A Backpack You Never Want To Be Without

Mechanical Engineering 310 Winter Design Document

Team Totto

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1 Executive Summary

A Smart Container

Urban travelers are active young adults who live in the city and rely on bags when traveling to work, school, or recreational activities. This team, composed of eleven engineering and design students, seeks to provide the experience of a smart container, altering the landscape of bags for the urban traveler. Throughout the Winter quarter the team has continued to innovate and create a vision of a container for the future urban traveler. The final product will seamlessly integrate technology that provides comfort, security, and item tracking to the user. By utilizing integrated electronics and smart materials technology, the team aims to offer a new, smarter experience that is different from any product existing in the market today.

Totto is a leading fashion company headquartered in Bogotá, Colombia that specializes in bags, clothing, and accessories. With over 500 stores in 22 countries, Totto has a large presence in Latin America but is working to expand to markets across the world. Representatives from Totto challenged the ME 310 student team to develop a smart container that meets the needs of the urban traveler. The introduction of a revolutionary product to their company line could help Totto reach new markets as well as retain current customers.

The student design team consists of eleven members from three continents. Shelby, John, and Colin attend Swinburne University of Technology in Melbourne, Australia. Xiomara, Miguel, Esteban, and Leonardo are from Pontificia Universidad Javeriana in Cali, Colombia. Jeff, Nikhil, Claire, and Caitlin attend Stanford University in Stanford, USA. The project presents the unique opportunity for students to collaborate on an international stage, and has a timeline from October 2013 to June 2014. During fall 2013, the team focused on benchmarking, discovering user needs, and prototyping critical components. In winter 2014, the team first tested non-conventional ideas to further understand the needs of the user and push the design envelope. Fully functional prototypes were developed to provide a reference for the scope of the project and the necessary components that must be refined for spring 2014.

Interviews and early prototypes indicated that users value the following qualities in their bags:

- Item tracking: Users need a reliable way to prevent forgetfulness and a system that confirms if they have everything they will need for a given task.

- Security: An increasing trend toward the use of public transportation spurs the need for security features to protect the bag or items in the bag, as well as to locate the bag if it is lost or stolen.

- Comfort and modularity: There is a need for an ergonomic bag to reduce the risk of back pain. In addition, users need a bag that is modular in nature, thus allowing them to customize the size of their bag for a given task or occasion.

The team decided to focus on these problems and create fully functional prototypes that explore possible solutions. This document gives the reader a complete view of this process, from early prototypes to functional systems that were tested with real users. The product development performed during the Winter quarter has driven the team's vision for the future. The team's vision for the Spring quarter is the Totto ForgetMeNot. The ForgetMeNot is a modular bag that helps users keep track of their items. The ForgetMeNot can alert the user if he or she has forgotten an important item by tracking whether or not the item is in the bag and by assessing the user's schedule. ForgetMeNot can also guard against theft and alarm the user that an item has been removed without permission. Furthermore, these features come in an ergonomically designed bag that effectively distributes its weight over the user's body. Although described in this document as separate features or prototypes, the team will strive to combine these key ideas into a single product that embodies the critical discoveries the team has made during user testing and the overall product philosophy of Totto.

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Glossary

Acrylic A lightweight, shatter resistant, transparent plastic [1]

Arduino An open-source computing platform based on a microcontroller board and a development environment for programming the board [2]

Backpack A bag carried on the back by two straps

Bandolier Bag A prototype that consisted of a belt-shaped bag that is easy to maneuver around the body; thus, items stored in the bag would be easily accessed

Benchmarking The process of comparing products, services, and processes with those of organizations known to be industry leaders

Big Box A prototype simulating a personified bag

Biomimicry The imitation of the models, systems, and elements of nature for the purpose of solving complex human problems

Bristol board An uncoated, machine-finished paperboard [3]

CEP Critical Experience Prototype; an experiential prototype that is deemed "critical" to progressing toward the final design

CFP Critical Functional Prototype; a physical prototype that is deemed "critical" to progressing toward the final design

Chameleon Blocks Bag A modular bag that incorporates customization. The user can choose different modules to attach to a wearable base

Dark Horse Prototype A prototype that allows teams to innovate without limits of practicality or feasibility. This prototype is an important step in the design process since the team has the opportunity to diverge and pursue previously untouched ideas

Eco-friendly Environmentally-friendly or not harmful to the environment

E-textiles Fabrics that have electronics embedded in them

EXPE The Stanford Design EXPErience; a celebration of students' creative work in design research, design practice, engineering, and manufacturing [4]

Force sensing resistor (FSR) A sensor that consists of a conductive polymer which changes resistance in a predictable manner following application of force to its surface. Applying a force to the surface of a the sensing film causes particles to touch the conducting electrodes, changing the resistance of the film [5]

ForgetMeNot Prototype of a container that prevents the user from forgetting his/her belongings

Functional Prototype An initial attempt at a prototype that can be presented at EXPE. The prototype should not have any "Wizard of Oz" elements (definition given below)

Funky Prototype A prototype that is mostly functional, yet, is not necessarily visually appealing (hence the word "funky"). If possible, this prototype should not involve any "Wizard of Oz" elements (definition given below)

Geo-Grab Bag A prototype that employed firm, yet adjustable, perforated aluminum strips, or "hooks," which essentially clipped onto the user's body in a form-fitting hug around the hips and over the shoulders

Item tracking A system that tracks the items stored in a bag (e.g., cell phone, wallet, books, laptop, etc.)

Jugar Bag A conceptual bag that would reward the user for frequent use of the bag, for using public transportation, for purchasing local food products, etc

Maxwell Bag A prototype exploring the possibility of an "endless energy container" that is able to harvest energy from environmental electromagnetic waves

Messenger bag A bag that rests on the lower back and is supported by one strap that usually runs over the shoulder and across the body

Microcontroller A small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals [6]

Mobile SmartCart An early-stage prototype that carries the user's belongings, follows the user, and provides items on the user's command

Needfinding The process of benchmarking and interviewing potential users to determine the market need for a product

OLED Organic light-emitting diode; a light-emitting diode (LED) in which the emissive electroluminescent layer is a film of an organic compound which emits light in response to an electric current. OLEDs are used to create digital displays in devices [7]

Persona A fictional character created to represent a specific user type or targeted demographic, attitude, and/or behavior set that relates to the product being designed

Phablet Hybrids of smartphones and small tablet computers with a screen size of five to seven inches [8]

Photoresistor A light-controlled variable resistor [9]

Piezo buzzer A piezoelectric audio signalling device that is used for making alerts [10]

Professor X A prototype using "X"-shaped straps instead of parallel straps to secure the user's bag and belongings closer to the user's body

Radio frequency identification (RFID) A system for tracking items that consists of a reader and tags. The RFID reader emits electromagnetic energy, and the tags (which have an antenna) send information back to the reader in the form of radio waves. The reader interprets the radio wave frequencies as data [11]

Urban traveler Those who commute frequently in urban areas

Wizard of Oz A design method simulating interaction behavior through human impersonation [12]

2 Context

2.1 Need Statement

Containers are essential items for urban travelers. When a container is used to transport valuable personal belongings, a wearable bag comes to mind (e.g., a backpack or a messenger bag). Because the wearable bag market is so well developed, one might think that such bags have been optimized such that they meet all user needs. However, this is not the case. There are still needs that are not adequately addressed by bags available in the current market.

To obtain a better understanding of these needs, users aged 17 to 25 were interviewed. This particular user age group was chosen for a variety of reasons. Urban travelers of this age group tend to be more mobile and require efficient solutions for transporting their belongings. These users also pose interesting design challenges since they often have lower budgets, use public transportation or bicycles, are interested in the latest technology, and are concerned with product eco-friendliness. Thus, this user group was deemed particularly apt since users are more inclined to explore unconventional and innovative bag designs.

Needfinding led to three important unfulfilled needs which are best presented as questions: Have you ever worried about the security of your bag? Are you frustrated when you forget an item? Have you ever felt uncomfortable wearing your bag? Many urban travelers answer these questions affirmatively. Hence, there is still a need for a safer, smarter, and more comfortable container (or wearable bag). Fulfilling this need would greatly reduce the anxiety and inconvenience of traveling in an urban environment and would lead to an improved urban traveling experience.

2.2 Problem Statement

Totto is a bag, clothing, and accessories company that was started in 1988 and is headquartered in Bogotá, Colombia. With over 500 stores in 22 different countries, Totto has evolved into a recognizable and leading fashion brand primarily in Latin America. However, Totto is looking to expand globally to markets including the United States, Italy, Australia, and Brazil. Representatives from Totto challenged the student design team to design a smart container that meets the needs of the urban traveler. The brief was left purposely broad to promote creative interpretation of the challenge. The team was, thus, urged to pursue innovative designs and concepts. In order to gain a better understanding of the brief, the concept of a smart container was deconstructed as shown in Figure 2.1.

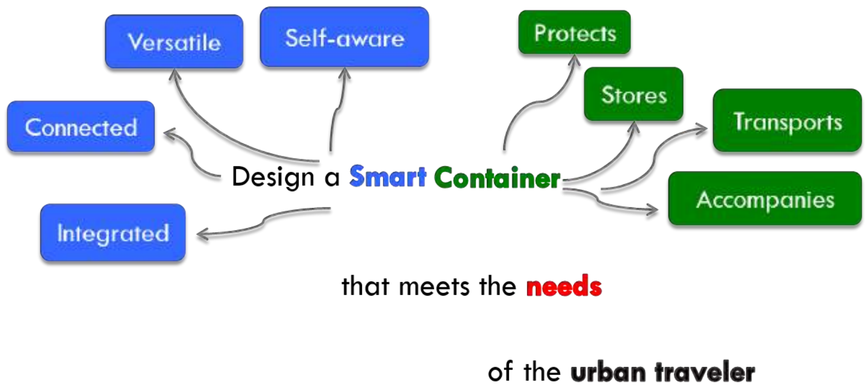


Figure 2.1: *An initial breakdown of the design prompt provided by Totto*

In the context of a container, it was determined that the word "smart" could mean that there are integrated technologies such as web connectivity, energy harvesting, or a user notification system. The word "container" in the brief created the opportunity for team creativity. That is, instead of limiting the design challenge to a conventional two-strap backpack, for example, Totto is challenging the team to invent new ways of carrying items.

2.3 Corporate Partner: Totto

Totto is an established company in Latin American countries. In December of 1987, Yonatan Bursztyn purchased a factory in Colombia with the dream of creating his own business and an international brand [13]. Initially producing leather bags, Yonatan and his first employees attended trade shows across the world to gain information about additional opportunities in the market. In 1988, at a trade show in Milan, Yonatan was inspired to create a line of canvas products that incorporated functionality, color, and design. At this point, the company needed a name. "Totto" was chosen as a name that is easy to pronounce in a number of languages, simple to remember, and short. In addition, Totto is similar to "Toto," an American rock group that Yonatan liked.

The employees of Totto eagerly began growing the company. In 1990, Totto introduced a clothing line and opened a franchise store in Cali, Colombia. By 1992, the company had an agreement with Disney and opened the first international store in Costa Rica. Over the next ten years, Totto continued to improve their products while focusing on durability, franchising, and community involvement. In 2002, Totto changed the company logo to the current image of two unconditional friends to focus on the human component of the products, giving them heart and soul (see Figure 2.2). Images of Totto's current stores are shown in Figure 2.3.

Figure 2.2: *The current Totto logo*

Figure 2.3: *Totto stores in Cali, Colombia*

Over the next few years, successful steps for Totto included introducing “Totto Tú,” a segment of the brand directed toward tweens, opening a flagship store in Bogotá, and relating the brand to popular Colombian sports figures. Today, Totto is headquartered in Bogotá, Colombia and has factories in China. Totto merchandise is sold through a number of different channels, from franchises to e-commerce. Customers at the flagship store have the opportunity to customize a bag with colors and styles. In approximately one hour, a customer’s bag is crafted, built, and ready for use.

Totto’s current business model is based on three business units that complement each other: backpacks, accessories, and clothing. With most of the revenue coming from backpack sales to the young student population, Totto has difficulty retaining customers as they graduate and begin jobs.

The Totto liaisons on the project challenged the student team to build a revolutionary container that would be introduced to their product line in the next five years and help Totto reach markets such as the United States, Italy, Brazil, and Australia. The company is interested in working with the students to gain insights on new technologies, trends, and needs of the future clients.

2.3.1 Corporate Liaisons

The team has the opportunity to work with three corporate liaisons for this project. Their details are given in the table below:

Table 2.1: *Totto liaisons*

Name	**Details**
Mercedes "Chedes" Moreno	Status: Director of Design and Development Contact: chedes.moreno@gmail.com
Juan Vasquez	Status: Vice President, Marketing Contact: Juan.Vasquez@totto.com
Cristian Morales	Status: Visual Designer Contact: Cristian.Morales@totto.com

2.4 The Design Team

Team Totto is composed of eleven members from three universities, namely Stanford University, Swinburne University of Technology, and Pontificia Universidad Javeriana. The team consists of students from a variety of backgrounds. Further details regarding each team member are given below.

Caitlin Clancy
Status: Master's Candidate in Mechanical Engineering
Contact: cclancy@stanford.edu
Skills: Experience with project management, basic machining, budgeting, natural gas drilling, safety programs, and system troubleshooting. Familiar with MATLAB, Solidworks, Wellview, and Python. Fluent in Spanish.

I was born and raised in sunny Tucson, AZ. I graduated from the University of Tulsa with a Bachelor's Degree in Mechanical Engineering and a love for country music. I enjoy design and biomechanics, and am looking forward to a great two (or maybe five) years here at Stanford. When I am not in classes, I'm usually playing sports, cooking, or dancing.

Leonardo Cuellar Rodríguez
Status: Bachelor's Candidate in Electrical Engineering
Contact: leonard.cuellar.21@gmail.com
Skills: Matlab/Simulink, RSLogix5000, Simatic, FactoryTalk, Wonderware, Labview, C++, Phyton.

I was born and raised in Cali, Colombia. I am studying Electronic Engineering with an emphasis in Mechatronics. I have had the opportunity to work in Centelsa (cable manufacturing company) for about 4 years where I have acquired an enormous amount of experience working with different people, sharing knowledge, and working on projects. I am curious, passionate, and hard-working. I love to spend time with my family. I enjoy playing video games, piano, and reading.

