Smart Buy

December 18th, 2011
Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, BC
V5A 1S6

Re: ENSC 440 Post-Mortem Report: Advanced Shopping Cart by SmartBuy Ltd.

Dear Dr. Rawicz,

Please find enclosed the post-mortem report for the : Advanced Shopping Cart (ASC) from SmartBuy. Ltd.

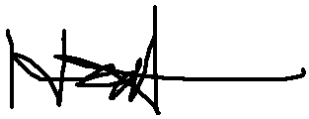
The design and implementation stages has been completed for the prototype of the ASC. The concept and technology of ASC would bring revolutionary improvements in the shopping industry.

In this post-mortem report, we will document the current state of the ASC system, deviations from the original design, and the future development for the ASB. The stages of development of the ASC shall be revealed in this document. In the end, team dynamics and individual reflections would also be included.

SmartBuy consists of five motivated and knowledgeable engineering students: Hank Cheng, Jeffery Chung , Leslie Man ,Bill Lu and Tom pan. These five individuals bring their experiences and knowledge in hardware and software engineering and telecommunications to the team.

For any inquiries or comments regarding our project, please contact our team through our CEO Hank Cheng, via email at Hca62@sfu.ca or telephone by 778-988-1688.

Sincerely,



Hank Cheng

Chief Executive Officer

SmartBuy

Enclosed: Post-Mortem for Advanced Shopping Cart

Smart Buy

Post Mortem

For an Advanced Shopping Cart System

Project Team

Hank Cheng
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Document Created

December 18, 2011

Submitted To

Dr. Andrew Rawicz
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Glossary

ASC Advanced Shopping Cart
ASCII American Standard Code for Information Interchange
CEO Chief Executive Officer
CFO Chief Financial Officer
CMO Chief Marketing Officer
COO Chief Operating Officer
CTO Chief Technology Officer
LAN Local Area Network
HTTP Hypertext Transfer Protocol
RFID Radio Frequency Identification
UHF Ultra-high-frequency
Wi-Fi Wireless Fideli

1.0 Introduction

ASC is an electronic add-on system for existing shopping carts. The goal of the ASC is to addresses several issues prevalent in supermarket environments such as checkout efficiency and theft, by introducing an electronic component. The system can be classified into two units; a central database server and the on-cart electronics. The database server will be capable of wirelessly broadcasting to and receiving information from all on-cart devices. The electronic device attached to each cart will have a tablet with touch screen display and a RFID reader with a range of three meters. Customers will be able to receive product information on the tablets in real time while avoiding the need for barcode scanning. Members of SmartBuy have been working as a team on developing this add-on system for the past 4 months. This document will provide the most current state and the deviation in design of ASC prototype, and the issues encountered during the development process. Future developments for the system will also be discussed.

Figure 1- Final prototype of the ASC

2.0 Current State of the Device

2.1 Overall System

The ASC is an automatic shopping ad-on system. It provides the user with automatic scanning and recording functionality while shopping. There are two units in the ASC system: the shopping cart unit and PC unit. These two units work in conjunction to provide a convenience and enjoyable experience for the users during shopping.

