, Asana was able to make some considerable achievements. Overall the product worked great but some aesthetic features could be improved upon for later revisions. For example, the integration of the MCU, wireless transceiver, and LCD packaged all into the scale itself would have increased portability and visual appearance.

4.2. Wireless

The system currently uses ZigBee as a wireless protocol for communicating to the PC. The reason behind this was the fact that ZigBee is a low power, low transmission rate protocol which is desirable for our needs. With devices such as the iPod Touch or iPhone becoming increasingly popular which have bluetooth capabilities, it would be to our benefit if our scale also used bluetooth as a wireless protocol. This would allow the scale to be able to interface with more devices. Also as mentioned previously, the wireless transceiver would be integrated within the chassis of the scale for future revisions.

4.3. LCD

The LCD used was more than capable in satisfying our objectives. It had internal memory which we never used, and required a backpack to be controlled serially. To bring down the cost of the scale, a more stripped down version of the LCD will be used while not compromising the functionality of the scale.

4.4. Microcontroller

One of the reasons we were not able to achieve a good battery life is the fact that the prototype used the Arduino board to connect the microcontroller to the LCD, Load Cells, and Wireless transceiver. In the future, we will eliminate the Arduino board which will drive the total unit cost down but most importantly improve battery life.

4.5. User Software

The user software met all of the initially set requirements. To improve the usability, an online database could be created where the user can access their data remotely. Also creating an application to run on cell phones where the user can receive and organize data could be extremely beneficial.

5. Budget and Schedule

5.1. Budget

Table 2 contains the individual component costs and total cost of our project up to April 19, 2010.

TABLE 2: BUDGET SUMMARY

Item Name	Description	Quantity	Actual Total Cost ($CAD)	Original Cost Projection ($CAD)
Anyload ES300 Digital Scale	Digital Scale consisting of 4 load cells and aluminum housing	1	115.50	290.00
Arduino Duemilanove	Development board with Atmel ATmega328P	2	67.92	120.00
Toshiba LCD	LCD with serial backpack	1	76.62	80.00
Xbee Wireless Module	Zigbee 802.15.4 with wire antenna	2	46.21	200.00
Arduino Xbee Shield	Expansion board for Xbee module on Arduino development board	1	27.33	
Maxstream board	Zigbee development board (used)	1	40.00	
Atmel RZUSBSTICK	USB powered Zigbee transceiver	1	47.50	
Shipping	All shipping charges on ordered components	5	55.21	n/a
Miscellaneous	Small items	n/a	56.55	
Total:			**549.55**	690.00
Total amount awarded through ESSEF:			425.00	425.00
Unfunded project cost:			**124.55**	265.00

The financial aspect of the project was kept organized and up-to-date with the aid of a shared online document. In this document each group member was able to include any costs incurred through components purchased for the project. Our Chief Financial Officer, Sasan Naderi, was in charge of the shared online document and dispersing of funds.

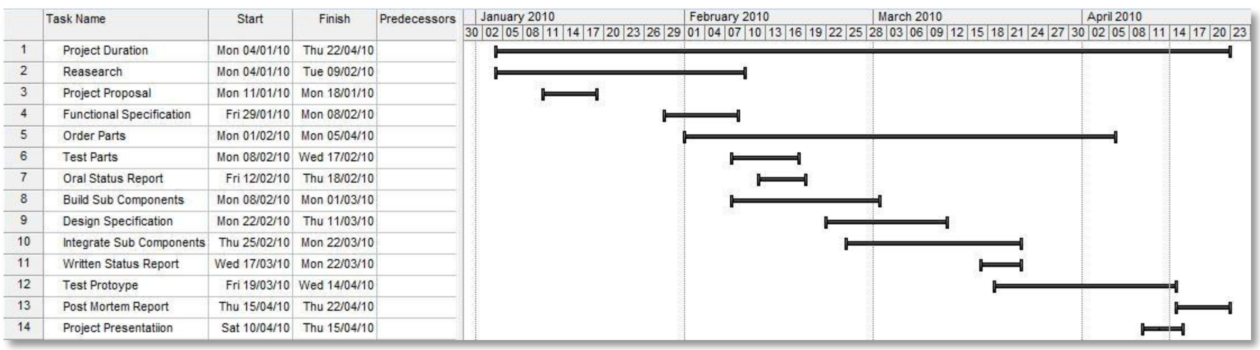
Our initial estimation, as presented to the ESSS, for funding was $690.00. This total lacked a miscellaneous section but, as it appears, still managed to cover more than the final cost of our project. Therefore it can be said that we managed to spend less than our initially estimated project cost. However, the $425.00 amount that we were awarded by the ESSSEF was insufficient by a total of $124.55. Currently, this cost is shared by all members of Asana and we plan to apply for funding relief from the Wighton fund.