John Eggleston
Status: Bachelor's Candidate in Industrial Design (Honours)
Contact: eggleston.jd@gmail.com
Skills: Industrial and communication design, design thinking, sketching, SolidWorks

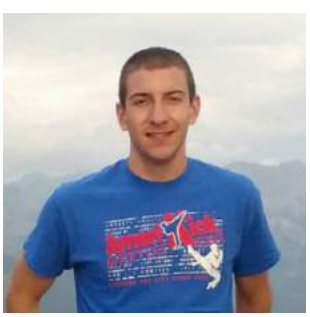
I was born and raised in NSW, Australia. I spent several years backpacking the globe before studying Industrial Design with a focus on Ergonomics and Medical Aids at Swinburne University. When I am not busy studying, I love camping, hiking, swimming, and eating mangoes.

Colin Giang
Status: Bachelor's Candidate in Digital Media Design (Honours)
Contact: cgiang@swin.edu.au
Skills: Project management, interdisciplinary collaboration, Adobe Creative Suite, user-centered design, user experience design, and interface design. I can also speak Cantonese.

I was born in Melbourne, Australia. I completed my Bachelor of Design (Digital Media Design) degree at Swinburne University, and this year is my Honours year. I have participated in Swinburne Design Factory's local interdisciplinary project, and I love working in groups. I enjoy various things when I am not designing or studying such as watching movies, playing video games, hanging out with my friends, and driving around in my car.

Shelby Grainger
Status: Bachelor's Candidate in Industrial Design (Honours)
Contact: shelbygrainger@hotmail.com
Skills: Industrial and communication design, SolidWorks, sketching, model-making

I grew up in the Goldfields in the mining town Kalgoorlie-Boulder, Western Australia. I am currently living in Melbourne where I have recently completed my Bachelor's Degree majoring in Industrial Design with a Graphic Design minor at Swinburne University. Over the past year, I have been working at a promotional company on a variety of different licenced toy products.



Jeffrey Infante
Status: Master's Candidate in Mechanical Engineering
Contact: jinfante@stanford.edu
Skills: SolidWorks, AutoCAD, MATLAB, Python, C++, basic machining

I was born and raised in New Jersey, and attended Rutgers University for my undergraduate education, majoring in Mechanical Engineering with an Aerospace Concentration. Outside of the academic world, my interests include staying fit by hitting the weight room, following the world of professional StarCraft II (a computer game sometimes compared to playing real-time chess, for the uninitiated), and making homemade pizza.

Claire Liao
Status: Master's Candidate in Mechanical Engineering
Contact: yufanl@stanford.edu
Skills: SolidWorks, Creo Elements/Pro, MATLAB, ICEM CFD, Fluent, C++

I am from China, and I obtained my Bachelor's Degree in Mechanical Engineering from the University of Michigan. My undergraduate studies were focused on thermodynamics, heat transfer, and fluid dynamics. I continue to keep exploring different possibilities in my life. I would enjoy starting my own company after graduation. I admire freedom, the love of people, and nature.

Nikhil Pansare
Status: Master's Candidate in Mechanical Engineering
Contact: npansare@stanford.edu
Skills: CAD (SolidWorks, Creo Elements/Pro, AutoCAD); modeling/simulation (MATLAB/Simulink, 20-sim); metalworking (lathe, mill, etc.); programming (C, C++); rapid prototyping (laser cutting/engraving, FDM)

I come from St. John's, Newfoundland and Labrador, Canada. I received my Bachelor's Degree in Mechanical Engineering from Memorial University in St. John's. My interests are in the fields of product design and robotics. More specifically, I am interested in mechanical and mechatronic product design, industrial automation, and humanoid robotics. Apart from academics, I enjoy listening to music, sketching, and playing cricket.

Esteban Paya
Status: Bachelor's Candidate in Electrical Engineering
Contact: estebanpaya@hotmail.com
Skills: Analog and digital electronic design, low-level programming languages, and high-level languages (C, Python, and VHDL)

I was born in Cali, Colombia. I am an Electronics Engineering student with an emphasis in Telecommunication. I am an organized, creative, and reliable person. I am able to work under pressure. I am an active member of IEEE. I also enjoy watching movies and being with my family.

Miguel Andrés Posada Grandes
Status: Bachelor's Candidate in Industrial Engineering
Contact: miguel.posadagrandas@gmail.com
Skills: MATLAB, Minitab, Promodel, Flexsim, AutoCad, sketching, Phyton, project management. I can also speak some Portuguese and Italian.

I was born in Bogotà, Colombia but raised in Cali. I spent six months practicing and competing in golf tournaments around the country before studying Industrial Engineering. I went to England as an exchange student for six months and also traveled around Europe. I really enjoy multicultural experiences, and I love sports. I also enjoy reading and have an interest in world history.

Xiomara Velasco Rios
Status: Bachelor's Candidate in Industrial Engineering
Contact: xiomaravelascorios@gmail.com
Skills: MATLAB, Minitab, AutoCad, sketching, and project management

I was born in Cali, Colombia. I am an Industrial Engineering student with emphases in Operations and Quality and Environmental Engineering. My interests include quality assurance, industrial development processes, product design, innovation, and professional development. I am proactive, disciplined, adaptable to change. I also have experience working in collaborative environments and am able to work under pressure in a team setting.

2.4.1 Coach

The details of the Stanford University project coach are given below. The team maintained correspondence with the coach during the Winter quarter and discussed progress on a bi-weekly basis.

Kelly Johnson
Stanford University Team Coach
Contact: kejohnson104@gmail.com

3 Design Requirements

Introduction

The Totto Smart Bag must meet the needs of an urban traveler. The team focused on the needs of:

- Item tracking and inventory management
- Security and theft protection
- Ergonomics and modularity of the bag

These requirements culminated from months of prototyping and user testing. The requirements described below address what the designed product needs to do, from a functional point of view, and be, from a physical point of view, to meet the needs of the urban traveler.

3.1 Functional Requirements

The functional requirements outline what the final product designed by the team should "do." That is, it is a detailed set of specifications (including metrics) that the product must meet from the perspective of functionality. Each requirement has been labeled as "internal" or "external," depending on whether it relates to the system itself or the system's interactions with the user and the environment. The functional requirements for the product being designed by the team are given in Table 3.1 below:

Table 3.1: *Functional requirements*

Requirement	**Metrics**	**Rationale**
The bag must keep track of the user's items **(external)**	The system must be able to store 50 items	The ability to track items would prevent users from forgetting items and provide them with a greater sense of security
The bag must sound an alarm if the bag is "armed" and an intruder attempts to open a zipper or lift the bag using its handle **(external)**	The alarm must sound if the zipper is opened by 25 mm or if a compressive force equal to the weight of the bag without any contents is applied to the handle	An alarm system would deter thieves and keep the users belongings secure.
The bag must provide recommendations to the user of what he/she needs to take based on his/her schedule **(internal)**	The system must have an integrated 7-day schedule in which the user can enter their activities and the items they need to carry corresponding to the activities	Having a system that recommends items to carry would reduce the burden on the user of having to recall exactly what he/she needs for a given task or event
The attachment system of the modules should be intuitive **(internal)**	The user should be able to take off and put on the modules easily in less than 20 seconds	The attachment system should not delay the user's packing
The modules should securely attach to the base **(internal)**	The modules cannot become unattached from the base when the user has locked them in place	The user should not have to worry about the modules falling off unintentionally

Functional constraints

- Item tracking must be achievable without the use of a smartphone. That is, the user should be able to use the bag and be warned of forgotten items without having his/her smartphone.

Functional Assumptions

- The items that the user wishes to track have RFID tags attached to them. This would allow the RFID tracking system to detect each item.
- The RFID tags and reader do not interfere with the functionality of any of the items.

Functional Opportunities

- After conducting extensive research, the team noticed that both security features and item tracking features had not been integrated into bags available in the marketplace. Thus, the team considered this an opportunity to create a unique product that differentiated Totto from other bag manufacturers.

3.2 Physical Requirements

The physical requirements outline what the final product designed by the team should "be." That is, it is a detailed set of specifications (including metrics) that the product must meet from a physical point of view (e.g., size, configuration, materials). Once again, each requirement has been labeled as "internal" or "external," depending on whether it relates to the system itself or the system's interactions with the user and the environment. The functional requirements for the product being designed are given in Table 3.2 below:

Table 3.2: *Physical requirements*

Requirement	Metrics	Rationale
Electronics must be hidden from user **(internal)**	Electronics are not visible or accessible to the user	The bag must be simple to use
Electronics must be adequately protected from the elements **(internal)**	Electronics must be unharmed after being exposed to heavy rain for 10 minutes or dropped from a height of 2 m	The urban traveler should not have to worry about the well-being of his/her bag in harsh weather
The base of the backpack must be adjustable to user's body **(external)**	Bag must be adjustable to fit users from 1.5 m to 2 m in height	The bag must not exclude users based on body size
Ergonomic base must not be so rigid that it restricts user's movements **(external)**	User must be able to touch his/her toes	Urban traveler cannot afford to have his movement restricted during everyday travel
Battery life must have a reasonable minimum **(internal)**	The bag must be able to run its electronic components for 36 hours on a fully charged battery	The bag should not stop functioning during a normal day's use
Electronic components must be removable **(external)**	User must be able to fully remove all electronics without assistance	Bag must be washable
Battery must be easily changed or charged **(external)**	User must be able to access battery or plug in less than five seconds	Electricity is required for bag operation
The ergonomic base must be easy to put on and take off **(external)**	Use must be able to put the bag on and take the bag off in the same amount of time as a normal backpack	The bag must not sacrifice simplicity for ergonomics
The modular backpack system should not reveal to others what the user is carrying **(internal)**	The modules can be placed inside the bag or otherwise obscured from view	The modules may alert thieves to the fact that the user is carrying expensive items. For example, a module designed to carry an iPad could be a target for a thief.
The ForgetMeNot system must be robust enough to handle occasional Bluetooth and WiFi disconnections **(internal)**	The bag must be able to track items for at least one full day with no errors due to lost connections	The user will expect the ForgetMeNot system to be robust and not require any form of maintenance
The electronic components in the bag should not be heavy **(external)**	The components should weigh no more than 500 g.	Too much weight in the bag would make it uncomfortable to wear and/or carry.

Physical constraints

- The bag must obey the law of gravity, for now at least.

Physical Assumptions

- User owns a smartphone with the capability to download apps and Bluetooth functionality (necessary in order to experience the full capabilities of the ForgetMeNot system).

Physical Opportunities

- Distribution of backpack weight to the hips to take the load off of the shoulders.

3.3 Business Requirements

Totto is a global business with the desire to expand and reach customers around the globe. Due to this, the requirements of creating a marketable and financially viable product are important to our team. The business requirements listed below have been developed with input from the team's corporate liaison. The designed product must do the following:

- Appeal to a wide range of consumers within the desired market (urban travelers)
- Have global appeal, with a focus on North America and Europe
- Have customization options
- Have a price point of about $100 USD

4 Design Development

This section describes the concepts and prototypes that led to the team's final design vision for Spring quarter. Relevant prototypes from the Fall quarter are discussed first. Subsequently, Dark Horse and Funky Prototypes from the Winter quarter are discussed.

4.1 Summary of Fall Quarter Development

The needfinding and prototype development that took place in the Fall quarter was influential to the team's direction and vision for the Winter quarter. This section will briefly outline the development that took place in the Fall quarter.

4.1.1 User Persona

Each team created a user persona based on the needs of a user in the team's home country. Subsequently, the teams collaborated to create a new user persona that incorporated feedback that each team received from the previous user personas. The result was Josh Turner, a 23-year-old engineering consultant who lives in Austin, Texas. He does not own a car, so he usually takes the bus to work and college (where he is a part-time student). Public transportation gets very crowded, which frustrates Josh, but he listens to music and uses his smartphone while he waits. As a result, Josh is often distracted during his morning commute and worries that he will forget items from his bag on the bus. In his free time, Josh likes to meet new people, go out to nightclubs, and watch movies with his friends. For relaxation, he likes to play sports as well as video games.

Figure 4.1: *A cardboard cutout of the team's user persona, Josh*

Since Josh has rent and bills to pay, he prefers not to spend too much money on his clothing and accessories. He wants a bag that is high-quality and makes him look chic and professional; he would also prefer a bag that he could carry on different occasions (i.e., formal as well as informal). Josh carries a phone, laptop, a tablet, keys, a wallet, and a lunch box to his office everyday. He thinks bag security is quite important because he has many confidential business reports on his laptop. Lastly, Josh is enthusiastic about new technologies and follows the news from companies like Apple and Google to see what will come to the market next.

4.1.2 The Massaging Bag

Summary

This prototype features a massaging pillow built into the back of the bag. The bag is designed to give the user better posture to prevent soreness and pain while wearing the backpack. The massaging feature gives the user a pleasant experience while wearing the bag. Initial benchmarking and needfinding revealed that there is a significant amount of backpack users who are not satisfied with the ergonomics of their bag. Many users complained of back pain and soreness after using their backpack for extended periods. This prototype was designed to promote proper posture when wearing a backpack, provide extra cushioning for the user, and provide the user with a pleasant massaging vibration for times when prolonged use of the backpack might cause back pain. Despite the low-resolution prototype, this bag will provide enough of a realistic scenario to gauge user feedback on the idea of a posture correction and massaging bag.

Development

To create this prototype, a massaging pillow was joined to an ordinary backpack using a buckled strap. Note that the buckled strap allowed the pillow to be removed from one bag and mounted onto another, thus allowing users to test the pillow on their own backpack.

Figure 4.2: *The massage bag featured an ergonomic cushion to promote proper posture*

Learnings

User testing of the massaging bag revealed great interest in the prototype. Most users were elated to have a massaging feature on their backpack. Overall, this Critical Experience Prototype (CEP) was very popular among users, and thus, the team considers it a viable element in the final design. It should however be noted that in the final design, the massaging pillow would most likely be integrated into the bag and not be removable, preventing users from easily removing the pillow and attaching it onto another bag.