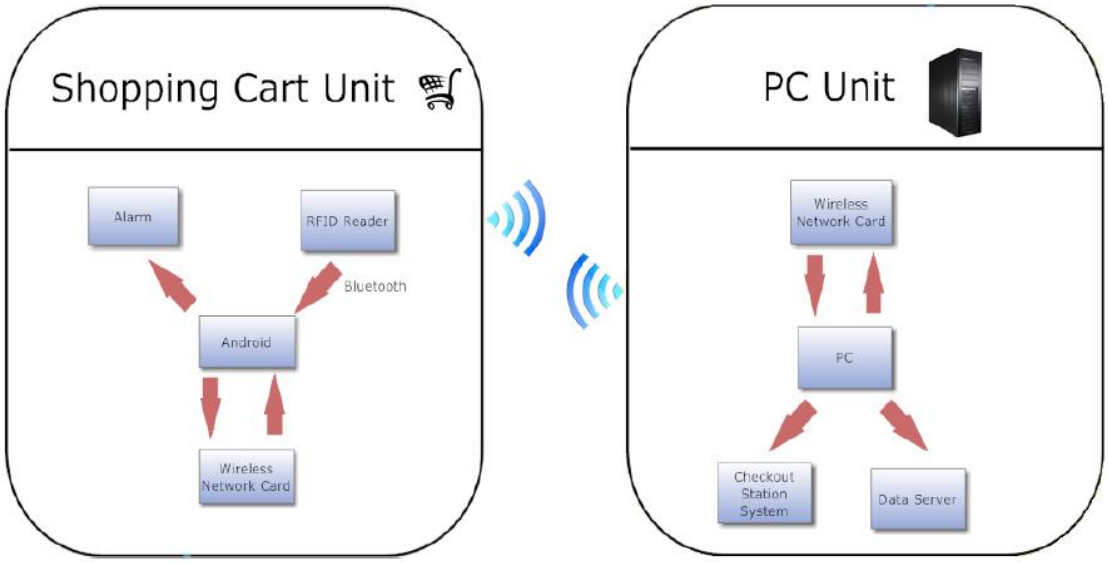

Figure 2 – Overview of the ASC

2.2 Shopping cart unit

The ASC provides the user of a better and efficient method of shopping by scanning the RFID tag on products automatically. The product would then show up on the tablet with its detailed information, such as price, nutrient, picture and etc. The tablet would be synching with PC unit in a real time style via Wi-Fi network. As for securing the tablet from being stolen from the mount, we have installed a siren alarm system would be trigger if the tablet is 5cm or further away from the mount.

The alarm system is a simple burglar detecting alarm system powered by a 9V battery. The system consists of two 555 timers integrated circuit, one buzzer, one LED and two switches. One of the switches is a magnetic normally open switch such that it becomes close circuit when the two pieces of the switch is separated to a distance greater than 2.8mm. When the circuit is closed, the 555 timer will create a signal between 1.4 kHz and 2.6 kHz and generate a siren sound. It will also trigger the LED to provide a warning sign. The other switch is an on-off key switch which allows the staffs to turn off the circuit and take the tablet out for charging.

2.3 PC Unit

The central database component comprises of a broadcasting tool; currently a router, and a windows or MAC operating system with Java capabilities. All data management and user interface implementations are included in a single .Jar file of 110 KB in size, which is a standalone file that can be transferred and ran on any PC.

Data transfer between tablets and the database is done through a local area LAN network and a FTP server, broadcasted through a router. A constant connection can be maintained and information can be updated in real time.

All information about inventory and cart status is stored in three database files: ShoppingList.db, ProductID.db, and Products.db. The information held and passed by these files include:

-Inventory information: Name, price, description, photo, RF tag IDs

-Checkout and security information: Cart ID, purchased items, checkout price

A digital security system is implemented using the broadcasting range of the router. For a market environment, this range can be set using a network of routers to specifically govern the allowable travel distance of the carts. While tablets remain in the range of signals, the connection between it and the database will be maintained. However, once tablets leave the proximity of the broadcasting routers, an alarm will sound on both the tablet and database, and the missing cart ID will appear offline. By setting the broadcasting ranges, such a system can allow the carts to be pushed to further distances such as the parking lot.

The current functionalities that can be performed by using only the user interface includes:

-Viewing, adding, and real time updating of existing and new products by dictating information of Name, price, description, and photo file path

-real time update and display of all purchases information made by tablets and alarm status in a persistent log

More functionalities can be performed by directly editing the database(.db) files:

-Editing and removal of existing product information

-Adding of new RF tag IDs and tying it together with specific items

3.0 Deviations from Initial Plans

3.1 Overall System

The ASC has achieved most of the functionality mentioned in the design specifications. Communications has been successfully established between the remote shopping cart and PC. The database of ASC would be immediately updated when the tablet sends information via WIFI . The size of the RFID exceeded our expectation, however that can be improvise in the future iterations. Few deviations occurred during the implementation process.

3.2 Mount Design

In the design specifications, we proposed that the mount would adjustable to the degree favoring the costumer's choice. The mechanism would be using clamp attached to the hurricane tie to rotate on the axis of the handle on the shopping cart. However, the handle was not able to fasten tie on the handle as we expected due to the unexpected increase the weight of tablet. It would also be impossible for us to drill holes in the handle to lock the mount since the shopping cart does not belong to us. Therefore we had to eliminate the adjustable mount features and replace the clamps with wires instead.