It is only logical to conclude that our project did not go over budget; it merely cost more than the funding we had received. However, the fact that members of Asana had to contribute to the project out of their own pockets can be attributed to several unforeseen factors. For instance, it was determined that the Atmel RZUSBSTICK could not be correctly programmed since we lacked a JTAG programmer. The purchase of a JTAG programmer was not feasible due to its high cost and hence the idea was discarded. Instead, we purchased an additional Xbee wireless module and a development board.

5.2. SCHEDULE

The Gantt chart in Figure 3 displays the final project duration for all individual subsections. In the beginning, the project schedule was created and has shown to be quite accurate and realistic. One of the only deviations that took place was in regards to ordering parts. Due to some unforeseen events, we were forced to purchase a new microcontroller. This caused our Order Parts subsection to be extended until April 5th, 2010.

The Asana team members also had other courses and commitments which required their attention. This also contributed to the minor fluctuations in the project schedule.



	Task Name	Start	Finish	Predecessors
1	Project Duration	Mon 04/01/10	Thu 22/04/10	
2	Reasearch	Mon 04/01/10	Tue 09/02/10	
3	Project Proposal	Mon 11/01/10	Mon 18/01/10	
4	Functional Specification	Fri 29/01/10	Mon 08/02/10	
5	Order Parts	Mon 01/02/10	Mon 05/04/10	
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	Thu 11/03/10	
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	Wed 14/04/10	
13	Post Mortem Report	Thu 15/04/10	Thu 22/04/10	
14	Project Presentatiion	Sat 10/04/10	Thu 15/04/10	

FIGURE 3: UPDATED GANTT CHART

6. Individual Contributions and Reflections

6.1. Sam Leung

Throughout the progression of the project, I have gained a lot of technical knowledge along with practice in people management and group leadership skills.

This project gave me exposure to weight scale components, microcontroller development boards, power management, and Windows forms applications. Even though I am not the expert in all aspects of the project, I was able to have at least a general understanding of all the components of our scale. Jump-starting the microcontroller program gave me insight to Arduino's C/C++ based language, and I wish that I was able to follow through more closely with the development of the LCD interaction, along with the board's input/output control. Having very close attention to detail and clean circuit making skills, it drew me close to the differential amplifier circuit implementation. Following Sasan's circuit design, I was able to tightly fit four amplifying circuits onto a single bread board. Being the main correspondent for characterizing the load cells gave me better bottom level knowledge of how the load cells react and behave under use. This made me very useful when it came time to troubleshooting our circuit models. Lastly, I picked up a high level programming language, C#, to implement the application responsible for managing and storing the measurements taken by the scale. Visual Studios definitely helped in making the object oriented language a lot easier to learn on-the-fly.

Interpersonal issues were kept to a minimal due to the fact that our group has worked closely in other course projects prior to this class. There was, however, a particular issue that arose due to miscommunication and a lack of stress management on my own part. As with most interpersonal issues in engineering, a drink or two at the local pub quickly solved the issue, and we were able to move on. In terms of group management, I felt that I confirmed my signs of leadership skills, but I definitely still lack the skill in persuading group members to have a strong desire in completing their tasks. I felt that the lack of desire really took a toll on the level of ingenuity that I know my group members are capable of.

Even in retrospect, I cannot clearly describe how I would do things differently for this project. I think the only difference I would have attempted to make was to define our group goals with more certainty. This would have probably required more knowledge and preparation, but should have led to shorter implementation time and troubleshooting. Overall I felt like the project was a success, and I am proud of our achievements.

6.2. WIL GOMEZ

This project has finally come to a close and I can finally say *we* did it. What the team and I have accomplished has undoubtedly taught me some lifelong lessons that will help throughout my career. From brain storming on how to tackle a problem, to finding work-arounds or solutions to unforeseen events that arise. I have improved on my technical skills such as working with ADC converters, writing LCD drivers, and coming up with weight calibration algorithms.

Initially when we started the project no one really had an idea on what component they were going to tackle. Having previous experience with embedded programming I decided to take the responsibility of programming the MCU operations and LCD. It took some planning starting the initial code because I had to take into consideration how the wireless and load cells were going to interact with the micro controller which was uncertain at that point. After doing some research I found that both the LCD and wireless transceiver both needed a serial port. Our development board only had one, so I created a serial port using two digital output pins.