4.1.3 The TottoSecure Bag

Summary

This bag features embedded electronics that allow the user to "arm" the bag, which means that the bag will sound an alarm if it is picked up or opened. For this prototype, the user arms the bag using a button, but a more refined prototype would feature a security key of some kind that would allow the user to arm and disarm the bag. This prototype features force sensors under the handles of the bag so that the alarm is triggered when the bag is picked up. Needfinding revealed that there is a gap in the market for a secure bag. With many urban travelers carrying thousands of dollars of electronics in their bags on a daily basis, there is a need for a secure bag. This bag focuses on theft protection. For example, a user might fall asleep on the train ride home after a day at work. An armed security bag would prevent a thief from picking up the bag and walking away with it. Despite the low-resolution prototype, this bag provided a sufficiently realistic scenario to gauge user feedback on the idea of a bag with security features.

Development

The alarm system was built using an Arduino microcontroller and an infrared distance sensor to sense when a thief attempts to pick up the bag. The sensor was mounted under the handle of the bag and thus was able to detect if a hand approached to pick up the bag. If the alarm system is tripped, a piezo buzzer emits a loud alarm, drawing attention to the bag and discouraging theft. The Arduino also powered an LCD screen which served as the bag's user interface.

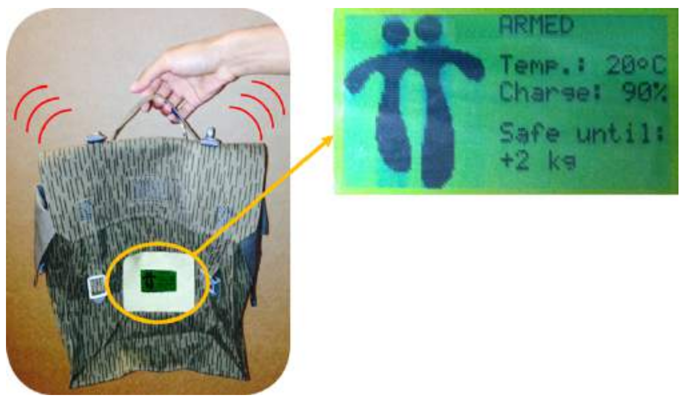


Figure 4.3: *This bag was able to alert users in the event of attempted theft*

Learnings

The first discovery that was made was that the choice of sensor for the alarm system is critical. It quickly became apparent that the infrared proximity sensor did not meet the needs of the bag's alarm system. One problem was that the sensor was prone to false positives due to variable lighting conditions and positioning of the backpack. A revision in the prototype design was clearly merited, and the infrared sensor was removed in favor of a force sensing resistor (FSR). The FSR was a much more suitable sensor for the alarm system. This sensor was mounted under the backpack's handle and would activate if someone picked up the bag by the handle. Ambient lighting, bag positioning, and light jostles of the bag did not cause the alarm to trigger. In essence, the user needs security features but will not purchase a bag if the alarm inaccurately triggers.

4.1.4 E-Textiles Simulation Bag

Summary

This prototype started off as a test in the benchmarking and brainstorming phase as a way to incorporate customization into the design. It soon became an experience test that gives the user the option of customizing and personalizing his/her bag with projections. The team saw the possibility of furthering this prototype by using smart materials or a flexible organic light-emitting diode (OLED) screen to add a display directly to a bag. Current e-textiles technology is not ideal for a low resolution prototype due to high cost and limited availability. This experience prototype was designed to simulate the experience of having a bag with e-textiles technology built in using readily available technology. The method chosen to simulate e-textiles sufficiently replicated the experience for the user so that interest in e-textiles could be determined.

Development

This prototype was created using a projector and a bag with a white canvas. The team could project any image or video onto the bag.

Figure 4.4: *Images were projected onto a bag in order to simulate the customization options that future e-textiles might allow*

Learnings

This was a unique way of displaying one's personality on the bag by using projections, and it can be a powerful tool for personalization in the future. Further investigation of the material and technology is needed to push this prototype further. The test provided interesting results giving an overall visual experience to everyone around the user.

4.2 Dark Horse Prototypes

The purpose of creating the Dark Horse Prototypes was to innovate without limits of practicality or feasibility. The Dark Horse Prototype was an important step in the design process since the team had the opportunity to diverge and pursue previously untouched ideas.

4.2.1 ExtremeMod Container

Summary

The "ExtremeMod" container was a prototype of a highly modular container system that allows the user to choose which container(s) he/she wishes to carry. Three containers were made: the first for a tablet computer, the second for a smartphone (which could be as large as a "phablet"), and the third for miscellaneous items. If the user wishes to use all of the containers, then they can be joined together and taken as a single container. If the user only wishes to take the smaller containers, then he/she can attach them to a belt which can be worn as a sash, around the waist, or around an arm.

Rationale

The primary reason for developing this prototype was to determine whether one bag or container is more useful or versatile if it can be separated into individual containers that the user can wear. Although modular bags do exist in the market (such as the Mission Workshop series of bags), completely modular bags were not found. That is, bags that were found consisted of backpacks onto which individual modules can be added. Thus, modules cannot be worn on their own.

Assumptions

Although only three containers (or modules) were made, it was assumed that reasonable data could be obtained from the prototype. Only three modules were made in order to rapidly construct and test the prototype.

Development

The prototype was constructed using clear and white acrylic and adhesive-backed hook-and-loop fasteners. The design was created using the SolidWorks CAD software and the acrylic was cut using a laser cutter in Room 36 of Stanford's Product Realization Lab (PRL). Images of the prototype are shown in Figure 4.5.

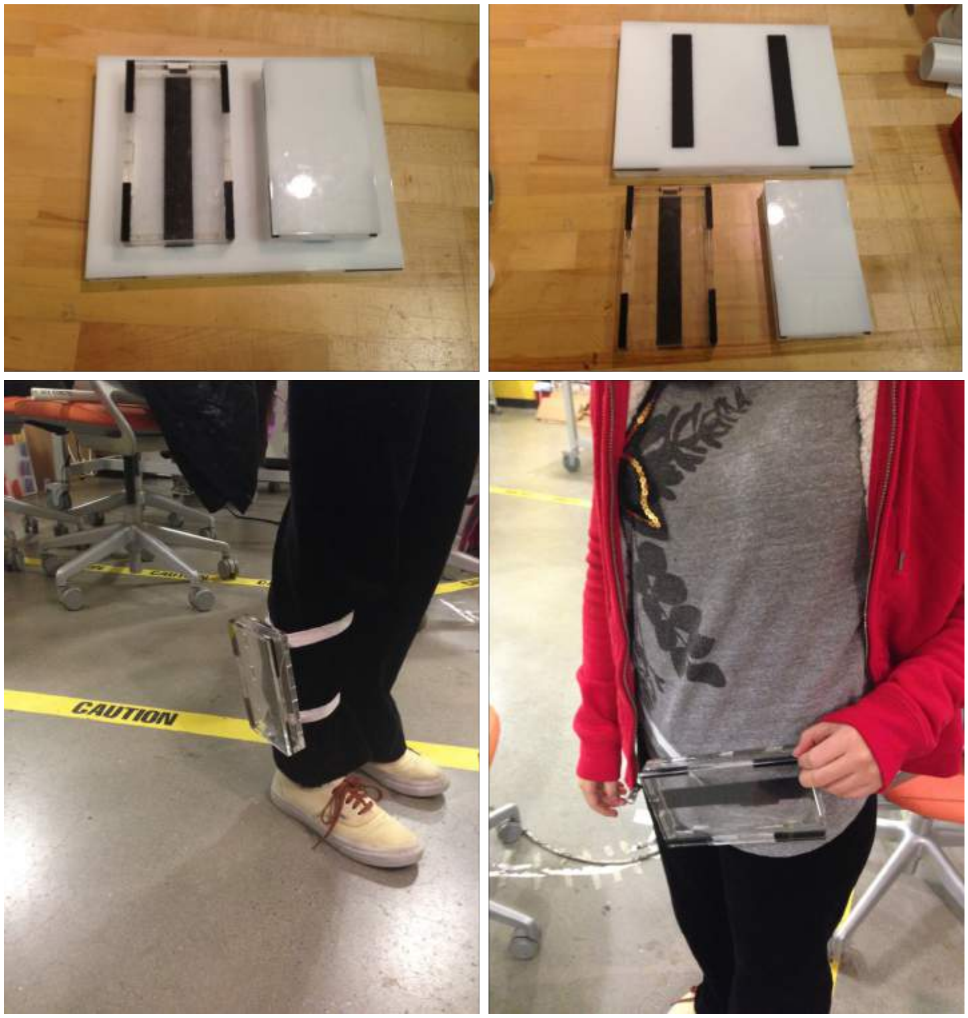


Figure 4.5: *From the top-left: All modules assembled; modules disassembled; module being worn on the leg; module being worn on the waist*

Learnings

Out of four users, three were interested in the versatility of the container system. One user, however, found it awkward to wear the individual containers on their waist, arm, or leg and instead opted to take all three containers, which defeated the purpose of the design. Thus, based on the user testing, the team decided to continue developing this prototype and possibly integrate it with future prototypes.

4.2.2 Mobile SmartCart

Summary

This prototype was a "Wizard of Oz" representation of a mobile cart that carries the user's belongings, follows the user, and provides an item on the user's command. In addition to the cart, as part of the prototype, the user would also wear a wristband which communicates with the mobile cart and informs the user of what the cart is carrying and the cart's current status (e.g., its distance from the user, its battery life, whether it is locked). The user can command the cart to provide an item by saying the name of the item to the wristband. The wristband would interpret the voice and communicate with the cart. The chosen item would then be raised by the cart, allowing the user to take the item. Version 1 of the prototype was completely non-functional, whereas Version 2 was equipped with motors to propel the cart and sensors to detect whether items were placed in the cart.

Rationale

The reason for creating this prototype was to ascertain whether users prefer carrying their items or whether they prefer having their items follow them (i.e., in a SmartCart). The prototype also allowed the team to evaluate any major challenges that would be faced if a functional version of the SmartCart were to be built.

Assumptions

The main assumption with this prototype was that the critical user experience of having a cart that follows the user and carries the user's items could be mimicked by a non-functional, Wizard of Oz prototype.

Development

Version 1 of the SmartCart, seen in Figure 4.6, was constructed using materials available in the ME 310 Loft. More specifically, it was constructed using cardboard, Bristol board, acrylic, paper tubing, and casters.

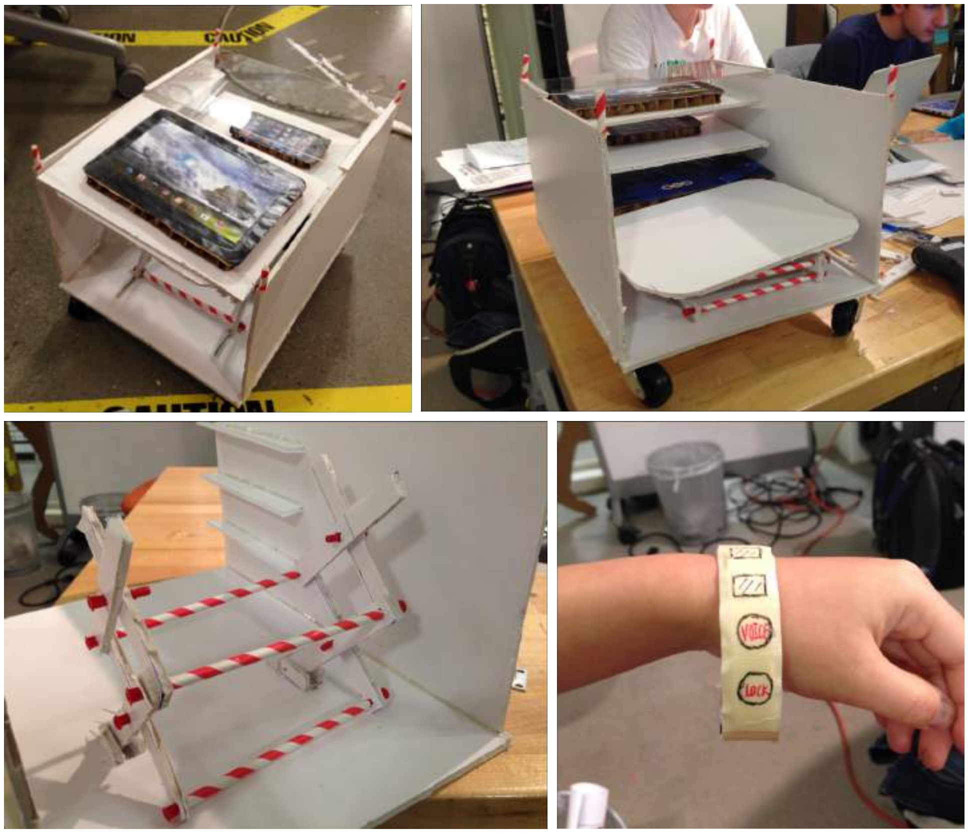


Figure 4.6: *From the top-left: Mobile SmartCart Version 1; scissor lift system in cart to provide item to user; scissor lift extended; wristband being worn*

Version 2 of the SmartCart, as seen in Figure 4.7, was constructed using clear acrylic. Stepper motors were used to propel the cart, and force-sensing resistors were used to detect whether items had been placed in the shelves of the cart. Version 2 of the cart differed from Version 1 in that the scissor lift system (top-right of Figure 4.6) was removed to reduce the complexity of the design. Arduino code for running Version 2 of the SmartCart is provided in Appendix E.