3.3 The RFID and Bluetooth

In our design specifications, we proposed to use Bluetooth to sync the RFID to the tablet. However, the Bluetooth we purchased was not able to do a two way communication between the two systems. In the end, we decided to use USB to establish the connection instead.

3.4 Coding of database and UI

All the originally planned basic functionalities were implemented successfully; however, not all are performed through the user interface. While all data manipulations and the UI are written into the same java package, some of the database editing can only be done directly instead of through the UI. This is due to time restrictions, as the functionalities can be performed, but not written into automation through Java.

4.0 Future Work

4.1 Overall System

There are several improvements needed to achieve for the system , therefore the ASC would be a competitive model in the shopping industry. Detailed upgrades for each unit of the system would be break down in the following section. The overall size of the RFID reader could be significantly reduced which would conserve much more space in the basket of the cart. In addition, the shape and dimensions of the mount could also be improvement to be more efficient and convenient for the user. Higher quality materials and painting would be an ideal for a new inspiring outlook which would in term promote the attention of ASC would bring in the market.

4.2 Shopping Cart Unit

One of the major concerns for the shopping cart unit is size and weight of the mount and tablet. The mount was not able to secure the mount with tablet to the handle firmly due to the weight problem. In the future tune up, we would come up with a much smaller tablet that is only designed to be used in shopping guidance, and thus reducing the size of the mount as well , to provide customers with much higher quality of shopping. The mount shall also be improvised to hold the tablet firmly other using tapes and easy for staff to eject at the checkout counter. In addition, the siren alarm would also need to redesign to achieve a louder beep for warning purpose. Also the magnetic switch shall need to changed and implemented behind the mount instead of putting in parallel to the tablet in our current design .Finally the Bluetooth shall also be implemented to abduct communication between RFID and tablet.

4.3 PC Central Database Unit

The current state of the database is barebones and demonstrates only the most fundamental functionalities, and message passing protocols between the tablet and PC. As with all software work, there will always be room for improvements. The adding of new functionalities has too much room for deviation, and will be different to suit the needs for each market.

For future work, the database will be completely retooled into an SQL database server implemented through XML. The current method of using Java and database format files are sufficient for demonstrating functionalities, but a SQL server will offer more protection in privacy and offer more accessibility. By keeping store information in a cloud network, there will be no risk of system failure in equipment and allows the data to be accessed from any location.

5.0 Budget and Time Constraint

5.1 Budget

Table 1 compares the project cost and the prototype cost of the project as of December 17th ,2011.

Components	Project Cost	Prototype Cost
Advanced Shopping Cart		
Aluminum Foil	$2.23	$2.23
usb cable	$5.41	$5.41
9 pin male	$1.35	$1.35
Bluetooth adapter	$77.28	0
UHF RFID	$417.4908	$417.4908
UHF Tags	$10.46343	$10.46343
125k RFID	$133.8357	$0
125k Tags	$5.18743	$0
Tablet	$0	$120
Mount and Alarm		
Battery holder	$1.04	$1.04
DC cable	$3.7	$3.7
sheet metal	$11.99	$11.99
Prototype board	$3.99	$3.99
breadboard	$4.65	$4.65
spray paint	$5.74	$5.74
key switch	$6.55	$6.55
magnetic switch	$6.6	$6.6
Miscellaneous		
Tax and Shipping	$159.902595	$104.94
Total	$849.13	$606.14

We did not include the cost of tablet in the project cost because it was from a group partner. The project cost is much more expensive than the prototype cost due to the fact that we bought the 125k RFID reader and Bluetooth adapter that did not work as we expected to. In addition, the tax and shipping is 3 times more expensive then we estimated in the beginning of this semester. Hopefully, we can reduce the shipping costs in the future, so the cost of the ASC will drop significantly.

5.2 Time Constraint

Figure illustrates the Gantt chart of the project. The team was supposed to follow the timeline proposed, shown in blue bars. However, things did not planned as we expected therefore, the actual time spent are shown in red bars. We spent much more time on the research and database programming. Basically, our planned for everything was extended to a later date because the RFID reader we bought did not work as we expected to. However, at the end we managed to finish ASC in the proposed schedule.