The LCD development was fairly straight forward except when dealing with some bugs the serial backpack had. Showing the weight distribution was simple enough, but drawing out each digit to show total weight was very time consuming. Also getting the scale to calibrate to zero was pretty tricky. I wrote many different algorithms refining this function only coming to find that it was not working properly because of a defect on one of the load cells. I eventually corrected this in software with the help of my team and we were able to get past that issue.

Overall I am very pleased with the execution of the entire project. I feel we all worked efficiently for the most part which is why we were able to deliver the product in the proposed timeline. We all took part in most of the different roles. I would have liked to get more involved with the design of the amplifiers as electric circuits is a field I am not too strong in. I also would have like to do some more project management as I have an interest on making improvements on the logistics of a project.

Looking back at everything I am very proud of my entire group. We all got along well and were able to complete this project without too many kinks. We have all learned from each other's experiences and are going to succeed in the future.

6.3. SASAN NADERI

Over the course of our project, I can honestly say that I gained some valuable skills that will be necessary in my future. Not only do they consist of technical skills but also interpersonal skills that are essential to functioning in a team environment.

Through previous co-op experiences, I had gained tremendous experience with research and understanding of complex technical documents. This was a skill that I had to use extensively in the early stages of planning to determine what hardware would interface with the other components in our system. Special attention had to be paid to the microcontroller in order to have support for many of the requirements we had determined in our functional specifications. A lot of the project rested upon the planning and research that I had done in the early stages. Near the end of our project I realized that I had made a minor mistake and a certain part I had ordered was incompatible with our design. Gurpal and I jumped into action and tried to resolve the problem. When we realized that a solution was unfeasible, we invoked a contingency plan. Although our final project schedule and budget were slightly affected, we still managed to finish our project on time. I believe what I learned most was the need to realize what requires a solution and what requires an alternative. This means that if a certain problem's solution requires too much time or money, then an alternative solution must be found quickly in order salvage the situation.

I also learned that team work is crucial to completing a project successfully. A team must always be supportive of each others' ideas. The team environment must nurture progress and not hinder it through negativity. Also the team needs to be accommodating to each individual's strengths and weaknesses. This allows each individual to be utilized to their full potential and help in progressing the development and testing.

I was very happy with the method in which our team developed many of our documents. We created an account with Google Documents and created a blank template and shared it online with all of the team members. We listed out each subsection and took inspiration from example documents in order to fill it out. We then assigned each subsection to a team member based on their project knowledge. Finally when the content of the entire document was finished, someone would integrate everything into a single Word document and format it. This method was efficient and fair for everyone and was also used for other documents such as the specifications reference sheet and project cost chart.

I can't say I'm surprised at how well our group has worked together. We've all been in the same project group in previous courses with exactly the same end result. I truly believe that all of my team mates will find high-paid jobs and succeed in them.

6.4. GURPAL SANDHU

Throughout the course of this project, I have acquired some valuable skills from product development in engineering. From proof of concept to the final design, I've applied the technical skills learnt from prior experiences while gaining new ones in the process. In addition to my technical skills, I also acquired some non-technical attributes that were applied in understanding group dynamics.

My responsibilities consisted mainly on implementing the wireless communication module. The experience introduced me to a new programming language, C#, and understanding the serial API library. Initially, the wireless receiver we ordered was incompatible with our design implementation since it required additional tools that were unattainable. As a result, I worked with Sasan in coming up with an alternate and affordable solution that will allow us to continue with the progress from the wireless side of development. In addition to wireless development, I also assisted in the development of other components in terms of testing and execution. The most significant of these was the integration between the load cell's and instrumentation amplifier. I assisted my team members with testing and resolving the load cell's amplified signal by applying my troubleshooting skills acquired from a previous co-op experience. The end result of the development thought me the importance of integrating components by making it self-contained and simple to use for my team members.

I was pleased with the approach my team members took in terms of organizing and categorizing the development process. The most significant of these processes was using Perforce for revision control and Google docs for managing our product documentation. Perforce provided each member access to the development code allowing changes to be applied and/or reverted. Google docs was not only used for organizing our project documentation, it was also used for reviewing component manuals or specifications, and monitoring the projects costs. In terms of improvement, I wished our approach in researching and purchasing parts could have been a lot better. Unnecessary costs were incurred because certain parts were not working as we expected, and therefore additional purchases were made to resolve those issues. However, we still manage to remain under budget in terms of what we initially purposed. Regardless, the final product was still implemented successfully with minor room for improvements.

I enjoyed working with my team members. We all have worked before in prior projects, and therefore each member is familiar with each other's strengths, weaknesses and character. Although, minor conflicts occurred, they were easily settled in a mature and professional manner by addressing and resolving individual concerns. Overall, the project was a success and I enjoyed the time spent with my group members during the development.