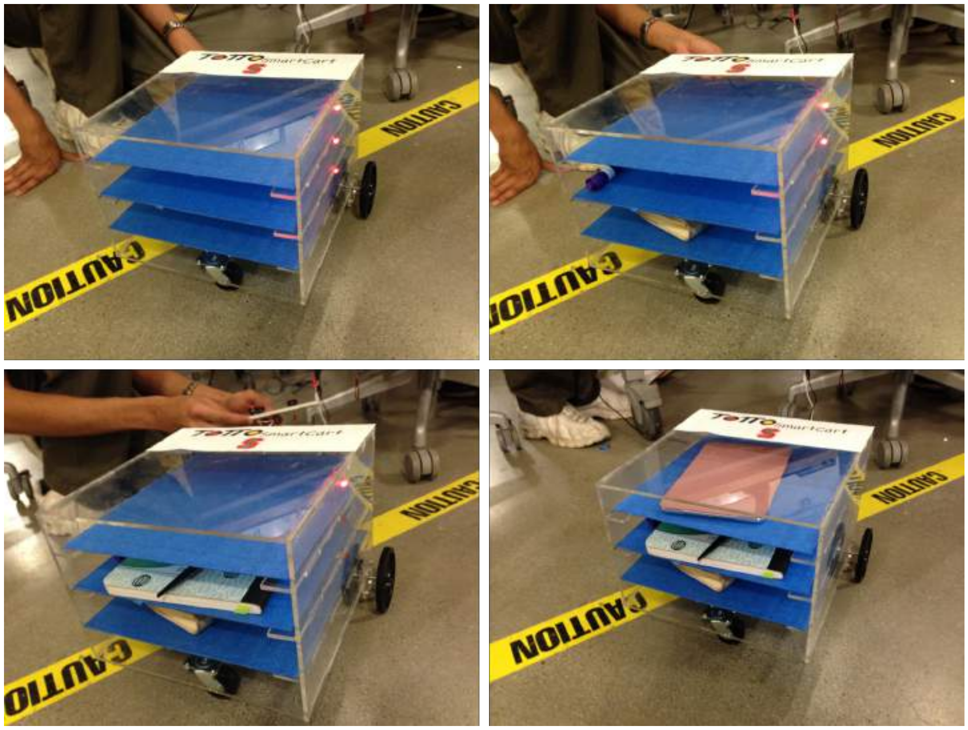


Figure 4.7: *LEDs indicate whether a shelf is empty as items are added to the Mobile SmartCart Version 2. From the top-left: No items (all LEDs lit); 1 item; 2 items; 3 items (no LEDs lit)*

Learnings

The SmartCart was tested with three users. One user found the cart to be inconvenient since he had to bend down to pick up items from the cart. Other users feared for the safety of their belongings since they were not physically connected to them. Additionally, one user suggested having the bag (or container) fly approximately 10 ft. above ground level while simultaneously following the user. This would reduce the likelihood of thieves having access to the belongings. Lastly, the team also noted that irregular surfaces (e.g., rough terrain, stairs) would pose a major problem for the SmartCart. Thus, from the user testing results, the team decided not to pursue this idea further since there was insufficient positive feedback from users. However, users were interested in the ability of the SmartCart to track the items placed on its shelves. This concept was further developed in the ForgetMeNot prototype (described in Section 4.2.3 below).

4.2.3 The ForgetMeNot Bag

Summary

Based on findings from the Mobile SmartCart, the team decided to pursue the idea of a container that prevents the user from forgetting his/her belongings. To implement this experience-based Wizard of Oz prototype, the team contacted urban travelers and obtained their weekly schedules. Based on these schedules and the items that the travelers needed to carry, text messages were sent to the users 10 minutes before the start of each activity, reminding them to take the items they needed in their own personal container (e.g., their backpack). In addition, a mobile application was made to mimic the interface between the container and the user.

Rationale

The reason for which the team decided to create this prototype was to see if users appreciated the idea of a bag that notified them of items they needed to take, kept track of their items, and warned them if they had forgotten an item they required.

Assumptions

Once again, it was assumed that a Wizard of Oz prototype would provide sufficient and valuable data to evaluate the prototype effectively.

Development

In order to send text messages to users at predefined intervals, an app called "SMS Scheduler"[1] was used. Furthermore, to develop the mobile app mockup, the "InVision"[2] online utility was used. Screenshots of the app mockup are shown in Figure 4.8.

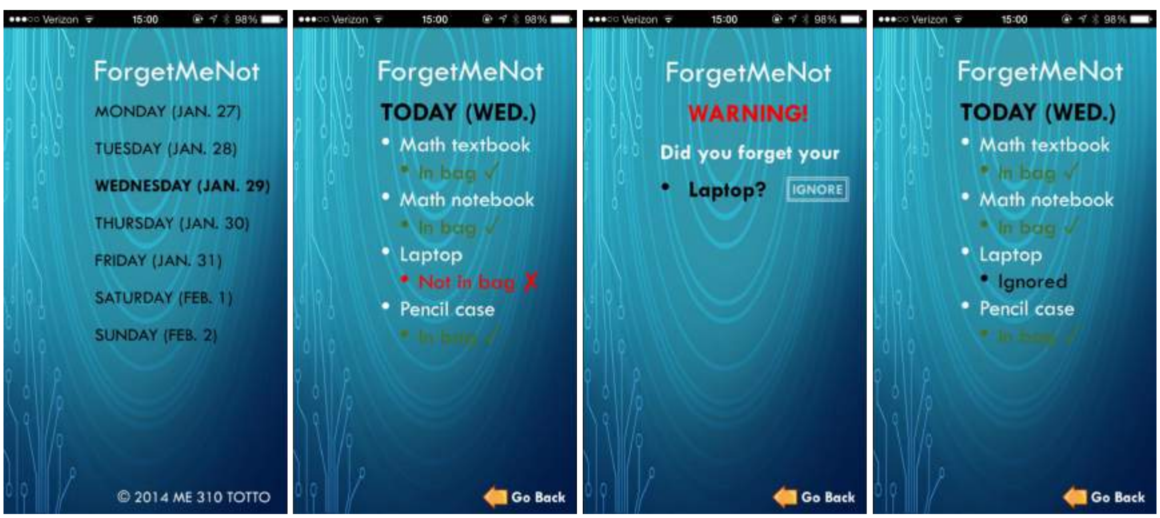


Figure 4.8: *Screenshots of the ForgetMeNot mobile application mockup*

Learnings

Upon completion of user testing, it was found that users considered continuous reminders of items they needed unnecessary. Users instead preferred reminders or notifications only if an

[1]https://play.google.com/store/apps/details?id=com.lylynx.smsscheduler
[2]http://www.invisionapp.com/

item had been forgotten. In addition, some users preferred the ability to occasionally check if all of the items they needed were in the bag (and, possibly, a "green light" to indicate that the bag was ready for transportation).

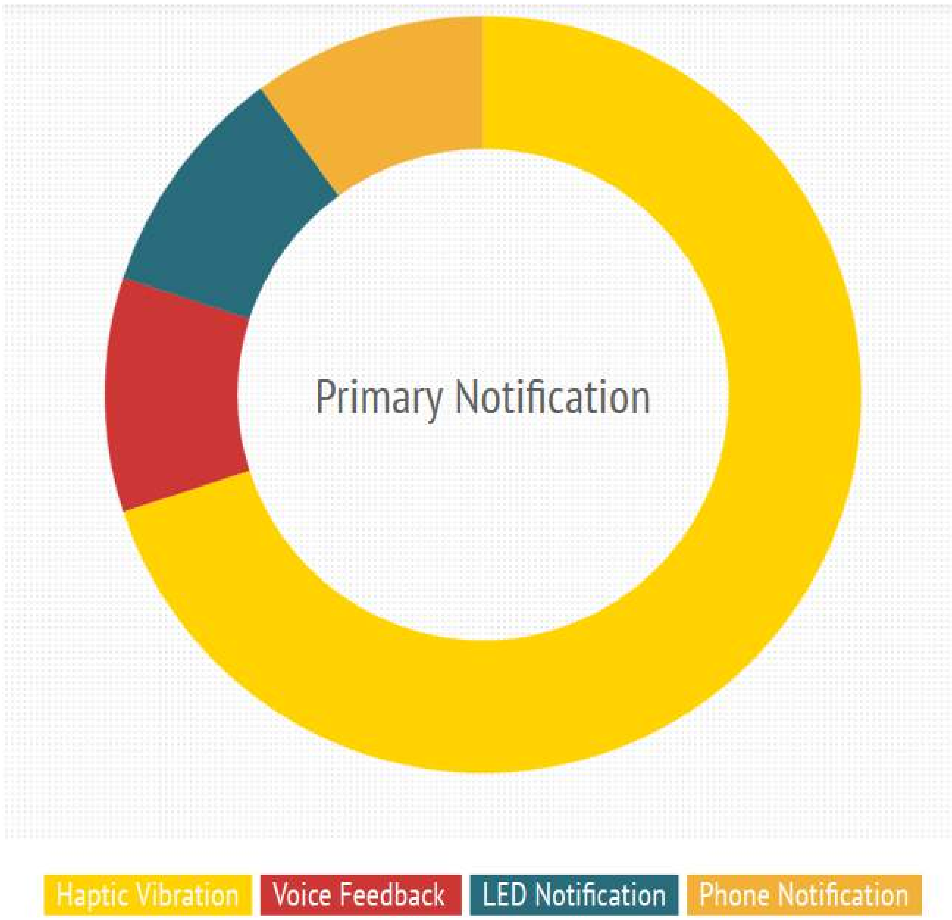


Figure 4.9: *Test results for the feedback method to notify users when they have forgotten an item*

The form of feedback received by the user when an item has been forgotten was also tested. Four forms of feedback were tested: (1) vibration (i.e., the bag would vibrate), (2) voice (i.e., the bag would speak to the user), (3) LEDs (i.e., lights on the bag would glow), and (4) phone notification (i.e., the phone would vibrate and a message box would appear). The results of this test are shown in Figure 4.9. It is clear from the results that most users preferred vibration feedback.

4.2.4 The Wolverine: Think it, Reshape it!

Summary

This prototype was created through a Wizard of Oz video clip to convey the idea of a modular container that the user could reshape at will. Without knowledge of the advanced materials that would be required to create such a prototype, the team decided to construct the prototype using modeling compound to simulate a self-healing polymer and, hence, convey the main aspect of this prototype.

Rationale

The Wolverine is designed to be a versatile container which makes use of a self-healing material. This gives the user the freedom to choose the type of container he/she wishes to carry. The container can be torn apart to create any shape or form; more material can be added to create a larger container if the user wishes to do so. In essence, the user has the ability to use his/her imagination to create a container.

Assumptions

The team assumed that the physical prototype would be manufacturable in the next five to ten years. The lack of a suitable material to create this prototype was the primary concern; thus, a stop-motion video was made to emulate the product.

Development

The prototype consisted of a stop-motion video to convey the main functionality of the prototype (i.e., the ability to reshape the container). Modeling compound (i.e., Play-Doh) was used to create the reshapable container. Snapshots of the stop-motion video are shown in Figure 4.10 below:

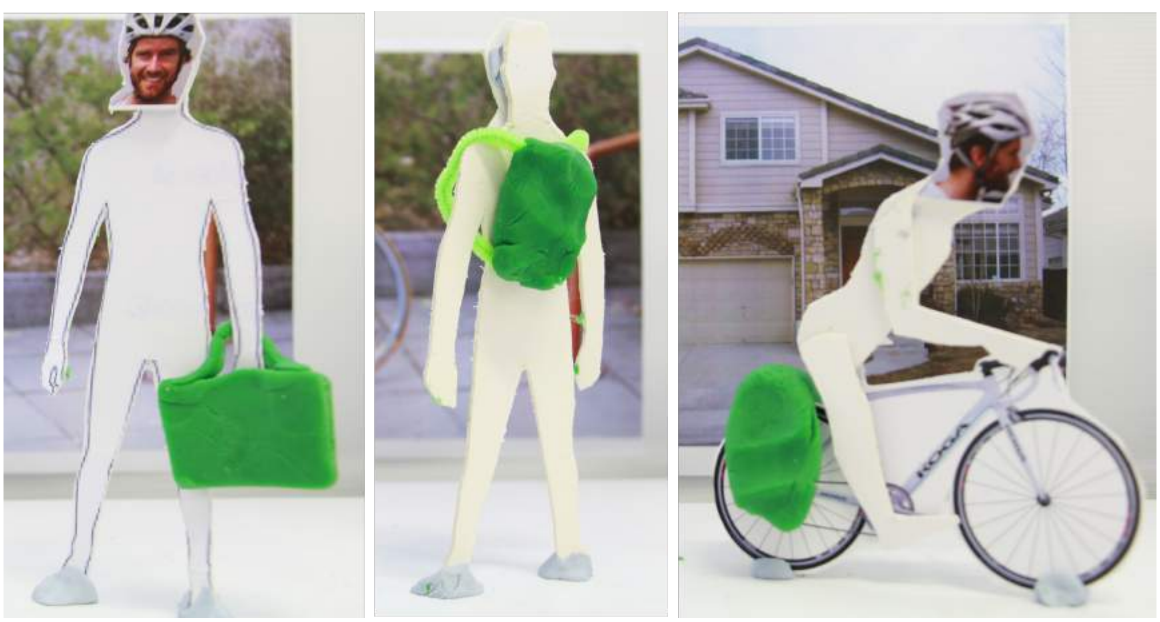


Figure 4.10: *Snapshots of The Wolverine stop-motion video*

Learnings

This prototype sparked interest in users, and many were excited about this concept. In addition, the stop-motion video was a fast and simple method of conveying the idea of a reshapable container. However, since the material required to produce such a prototype was not commercially available, it was deemed infeasible to continue further development of this concept.

4.2.5 The Big Box

Summary

The focus of this prototype was to test if the user could emotionally connect to a container. The underlying question was whether it would be easier to form a connection if the bag were personified. Two iterations of this prototype were created. The first consisted of a large box with a person inside to simulate an automated system within the bag. After the first round of user testing, it was realized that the prototype needed improvement since the overall size of the box was deleteriously affecting user responses. The second iteration consisted of an ordinary backpack with blue tape adhered to it to indicate the zones with which the user could interact. This prototype was better received than its counterpart. A member of the team stood behind the cardboard screen (refer to Figure 4.11) and mimicked the bag's "vocal" response to the user's touch and voice.

Figure 4.11: *Final Big Box prototype; cardboard screen is shown in the lower image*

Rationale

The Big Box prototype was designed to test for the emotional connection a user could develop with his/her bag. The prototype also allowed the team to assess the type of interaction that users preferred with the bag (i.e., voice, gesture, or touch). It was hypothesized that the strength of the emotional connection between the user and his/her bag could directly influence the length of time for which the user keeps and maintains the bag. The team designed the prototype to encompass the user test, with a larger emphasis on the user's experience and interactions.

Assumptions

The main assumption the team had was that the prototype would be easily created. Furthermore, it was assumed that it would be possible to gauge the emotional connection between the user and the bag.

Development

The prototype development phase was challenging for the Big Box. Initially, the team struggled with developing a prototype that would allow the team to obtain significant insights from user testing. Creating and testing this prototype spanned over two weeks of the Dark Horse Prototype phase. Prior to creating the first Big Box prototype, the team decided to enact the experience of a bag that has the ability to speak to the user (i.e., a personified bag). A picture of the enactment is given in Figure 4.12.