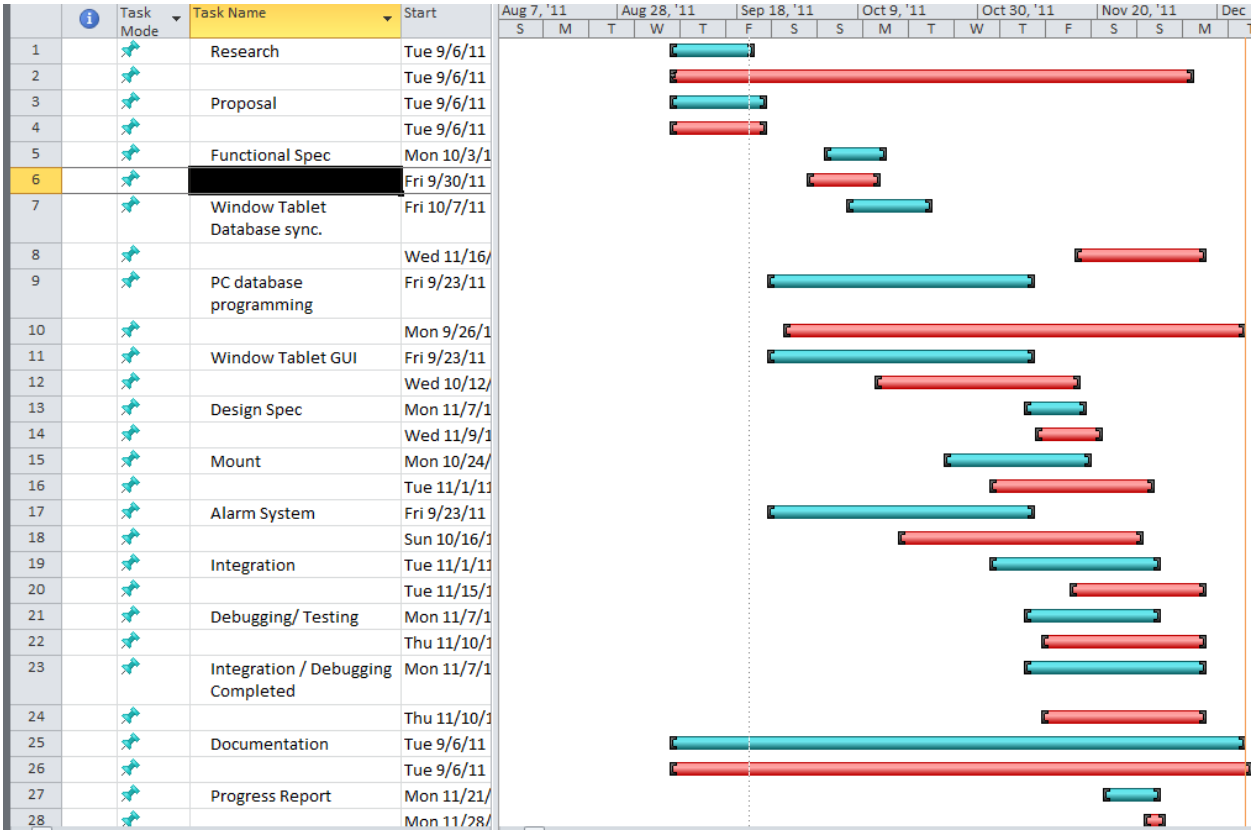

Figure 3 - Gantt chart

6.0 Team Dynamics and Individual Reflections

The Team of SmartBuy had a valuable experience in working as a team closely in the past four months. Having worked with each other members of the group in the past, we recognized the strength and weakness of each individual. Tasks corresponding to hardware and software components had been assigned to individual members based on their strengths. The project roles were distributed evenly to increases efficiency for the team throughout the entire project.

Meeting were set up in a regular time interval during the semester, therefore members of the team would be aware of the latest progress of the project. The hardware team and software team work separately as planned but meet up to discuss issues or suggestions frequently.

Problems such a stress and idea conflict often occurred during the semester, but the team members were able to pull it over and move on to the right track. Strong team work was encourage and emphasis. The team has become a stronger as the project progressed.