Figure 4.12: *Team member personifying a backpack*

Subsequently, the team created a large box with a team member controlling the functions and acting out the sounds (refer to Figure 4.13). This proved to be unsuccessful after the first user test; hence, a smaller, less clumsy version (shown earlier in Figure 4.11) was made to gain insights from users.

Figure 4.13: *Initial Big Box prototype*

Learnings

For this prototype, the team conducted pre-test interviews to ascertain the user's feelings toward his/her bag. After the pre-test questions, users tested the Big Box prototype. After users tested the Big Box, the team concluded the interview with a final set of questions related to the prototype. The questions that were each user was asked can be seen in Appendix B. The learnings from the user tests are detailed below:

- The initial Big Box prototype was quite large and distracting; this tended to confuse users.
- Interacting with the bag using vocal commands might not be as readily used in public spaces.
- Users preferred the bag to respond with vibration or lights rather than sound.

4.2.6 The Bandolier Bag

Summary

After testing the Big Box prototype, the team found that a large percentage of participants interviewed wanted to improve the accessibility to items in their bags; that is, users wanted to access items without having to remove their backpacks. Participants stated that this was annoying and forced them to place the bag on an unclean surface (such as the ground). The team began brainstorming ideas to create a product that eliminated this issue. Brainstorming and research led to various prototypes. Subsequently, the team decided to create a bag that is based on a "bandolier," a belt with pockets to hold items (traditionally, ammunition). Such a bag would be easy to maneuver around the body; thus, items stored in the bag would be easily accessed.

Rationale

This prototype was designed to explore the idea of being able to quickly and effortlessly access highly used items such as a phone, wallet, keys, or water bottle without having to stop and remove the bag. Users that tested the Big Box prototype indicated that these items were used most often and were, at times, stored in a backpack. The key requirements for the Bandolier Bag were the following:

- The bag must hold four personal items: phone, wallet, keys, and water bottle.
- Items must be accessible without having to remove the bag.

Assumptions

Before starting the prototype creation process, the team assumed that the user would like to keep his/her personal items close to themselves without carrying an extra bag. It was also assumed that users would prefer wearing their day-to-day items on the belt rather than storing them in their pants or shirt pockets.

Development

The Bandolier Bag prototype consisted of a belt with multiple pockets for storing small items. The belt and pockets were made using a heavy-duty fabric and elastic cord. After multiple iterations, the Bandolier Bag prototype was given to users for testing. A labelled image of the prototype is shown in Figure 4.14.

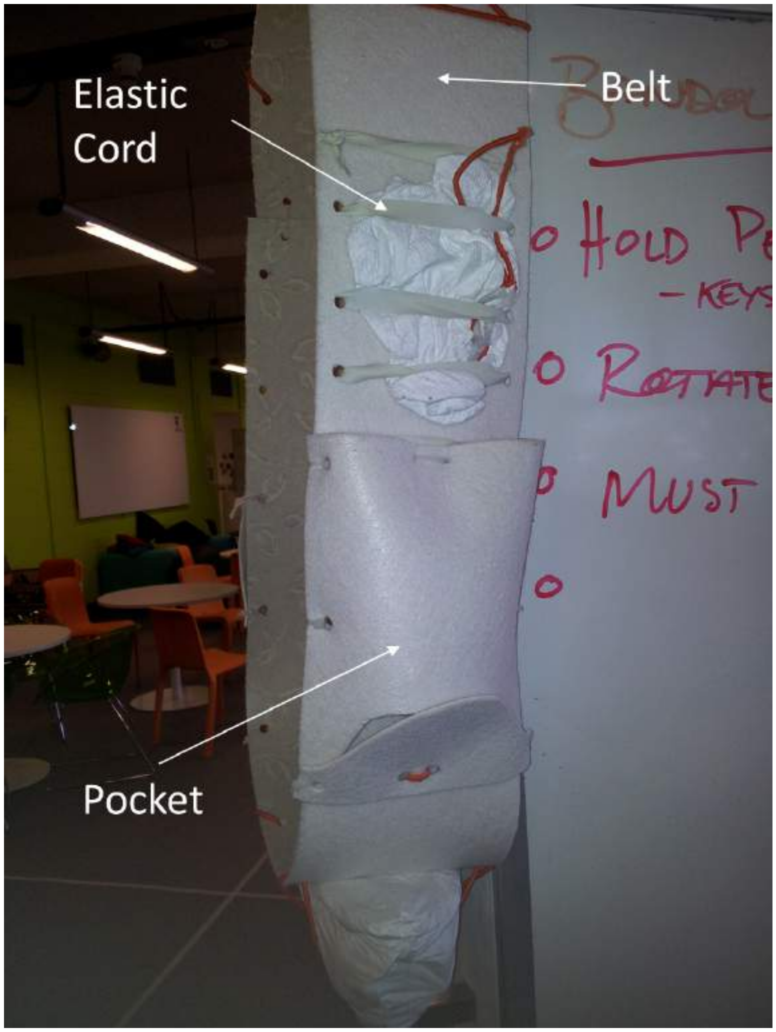


Figure 4.14: *Labelled image of Bandolier Bag prototype*

Learnings

This prototype led to a variety of interesting insights. Participants thought that the prototype felt more secure and stable than an ordinary backpack. (Images of users testing the prototype are shown in Figure 4.15). A key observation was that half of the users wore the bag on the left shoulder, whereas the other half wore it on the right shoulder. Participants felt it would be beneficial and easier to quickly select items out of the Bandolier Bag if each pocket had a variety of access points (e.g., the pocket shown in Figure 4.14 could be opened from the shorter side as well as the longer side). Users also suggested having pockets along the side seam of the belt. Lastly, an important finding during testing was that users found the sash bulky and cumbersome to maneuver when heavy items were placed in the pockets (e.g., a full water bottle); heavy items also tended to cause the sash to slip off of the user's shoulder. Thus, it was decided that, if development of the Bandolier Bag were to continue, the prototype would have to redesigned such that it is less cumbersome to wear with heavy items and is less likely to slip off of the user's shoulder.

Figure 4.15: *Users testing the Bandolier Bag prototype*

4.2.7 The Maxwell Bag

Summary

Everyday, people are surrounded by electromagnetic waves from sources such as radios, cell phones, and WiFi. The idea of this prototype was to create an "endless energy container" that is able to harvest energy from electromagnetic waves and store it for charging the user's electronics, such as a cell phone, a laptop, or a tablet computer. Although this technology does not currently exist in a commercial capacity, this prototype was designed to provide the user with the experience that such a bag would provide.

Rationale

The team noticed that there is a trend and need for renewable energy sources. The usage of smartphones and other gadgets in everyday life has increased dramatically in recent years due to the improvement of WiFi services and mobile networks, as well as apps that have been developed to complement many activities. This is why it was considered important to offer solutions that allow the user to keep their devices charged and available whenever they need them and wherever they go.

Figure 4.16: *The Maxwell Bag prototype was given badges to let the user know it was environmentally friendly*

The Maxwell bag is a backpack that would incorporate technology to become an endless energy source by gathering several types of electromagnetic waves from the environment in order to charge the user's electronics. This type of solution takes environmental sustainability into consideration and doesn't depend on sunlight or weather [14]. Despite the fact that this technology is not ready for mainstream commercial use, the team believes that a bag based on this technology could revolutionize the backpack industry. The team was also interested in the user's response to having energy harvesting equipment in his/her backpack. It was thought that users might feel some hesitation about having this technology in the backpack, due to a possible fear or misunderstanding of technology involving electromagnetic energy.

Assumptions

The following assumptions were made in the development of the Maxwell Bag prototype:

- The technology needed to produce the Maxwell bag is commercially available
- In the future, electronics will require less power than today due to technological advances.
- The environmental problems that society faces today will have grown worse and as a result the general public will have a sincere interest in green products, as well as a desire for innovation in the field of sustainable energy.

Development

To develop the Maxwell Bag system, the team used a portable power supply to charge the devices, an Arduino microcontroller to control the system, LED indicator lights, and an XBee-PRO module. Some badges were also affixed to the bag to indicate that the energy coming from the environment is completely renewable (as seen in Figure 4.16). The portable power supply was hidden inside of the bag and an antenna (XBee-PRO) was placed on the outside of the bag to provide the illusion of a device that captures electromagnetic waves. This was included to complete the experience for the user, who was under the impression that the technology to capture the energy was implemented in this prototype. It was important that the user did not realize that a portable battery was really charging his or her electronics. Finally, there were some LEDs that lit randomly to simulate the capture of energy. Labelled images of the Maxwell Bag are shown in Figure 4.17 below. In addition, pictures of users wearing the Maxwell Bag are given in Figure 4.18; users are displaying their smartphone to emphasize the fact that it is being charged by the Maxwell Bag.

Figure 4.17: *The electronic components in the Maxwell Bag prototype*

Learnings

The learnings from testing this prototype are detailed below.

- Users would be willing to pay a higher price for a bag that gives them free and renewable energy.
- Users prefer that the electronic components of the energy harvester be hidden from view.
- Users prefer that the electronics are removable so that the bag can be washed.
- Users did not like indicator LEDs on the exterior of the bag because it was uncomfortable and they did not want to draw extra attention in the street.
- Users did not notice the extra weight due to the electronics.
- Users were worried about the reliability of the bag and the possibility of needing technical support.
- Users would like the bag to make a sound or give some other indication when a device is connected or disconnected from the charging system.

Figure 4.18: *Users testing the Maxwell Bag prototype*

4.2.8 The Intelligent Straps Bag

Summary

The majority of backpacks are designed with two shoulder straps which allows the user to distribute the weight over both his or her shoulders for greater comfort while carrying heavy loads. However, the team observed that many users only use one strap when using the backpack for a short period of time. This prototype helped the user to remember that he/she should use both straps for proper ergonomics.

Rationale

Ergonomics and comfort have been determined to be important factors to consider in the design of wearable bags. With the Intelligent Straps bag, the team wished to continue exploring the concept of ergonomics and see if users appreciated a bag that was concerned with the user's well being. That is, the bag monitored whether or not it was being worn in an ergonomic fashion. Due to the fact that the team had been hesitant to explore this project direction in the past, it was decided that this prototype would be fabricated for the Dark Horse Prototype phase.

Assumptions

The following assumptions were made in relation to the Intelligent Straps prototype:

- The user would use the backpack with only one strap at least some of the time.
- The user would like a visual indication that he/she has poor ergonomic habits.

Development

To develop the Intelligent Straps prototype, the team used an Arduino microcontroller, two photoresistors, and a pair of LED lights. Differing amounts of light would be incident on a photoresistor depending on whether the strap was on the user's shoulder or hanging off to the side. Depending on which photoresistor was receiving ambient light, LED lights were turned on in the straps as a visual reminder that the user should be wearing both straps. If the user was wearing only the left strap, an LED on the right strap turned on. The prototype can be seen in Figure 4.19 below.

Figure 4.19: *The internals of the Intelligent Straps bag.*

Learnings

Testing of the Intelligent Straps prototype led to the following learnings:

- Users were not really concerned about the ergonomics of wearing only one or both straps. They preferred to have a smart bag that gave them some other functionality.

- Users suggested that vibrating straps would be better than LED lights for notifying them if they were wearing the bag incorrectly.
- Users liked that this bag incorporated electronics but wanted them to be well hidden.
- Users liked the idea of interacting with their bags.

4.3 Funky Prototypes

In the Funky Prototype phase, teams created functional prototypes that could be given to users for testing. The prototypes, however, did not have to be visually appealing (hence the word "funky"). The focus in this phase was on creating prototypes that involved very few, if any, Wizard of Oz elements.

Initial Brainstorming

Before starting the Funky Prototype phase, some team members attended a product development workshop called "PD3: Product Development in 3 Hours," held at Swinburne University of Technology. The PD3 workshop is a workshop designed to accelerate the design thinking process of conceptualizing new concepts. The team began this workshop by printing pictures of all of the different prototypes and concepts from the Fall and Winter quarters. These pictures were then adhered to a poster that was divided into seven categories: sustainability, personalization, materials, technology, security, cost, and ergonomics. This was an effective method of refreshing the team's memory of past prototypes and concepts (refer to Figure 4.20). The method also allowed the team to explore previously undiscovered areas of the design space.

<table>
<tr><td>1. Sustainability</td><td colspan="2">2. Personalisation</td><td>3. Materials</td></tr>
<tr><td>4. Technology</td><td>5. Security</td><td>6. Cost</td><td>7. Ergonomics</td></tr>
</table>

Figure 4.20: *Table used to organize past prototypes*

The team also the mapped the different concepts in an affinity diagram (mentioned earlier in Section 4.2) in order to visualize the location of the current design in the overall design space. The diagram is shown in Figure 4.21. The abscissa of the diagram was a timeline (ranging from the present to the future), and the ordinate was a feasibility scale (ranging from infeasible to feasible).

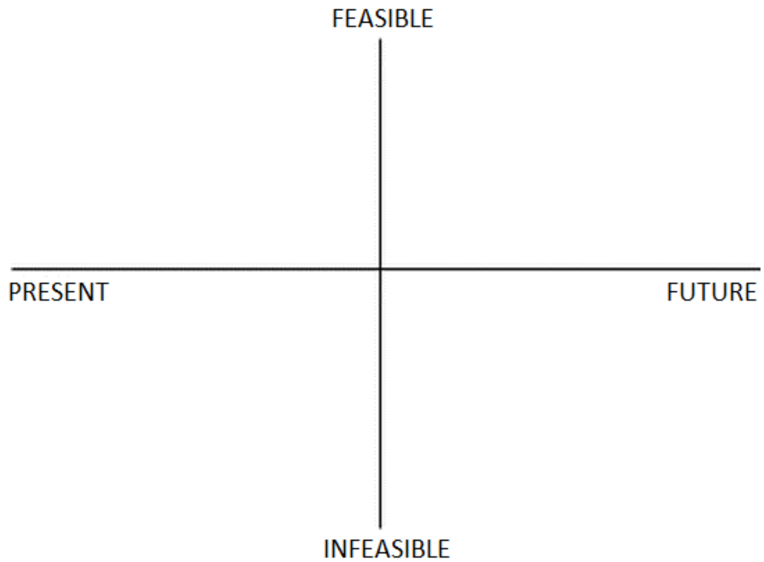


Figure 4.21: *Affinity diagram used for past prototypes*

4.3.1 ForgetMeNot

Summary

Work on the ForgetMeNot prototype was continued in an effort to make the prototype more functional. That is, the focus was on replacing the Wizard of Oz aspects of the Dark Horse Prototype with actual, functional components. Initially, the electronic system required to track items placed in the bag was prototyped. Subsequently, the interface between the user and the bag was developed. Users were given the option of a mobile application and a touch screen on the bag itself. Both the tracking system and the interface were then subjected to user testing.

Rationale

The team decided to continue developing the ForgetMeNot system since sufficient positive feedback was received from user tests of the corresponding Dark Horse Prototype. Thus, to evaluate the feasibility of such a system, the team decided to engineer a simple, yet functional, version of the Dark Horse Prototype.

Assumptions

To simplify the engineering process, the team assumed that the system would track items using radio-frequency identification (RFID) tags. That is, the assumption was that in 5-10 years many items would have integrated RFID tags or that users would purchase tags from Totto (possibly integrated into stickers) and place them on the items they carry. In addition, it was assumed that the calendar-based item recommendation feature shown in the app mockup (refer to Figure 4.8) would be incorporated in the future. This allowed the team to focus on the design of the tracking system and the user interface.

Development

To develop the RFID tracking system, an ID Innovations ID-20 low-frequency (125 kHz) RFID reader, interfaced with an Arduino microcontroller, was used. A piezo buzzer was also added to the system to indicate that a tag had been scanned. In addition, a Bluetooth transceiver was used to communicate with a smartphone via Bluetooth. A schematic of the circuit is given in Appendix D; an image of the circuit is given below in Figure 4.22. Note that an LCD was initially added to the system to display the items registered with the system (i.e., the names associated with the RFID tags). However, the display was later removed after developing the mobile app.

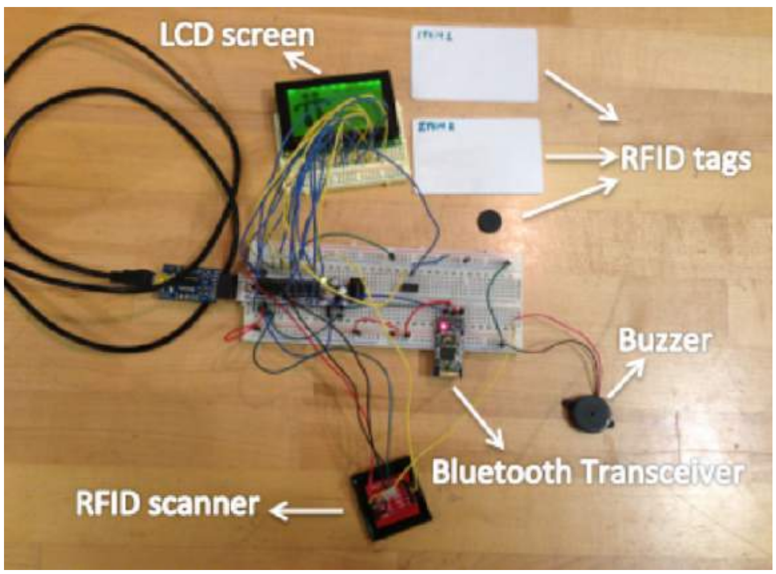


Figure 4.22: *Initial ForgetMeNot RFID circuit*

For the user interface, an Android app was created using the MIT App Inventor[3] (AI) web application. The app made use of an Android smartphone's Bluetooth communication capability to communicate with the Arduino Bluetooth transceiver. A screenshot of the app is given below. Users would register items by scanning a tag and entering the name of item in the text box labelled "Enter Data Here." Registered items would then be visible as either "in" or "out" below "Registered Items" on the app screen.

[3]http://appinventor.mit.edu/explore/

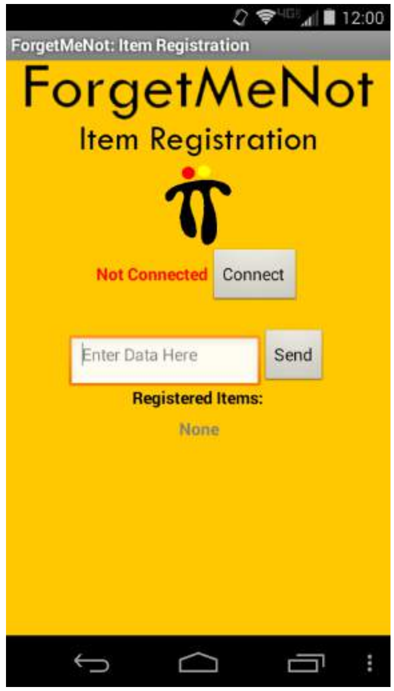


Figure 4.23: *Screenshot of the initial version of the ForgetMeNot app*

Learnings

The goals of user testing were to evaluate whether users found it acceptable to have RFID tags on their items, whether they found it acceptable to scan in/scan out items, and whether they had a preference for the location of the RFID scanner in their bag. The team also wanted to see whether users prefer a mobile application or a touch screen integrated into the bag as the interface between the user and the bag.

The RFID system and interface was tested on three users. After user testing, it was found that two of the three users found the system fascinating and did not consider having RFID tags on their items or having to scan items in and out a hindrance. The third user was interested in the ForgetMeNot system but was hesitant to have RFID tags on his items. He also found the act of scanning items mildly annoying. This finding led the team to further research RFID scanning systems to see if systems with greater read range and with comparable weight and power requirements were available. This is discussed in further detail in Section 5.2.1.

Users also suggested having an integrated calendar system that is aware of the items the user needs to carry; this was considered by the team and, as stated earlier, not included in the prototype in order to reduce complexity. In addition, users suggested expediting the item registration process; typing the name of every item was, for most users, too time consuming. Lastly, with regard to the interface, most users preferred the mobile application as it was more discreet than an integrated screen. Users thought that a screen integrated into the bag would be susceptible to damage and would attract thieves. Thus, positive feedback was once again obtained from the prototype. This led the team to continue developing the ForgetMeNot system for the Functional Prototype (refer to Section 5.2.1).

4.3.2 The Jugar Bag

Summary

The "Jugar Bag" was a conceptual bag that would reward the user for frequent use of the bag, for using public transportation, for purchasing local food products, etc. A small, inexpensive electronic unit embedded within the Jugar Bag would synchronize with the user's smartphone. The user would use his/her smartphone combined with an app to log how much they use their Jugar Bag and where they use it. This process would be very similar to "checking in" on "Foursquare[4]," an app that rewards users for checking into venues multiple times. Frequent usage would accrue rewards points for the user which could be redeemed at participating venues (such as movie theaters), Totto stores (bag upgrades or accessories), or the Totto online community (in the form of achievement badges).

Specific user hobbies could be addressed as well. For example, a Totto bag designed to carry a skateboard could log the frequency with which the user goes skating. Rewarding the user would encourage personal development and bag usage. Furthermore, the value of the rewards could increase with the age of the bag; this could increase brand loyalty. A comprehensive graphic that illustrates the functionality of the Jugar Bag is given below:

[4] https://foursquare.com/

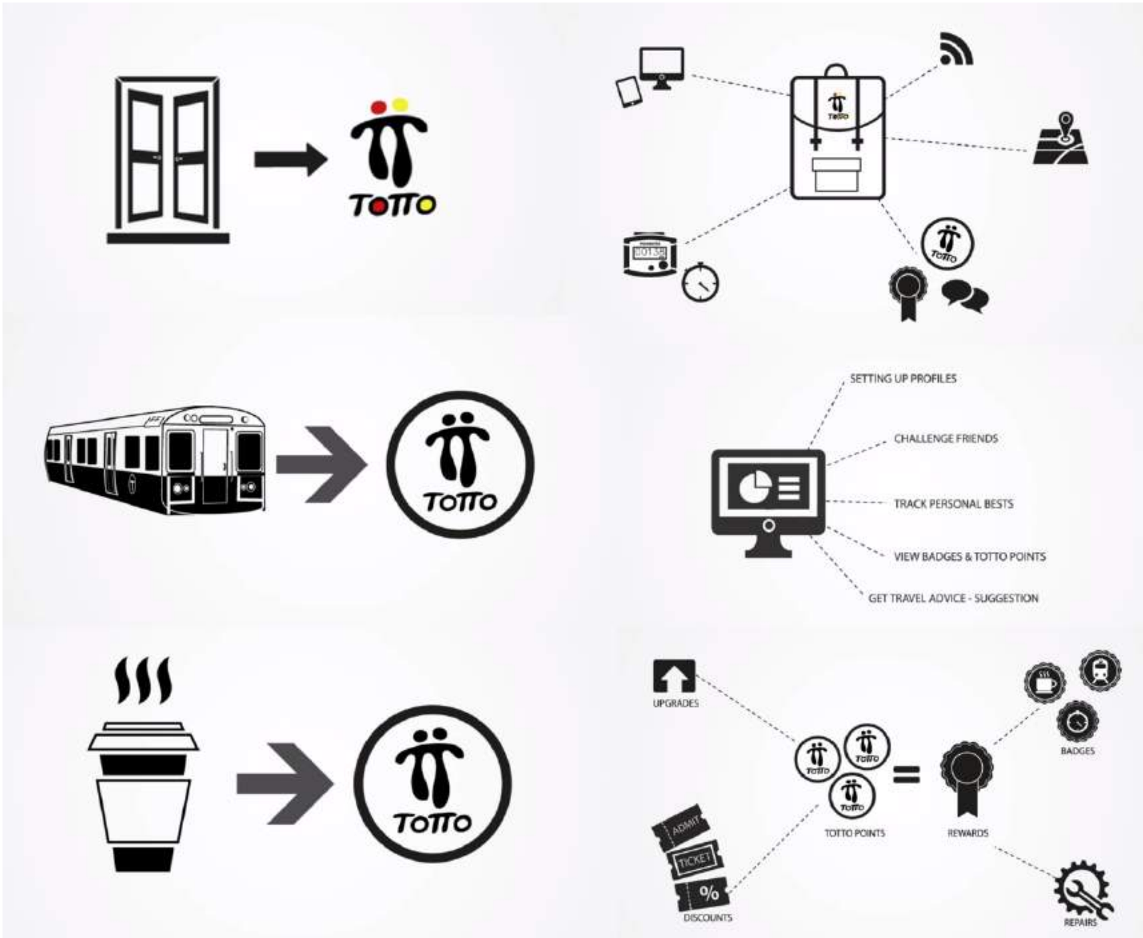


Figure 4.24: *Functionality of the Jugar Bag*

Rationale

In essence, the Jugar Bag was designed to investigate the concept of "gamifying" a bag, i.e., converting the bag-wearing experience into a game. The team chose to convey the concept via a short infographic animation with a voice over. The animation showed the main aspects of the prototype concept. The team decided to create an animation rather than a physical prototype due to the complexity of the system and time constraints.

Assumptions

The team assumed that users would take the time to program their hobbies and needs into a smart container, and have the desire to connect, communicate, and compete with others on an online platform. The team has also assumed that the user will form an emotional attachment to the container due to the incorporation of this technology, which will increase the longevity of the product and loyalty to the Totto brand.

Development

Further details regarding the Jugar Bag can be found in Appendix C.

Learnings

The team disseminated a questionnaire to capture user responses. The results are summarized below:

- Participants that played video games were interested in the Jugar Bag.
- Participants were especially interested in the ability to upgrade their bag and earn bag enhancements.
- Participants were also interested in the social aspect of the concept, that is, having the ability to compete with friends globally.

In addition to learnings from user testing, the team also deemed that the Jugar Bag has significant potential to be integrated with other prototype ideas. However, the overall complexity of the design and the benefits for Totto would have to be carefully assessed before further development.

4.3.3 The Geo-Grab Bag

Summary

Geo-Grab is a backpack that has the ability to hug the body. The main structure is designed to hook over your shoulders and gently grab onto your hips. This hugging backpack idea was spawned from an interviewees vision, who was interested in the idea of having a bag that would grab and attach anywhere on the body. The concept of these prototypes were creating an attachment from bag to body alternative to parallel straps.

Rationale

Geo-Grab begins to explore the benefits of a backpack with no straps and a backpack that forces the wearer to utilize the hip strap to distribute the weight evenly. Idea is that this will create a more ergonomic pack by redirecting the weight to your hip bone, therefore reducing the strain on your back, neck, and shoulders. The core focus of this prototype was ergonomics, with the ultimate goal of reducing back strain. This prototype was also designed to create a less restrictive backpack; experimenting with different straps systems that would be able to support the contents of your backpack.

Assumptions

We created the straps out of bendable metal strips with the assumption that they would be able to bend to fit and mold comfortably to the wearer.

Development

Exploration into ways to create this flexible form hugging backpack proved to be challenging. We create an extremely low resolution, semi-functioning prototype. The main component of this prototype was created out of cardboard, with metal strips inserted into the shoulder and hip sections to create the flexible straps. This material choice was made to allow the user to bend and mold the straps, creating a semi-custom fit.

The prototype employed firm, yet adjustable perforated aluminum strips, or "hooks," which essentially clipped onto the user's body in a form-fitting hug around the hips and over the shoulders. The prototype did not have straps to secure the bag which gave the user greater freedom of movement. An image of the prototype is given in Figure 4.25.

Figure 4.25: *The Geo Grab Bag*

Learnings

Through a variety of different user tests, we discovered that users were pleased by the comfort that this bag gave them. They felt that a backpack with a rigid and structured back panel enforced proper posture. Some users found the hip belt uncomfortable, which indicated that a future prototype would need to have a greater degree of adjustability based on the user's height.

Users were quite interested with this design, although there was some confusion about how to actually put the backpack on Some users tried to sling the backpack over their shoulder, like they would a conventional backpack, while others reached over the shoulder and attached the device at the shoulders, then adjusted the hip component.

After constructing the prototype, user testing was performed. The results are summarized below. Additionally, pictures of users wearing the Geo Grab Bag are given in Figure 4.26.

- Most users were felt that the bag was more secure on their back than an ordinary backpack.
- Users also felt less restricted while wearing the bag. In fact, one user stated that he "could perform parkour" while wearing the bag.
- Users also stated that the bag improved their posture.
- We discovered that creating form fitting prototypes limits the opportunity for testing because each bag is custom fit to one user's body.