6.1 Hank Cheng- CEO

My initial role in this project was to be in charge of the daily progress of the project and call up additional meetings other than our weekly meetings when needed. I was also responsible for software design of the Windows Tablet unit. This project allowed me to gain much experience in project management.

At the beginning of the project, we ordered an RFID reader with RS-232 interface. This RFID reader was chosen in our design is because of that it does not required the RFID information receiving part to initiated with any command through the serial port and it is also very easy to send the information over Bluetooth serial protocol. Therefore, I chose to use a low-cost Android tablet to act as both the RFID reader and the touch screen. I spent a lot of time on learning Android mobile programming. However, it turned out that the one we ordered cannot read multiple tags at the same time as we expected. We then had to order the other reader which is capable of doing that as the one we have now. I had to change the design to use a Windows Tablet because the Software Development Kit (SDK) came with the RFID reader was for Windows operating systems only. If I had to stay with Android, it would have been too challenging and time-consuming for me to port the SDK to Windows because the new reader required very complicated commands.

My major contribution in this project was the design of the graphical user interface of the shopping list and catalog programs users would see on the touch screen. As I did not have much experience in GUI design, I researched on that and finally chose a scripting language called AutoIt because it is very easy and similar to C/C++ which I am more familiar with.

An important thing I learned from this course is how difficult it is to manage an on-going project. Meetings had to be held every week to make sure everybody is on track. Miscommunication sometimes happened and a course of action had to be taken seriously otherwise there might be uncorrectable consequences.

In conclusion, this project has given me a vast amount of to apply my programming knowledge and skills I learned from SFU's engineering program. I also gained an opportunity to know what it takes to develop a product to from a concept. Overall, these past months were a very helpful experience to my future career.

6.2 Leslie Man - CFO

My initial role was to determine the parts required for the project. I was in charge of acquiring the components that were required for the project. I had to order and communicate with the suppliers for more information about the components I wanted. Because the lack of information given about the RFID reader by the suppliers and I had to communicate with him, the time to obtain the item was much longer.

I designed the mount, and build it according the dimension I wanted. This allows me to have more hand on time with the machinery in order to cut and bend the mount to desire size. I learn that metal sheet have better finish with metal chopper than with a bench saw. Due to the fact, that the metal sheet is too thin and will vibrates a lot if using bench saw.

I helped in making the alarm system with Jeffery Chung and Tom Pan. This process exercises my soldering skills and circuit building skills. Also, I helped in designing the user interface for our tablet. While working on it, I learned that it quite difficult to design a user interface that is user friendly for everyone.

In the end I installed the RFID reader, tablet, and alarm into the shopping cart along with my team members. Due to the fact that the shopping cart was borrowed from "Nester Market" we were unable to modify the shopping cart itself. Because of that we spent more time than we expected to safely secure the mount and the RFID reader onto the shopping cart.

To conclude, this project has given me a lot of experience both in applying learned skills from SFU's engineering program and in newly learn skills. Also, I have learned that shipping and handling fee should be more considerate in budget control. I had a really good and fun time working in this project with my team.

6.3 Zhiyou Bill Lu – CMO

My role in the Smart Buy ASC project was to assist the CEO in overseeing and outlining the essential functions and responsibilities of the team, as well as to design and create the hardware and software components for the PC database. The amount of time devoted to coding had restricted by involvement in the cart hardware components, in issues such as purchase of the RFID reader, and the setup of the power supply. These limitations contained my involvement to the software components, and I was only involved in organizing the software functionalities. Much of the hardware management responsibilities were delegated to the CEO.

Finding a simple broadcasting method was easy, and I settled on the use of a router and local area network very early in the development and it was never changed. However, due to suggestions from Hank Cheng about the data transfer protocols, we decided to switch from http to ftp protocols late in the project development. Such a change allowed easier transfer of data, and posed very little difficulty in restructuring the database. This exercised my past skills in setting up a portable LAN file sharing system, and I developed more knowledge in file transfer protocols.

I had initially planned to learn Java and code the database in a very limited amount of time, and devote my remaining attention to help in the hardware developments. The actual process of learning Java, and coding the user interface and functionalities drained significantly more time. After spending approximately twice the originally planned time to write around 1000 lines of code, very little time was left for integration with the tablet. Thus the integration had to be done near the end of the semester, while the workload was peaking. This experience has taught me not to underestimate any software coding projects, and to find better methods of integration, such as step by step modular integration spread evenly throughout the development.