In summary, users gave positive feedback regarding the replacement of ordinary backpack straps with the aforementioned hooks. However, it was found from testing that further adjustability would have to be added to the hooks so that the bag can "hug" a variety of body types.

Figure 4.26: *Users wearing the Geo Grab Bag*

4.3.4 Professor X Bag

Summary

The creation of this prototype occurred at the same time as the Geo Grab Bag. The team created both prototypes to explore the same idea of bio-mimicry., and both serve as the base of the Bug hug functional prototype. The Geo Grab Bag was taken further and the Professor X Bag was not, due to the more positive user response to the design of the Geo Grab Bag. The "X" straps were meant to simulate octopus tentacles that latch on to the users. Due to the lack of suitable material it was just created with twill.

Rationale

Professor X was created to explore and experiment with different strap configurations and tightening methods. The goal was to explore and enhance the ergonomics of the pack through experimentation with the back panel, straps, or the way the bag was attached to the wearer. The focus of this prototype was on the straps forming an "X" shape on the user's chest bio-mimicking octopus tentacles. The main test was on how comfortable the user felt with the straps being crossed over rather than parallel.

Assumptions

It was assumed that using X-shaped straps instead of parallel straps would secure the user's bag and belongings closer to the user's body. This validity of this assumption was investigated by testing the Professor X bag with users.

Development

The Professor X bag was made using twill fabric and closed-cell foam. The prototype was assembled using adhesive tape, staples, and hook-and-loop fasteners. Hook-and-loop fasteners and adhesive tape allowed the team to quickly modify the prototype based on the user's body characteristics and/or feedback. Pictures of a user wearing the Professor X bag are given below:

Figure 4.27: *A user wearing the Professor X bag*

Learnings

User testing for this prototype brought up a variety of different concerns. The pack was not the most suitable women as the straps crossed over the front of the body sitting in an awkward and uncomfortable position. This was less of an issue for male users, but there was also some concern that the straps rest close to the neck. The team believes this can be fixed with further development and exploration into strap positioning. Some users felt that having the straps cross over the chest helped to address weight positioning issues and remove strain on their neck and shoulders.

The responses from users that tested the Professor X bag are summarized below:

- Most users liked that a portion of the bag's weight was being distributed over the chest instead of the shoulders.
- Some users suggested that the crossover pivot point on the back (refer to Figure 4.28) needs to be adjustable to suit their torso length.
- Others suggested that the opening for the neck needs to have more adjustability and that the straps need more padding to make the bag more comfortable.

Figure 4.28: *Crossover pivot point of the Professor X bag*

4.3.5 Chameleon Blocks Bag

Summary

Some of the main findings from past prototypes, which are summarized below, led the team to the idea of a modular bag that incorporates customization.

- Males and females have different expectations for what their bags will contain. For example, males tend to carry their essential belongings such as keys, wallet, and phone in their pants and not their bags. Conversely, females are much more likely to carry essential belongings in their bags.
- Users want to organize their belongings in their bag in such a way that allows them to be retrieved in an easy and fast way.

- Users may choose a different bag depending on the items they are going to carry or their destination. For example, many users have a bag specifically for going to the gym.

The Funky prototype gave the team an opportunity to converge on a few ideas. We combined the ideas of personalization, security, and modularity. The modular system features interchangeable containers that are specifically made for different items, and attach to an ergonomic base. For example, if the user wants to carry only a tablet, he or she would buy a module for the tablet and not attach any other modules. The user would choose what modules to use depending on the items he or she plans to carry. Each module in Figure 4.29 is a different size and also incorporates personalization through the choice of color.

Figure 4.29: *The Chameleon Blocks bag*

Rationale

The prototype is unique because the company will sell a variety of modules in different colors and materials instead of entire bags. The user can personalize the exterior of the bag with the color and form that they want.

Assumptions

The assumption was made that the user will be motivated to buy the base as well as multiple modules because he/she will be able to take only what is necessary.

Development

The base was created as the main unit upon which the modules are attached. A range of modules in different sizes and shapes were developed to test the overall versatile design.

Each module had hook-and-loop fasteners on both sides, so the module could be attached to the base and other modules could be attached to that module as well.

Learnings

The team gave the base and the modules to users and let each user choose which modules would best fit their needs. The learnings from user testing were the following:

- The modules should have different shapes and not only be rectangular.
- The users were worried about the security of the blocks because hook-and-loop fasteners do not provide the most secure of attachments.
- The idea was well received by both male and female users because both were able to see a weight and space reduction.
- The user should be able to store the modules inside the backpack.
- The base of the backpack should come in multiple sizes to accommodate many different users.

5 Design Specifications

5.1 Vision

The team's vision for the Spring quarter is the Totto ForgetMeNot. The ForgetMeNot is a modular bag that helps users keep track of their items. The ForgetMeNot can alert the user if he or she has forgotten an important item by tracking whether or not the item is in the bag and by assessing the user's schedule. ForgetMeNot can also guard against theft and alarm the user that an item has been removed without permission. Furthermore, these features come in an ergonomically designed bag that effectively distributes its weight over the user's body. The item tracking, security, and ergonomics features of the ForgetMeNot bag are described in detail in the sub-sections below. Although described as separate features or prototypes, the team will strive to combine these key ideas into a single product that embodies the critical discoveries the team has made during user testing and the overall product philosophy of Totto. Note that the Stanford team's Winter quarter presentation, which also outlines the design vision, is provided in Appendix I.

5.2 Functional System Prototype

This stage of the project begins to synthesize the strongest and most complementary concepts into a singular vision for a product that will be developed in the Spring quarter.

5.2.1 ForgetMeNot System

Summary

The functionality of the previous ForgetMeNot prototypes was expanded and integrated into a usable bag for long-term testing. The main features of the system incorporate item tracking, security, and a smartphone app.

Rationale

Based on positive feedback and a need for a more complete prototype for testing, the team incorporated the most successful components of previous designs into one system. A full test with the system completely integrated into a bag was necessary to gain further insights about the advantages and disadvantages of the system.

Assumptions

The main assumption is that all of the user's items can safely be tagged with RFID tags. In addition, the user had to present 5-10 items that he/she identified as "important." The team assumed that the user would not be bothered by forgetting items that were not tagged.

Development

In addition to the ForgetMeNot system shown in Figure 4.22, a vibration feedback system (in the form of a massaging pillow) was added to give users haptic feedback if they had forgotten an item. Vibration would be triggered by two force sensors located in the straps of the bag. That is, if the user were to wear the bag, the force sensors would trigger vibration if the system determined that an item had been forgotten. The ForgetMeNot bag is shown below in Figure 5.2. The Arduino code is provided in Appendix E, and the updated circuit schematic is given in Appendix D.

Furthermore, multiple changes were made to the app. It was made more visually appealing, and an “Ignore” button was added so that users could ignore the in/out status of an item and prevent the bag from vibrating if an item were not in the bag. The registration process was also updated. More specifically, a voice command feature was added so the user could simply say the names of the items to register them instead of typing in a text box. Lastly, memory was added to the ForgetMeNot system by making use of the memory capabilities of the smartphone as well as the Arduino microcontroller. This allowed the system to retain item information (i.e., name and RFID tag code) even after powering off the system. To reset the system and clear the memory, a “Reset” button was added to the app. A screenshot of the updated app is given below in Figure 5.1. The AI block diagram of the app is given in Appendix F.

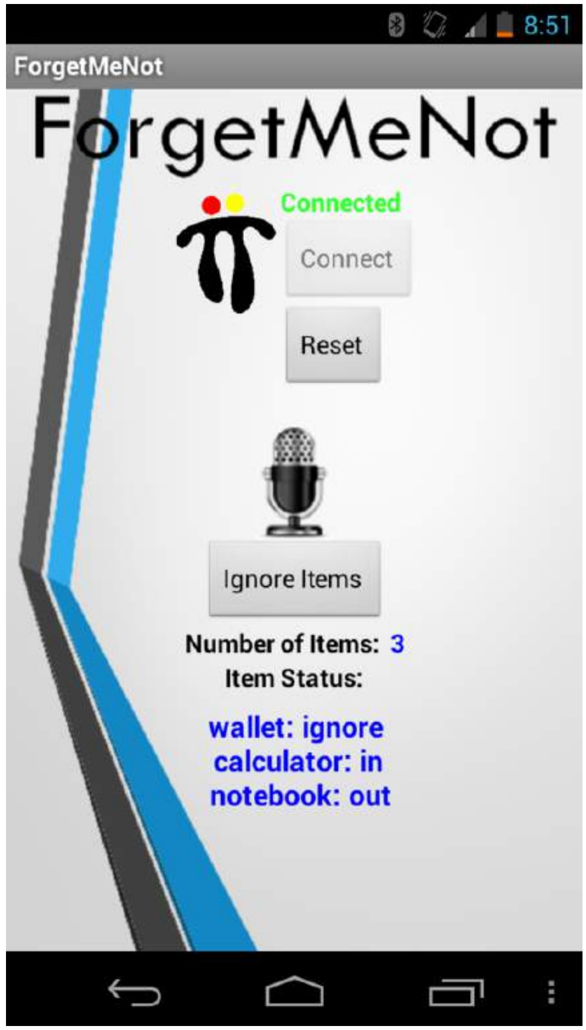


Figure 5.1: *Screenshot of the updated ForgetMeNot app*

The main concern with the integration of the circuit into the bag was reliability. Both the battery life and the integrity of the circuit were tested. A bag is subject to movement throughout the day which tends to shift items inside the bag. Thus, it was important to place the RFID components in such a way that the motion of the bag would not result in failure.

Figure 5.2: *The ForgetMeNot bag with electronics hidden from user*

User comments from the previous ForgetMeNot prototype suggested that another way to alert the user of a forgotten item is a visual display. Thus, the team decided to create a visual display using fiber optic fabric; this is shown in Figure 5.3. In the display, the Totto logo would not be fully defined if an item were missing, but would be fully defined if all items were in the bag. The team also foresees fiber optic fabric such as this being used for customizing a bag. Fiber optic fabric offers the advantage of low power consumption, because many fibers can be lit using a single LED.

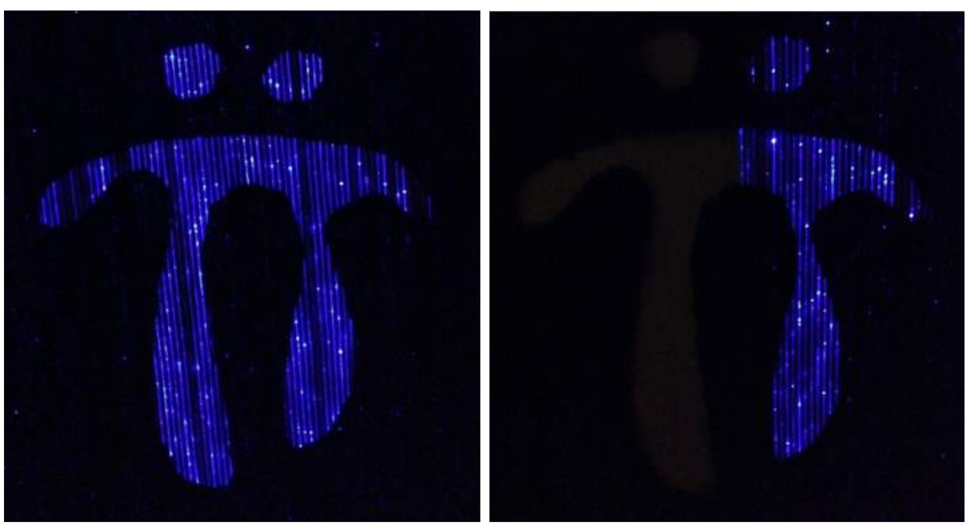


Figure 5.3: *Fiber optic display; all items in bag (left) and item(s) missing (right)*

Learnings

From an initial user test with the bag, several software and hardware issues were found. Software issues included those associated with the AI Android app as well as those associated with the Arduino code. These were minor issues and were fixed relatively quickly. With regard to hardware, it was found that the Bluetooth transceiver, which was initially placed inside the bag, was not able to find a consistent connection with the smartphone. Thus, the transceiver was moved to the outer surface of the bag where it could more easily connect with the phone, while still being protected by a layer of fabric.

Figure 5.4: *A user wearing the ForgetMeNot bag*

After fixing the issues found during the first user test, the bag was tested for one full day by two members of the team. No major software and hardware issues were found with the ForgetMeNot system. It was found, however, that the Android memory management system tends to close the ForgetMeNot app after approximately 45 minutes if it is running in the background. The main issue with this occurrence is that, if the user were to scan in or scan out an item, the app would no longer keep track of the item's status (i.e., whether it is in the bag or out of the bag). In other words, the app would no longer be synchronized with the bag which would confuse the user and necessitate a reset of the system. The team realized that this problem could be solved by either ensuring that the app synchronizes with the bag after a connection is established, or ensuring that the app is run as a "Service" on the Android operating system. The latter option cannot be implemented using App Inventor, so if it were to be implemented in the near future, the app would have to be created using the Android software development kit (SDK).

In addition, research into RFID reader technologies led to the discovery of an ultra-high frequency (UHF) RFID reader which runs on 5 volts, has a read range of 0.5 m to 1 m, and can read multiple tags at once. This was an exciting finding for the team since such a reader could periodically scan the entire bag and see which items are still in the bag (or even near the bag). Due to time constraints, the reader was not tested during the Winter quarter. However, it will be tested early in the Spring quarter to evaluate whether it provides an improved user experience.

5.2.2 The Modular Bag

Summary

The team decided to further develop the idea of a modular container (previously explored in Section 4.2.1 ExtremeMod container) and created a modular bag with a functional modular system for user testing. This functional prototype was made with two different bases to see which one the user preferred. One base features normal backpack straps, and the other is an ergonomic base that hugs the user around the shoulders and hips to help the user distribute the weight of the bag across his/her body, rather than loading all of the weight on the shoulders.

Rationale

The Modular Bag prototype was created to further explore the idea of a modular bag. Although modular backpacks already exist in the market, most involve either hooks or cords to attach the modules to the base. Thus, the team saw an opportunity to create a modular system that uses pins and an associated locking mechanism.