My initial decision to code in the NetBeans integrated development environment had saved me a lot of time in the visual designing components. Using the JFrame containers, the user interface layout can be easily designed and created in Java. However, learning the language from scratch while also considering the functionality viabilities of the project put a strain on the speed of progress made. Since my main involvement in this project is software-based, it allowed me to learn a new coding language and a lot of good coding practices in the parsing of database/text files.

This project has allowed me to come in contact with new knowledge that otherwise wouldn't have been included in the normal Electronic Engineering curriculum. This course provided me with the vital experience of developing a new product with a team, and seeing it through all aspects of design and marketing.

6.4 Tom Pan- COO

As the COO, I was in charge of organizing meetings, ensuring that the project is on schedule, and that all tasks are on track. One of my roles was to document the minutes and agendas for every meeting and to distribute them to each member of the group to provide them with a summary of the discussions.

On the development level, I have focused on research and the implementation of mount and siren alarm system for the ASC. I was also involved in hardware components fabrication and the mechanical design of the mount. During the development process of the ASC, The technical skills I learnt from school and my co-op terms definitely benefitted me in this project, as I have been exposed different levels of software design. I was also able to refine my soldering skills. I also gained new skills and experiences in designing and working with metal working and circuit constructing.

In this project, one of the most challenging parts was to keeping the same pace as proposed in the Gantt chart during the semester. The project was delayed due to vary change in delivery time and change in design, therefore we are always behind schedule. There are a lot of times when the team ran into problems such as design failure and device malfunctioned, but eventually an solution can always be found just few days later. Once the siren alarm and RFID was installed, we again encountered problems. The Sound of the alarm was not as loud and we expected, especially in noisy environments such as the shopping mall. Also the RFID reader was being interfered by the basket on the cart made of aluminum and was not able to detect the RFID tags on the items.

Despite that, we still manage to deliver the final prototype before deadline, after resolving those issues.

Overall, SmartBuy members were energetic about the development of ASC. With members worked side by side endlessly, combined with their skills and efforts, our team successfully achieve our initial goal- the final prototype of the ASC. With such a valuable experience, we will for sure apply it to the real life in design and implementation in the future.

6.5 Jeffery Chung – CTO

As the CTO of the company, I was in charge of handling technical issues and problems associated with the project. My roles included the design of the product, circuit schematic, issues troubleshooting, and failure investigation.

On the development stage, I have focused on the research and the implementation of the alarm system and the possible algorithm that will trigger the alarm. I was also involved in hardware component fabrication and the mechanical design of the mounting system.

While working on this project I have learned many skills in hardware and mechanical design. As students majored in electronic engineering, our group do not have sufficient knowledge in mechanical designs and fabrications. Therefore, we came across a lot of difficulties and challenges and experienced many failures with the design. However these challenges motivated me and my teammate to work harder to get the design complete. Aside from the mechanical design, during the implementation of the alarm system, I am able to apply electronic skills learned from school and improved them. The experience with the mechanic and electronic components will be very beneficial to me in the future when I develop my own prototype.

This project has allowed me to see my insufficiency skills and knowledge in electronic, especially during the research and development stage. Some functionalities of our system did on work perfectly during the development stage such as the RFID reader. The first RFID reader can only read one tag at a time which is different from our expectation. Although we can identify the cause of this issue, we do not have adequate skills to fix the problem or build our own RFID reader and we are forced to buy a more expensive reader.

Overall, I learned a lot from the development of the project such as the things that I am capable and area that I should improve. All team members are motivated, cooperative and supportive. We have successfully finished the prototype of the advance shopping cart system. Yet, there are still a lot of future developments that should be carried to this product before bringing it to the real market.

Conclusion

The ASC prototype has been successfully completed. The goals that SmartBuy set have been accomplished. Valuable experience in technical and non-technical was obtained in the project phases, design, implementation, and testing,

Figure 4 – Mounts and Tablet

We at SmartBuy would like to recognize Dr. Rawicz and Mr. Sjoerdma for giving us the opportunity to proceed this project for the past four months.