Assumptions

The following assumptions were made in relation to this prototype:

- Users have a desire to customize the location of the items in their bag.
- The process of reaching a proper weight distribution will not be too difficult for the user.
- Users want an alternative option of a modular backpack with modules that can be locked to the base.

Development

Figure 5.5 shows the modular backpack prototype that the team designed. The prototype is made of straps and backplate from a common backpack, which is attached to a flat panel that serves as the base for connecting items to the bag. Users add and attach different modules in any direction and position, enabling them to personalize the look and size of the bag. There is a balanced distribution of weight of the modules, and the users maintain the ability to reposition the modules for aesthetic purposes.

Figure 5.5: *The modular base (left) and the entire Modular Bag (right)*

The system of the blocks and attachments consists of a base made of two flat panels. One panel is on the exterior of the bag, and the other is on the inside. Both panels have the same number of holes, distributed every 3 cm, that serve as attachment points modules. Each module has pins that hook into these holes. The holes of the two panels can be aligned by moving the interior panel up or down. The vertical movement of the panel is done with the handle located on the left of the base; this movement blocks or allows passing of the pins through the panels. The modules are thus locked in or free to be moved. The handle location is easily accessible to the user. This prototype offers an alternative that is more secure and aesthetically pleasing than previous iterations. The design is extremely flexible due to the hole and pin system and there are no unsightly fixed hooks or attachment hardware.

To achieve alignment between the two panels that provides the functionality of the system, the team created many drawings and plans. Once those were finalized, the parts were made on a laser cutter to achieve high precision. The drawings and plans are shown in Figure 5.6.

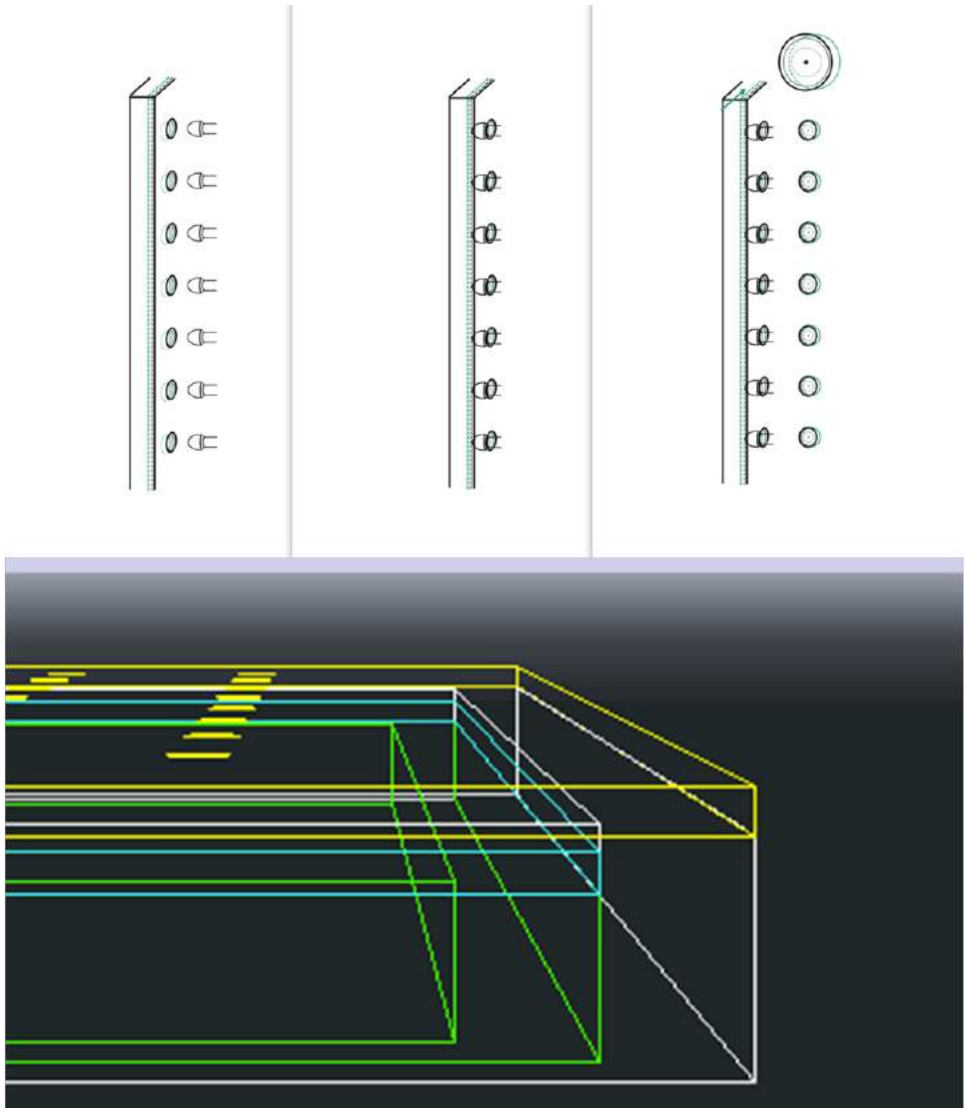


Figure 5.6: *Attachment system concept (top); rendering of the modular base (bottom)*

The make the prototype, the team chose materials that could be stretched out and secured with two frames. There is a 3-mm spacing between the smaller and larger frames. These permit movement for locking and unlocking of the modules.

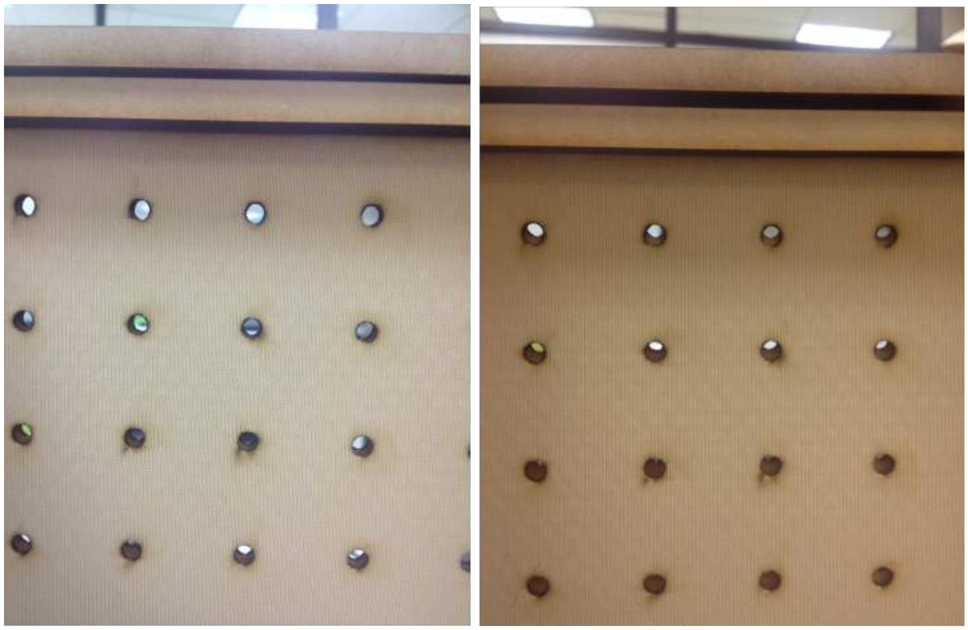


Figure 5.7: *Locking system unlocked (left); locking system locked (right)*

After initial testing of the system, the team realized that the elastic layers yield to the pulling of the module even when the system is locked. Thus a stronger system is required to make sure that the modules do not move once in place. A new prototype was made with an acrylic base and aluminum pins. The materials for a final product would be likely different.

In addition to the prototype described above, an alternate base for the Modular Bag was also made using plaster tape. This base was similar to the Ergonomic Base described later in Section 5.2.3. The alternate base is shown in Figure 5.8 below. The alternate base allowed the team to assess the user's reaction to a backpack that does not have straps.

Figure 5.8: *A user wearing the Modular Bag with the alternate base*

Learnings

The team gave the base and the modules to three different users and allowed them to choose which modules they wanted use. First, users were allowed to choose from different modules for common items such as an iPad, laptop, keys, wallet, water bottle, a notebook, and papers. The team gave the prototype to the user for one hour so they could test out the bag and gather some general impressions. Next, the same users were given modules with bigger and more generalized designs and once again allowed to use the bag for an hour. Learnings from users are detailed below:

- Users reported that they preferred the modules to be inside of the bag. The users were worried about the security of the modules because it allows other people to know exactly what they were carrying.
- Some users would not interact with modules because they did not like having to choose the placement of the modules that correctly distributed the weight on the backpack. They prefer pre-designed pockets.
- Users enjoyed creating an identity for the bag through the unique and personal placement of the modules. They also felt more organized carrying only the items that they would use in the day, and knowing where those items were.
- The users liked the idea of the ergonomic base and felt a weight reduction on their backs.
- The users liked new ergonomic base without straps and thought it was very cool and comfortable.
- The system should be waterproof.
- The users preferred bigger and more generalized modules over the modules that are shaped according to their content.

5.2.3 The Ergonomic Base

Summary

This prototype builds on the learnings from the Geo-Grab bag described in Section 4.3.3. The team formed papier mâché over the torso of a male and female mannequin to explore the possibility of creating a base that was ergonomically designed for each user. The goal was to create an ergonomic base that would increase comfort and reduce the possibility of back strain. This would be achieved by making the hips bear some of the load; thus taking weight off of the shoulders.

Rationale

As with the Geo-Grab prototype, the Ergonomic Base was created with the intention to increase comfort through ergonomics and bring the weight of the backpack closer to the body's center of gravity. The team also wanted to explore the possibility of a form fitting bag and look into alternative methods of carrying everyday items (e.g. strapless, close to the body). We wanted to answer the following questions with the creation of the ergonomic bag prototype:

- Can we create the base of a strapless bag?
- Will the base be strong enough to hold all of the users items?

Assumptions

The team has made the assumption that an anatomically fitted base will mitigate the risk of injury and discomfort that might arise with poor ergonomics. The team also assumed that with a fitted base in place, an appropriately weighted container could be attached at a later time. A base that "hugs" the user would also enable the removal of traditional closed loop straps, limiting the possibilities for incorrect use by the user.

Development

The development of this prototype began by brainstorming different ways and materials that could be used to create a back mold. It was determined that papier mâché would be a great way to prototype in a quick and simple way. The mannequins were covered with plastic wrap for protection and then covered with newspaper, as seen in Figure 5.9.

Figure 5.9: *Fabrication of the ergonomic base using papier mâché*

Two functional prototypes were finalized, as seen in Figure 5.10, one for a male user and one for a female user. The team successfully created a simple modular system to enable a variety of containers of different sizes and functions to be attached to these ergonomic bases (Figure 5.11).

Figure 5.10: *Finalized papier-mâché prototypes*

Learnings

The Ergonomic Base prototypes were effective in visually explaining the concept to the users. Because the prototypes were molded to the form of the mannequin and not each user, it was difficult to obtain true feedback on the comfort of the system. While the Ergonomic Base was not a complete success, users found the concept to be quite intriguing. Users also enjoyed the idea of being able to attach different components depending on what items they needed to carry. These user tests of the Ergonomic Base prototype led to the following learnings:

- The base will not fit the user if he/she is wearing a coat.
- The mold fits the mannequin perfectly but does not fit a wide range of users. This limits effective testing because the bases will not fit many users.
- The harness passively hugs the user but can potentially slip off with excessive movement. An active hugging feature might correct this problem. This is explored in more detail in the Bug Hug Prototype (Section 5.2.4).

Figure 5.11: *Prototypes with modular containers*

5.2.4 The Bug Hug Bag

Summary

This prototype incorporates an "active-grip" system to hold the backpack close to the user's body, providing a more natural center of gravity. Articulated "tentacles" replace common closed-loop shoulder straps and are able to automatically adjust to the user's torso length. The prototype also includes a molded waist belt which passively grips the user's hips. Neither attachment requires a closed-loop system.

Rationale

Continuing with the concept of an ergonomic harness which eliminates closed-loop straps, the team wished to address the issues associated with achieving an individual fit.

Assumptions

The assumptions in relation to this prototype were the following:

- The active response of the tightened shoulder harness should increase the user's sense of security and comfort.
- The waist strap should be able to support a 9-kg load without a closed-loop strap.

Development

The development of the articulated shoulder harnesses required several prototypes in order to achieve a comfortable and secure fit for the user. Figure 5.12 shows the initial small-scale mock-up of the "scalloped" harness design.

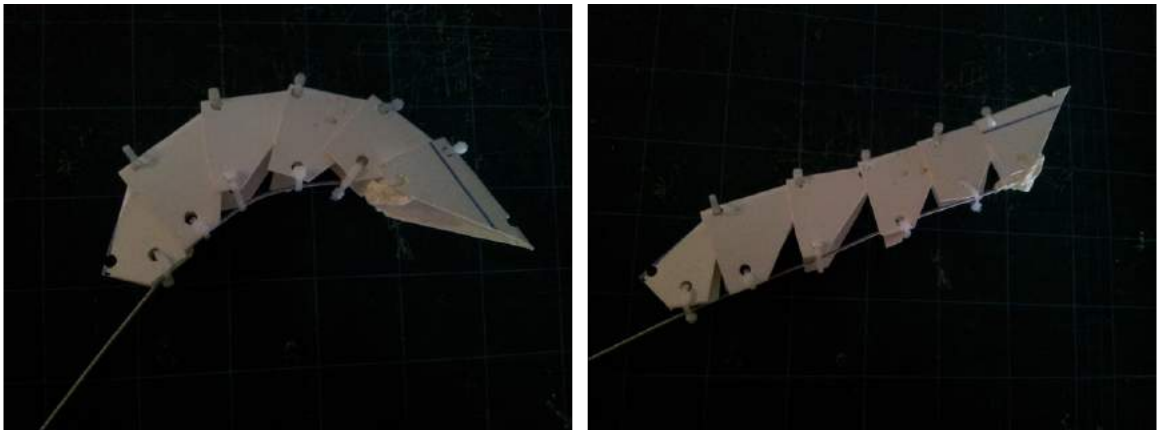


Figure 5.12: *Initial harness prototype; retracted (left) and extended (right)*

This initial prototype led to laser-cut components being developed for a full scale prototype, as seen in Figure 5.13. This iteration of the prototype was designed with the same "scalloped" shoulder harnesses as the initial prototype. These full scale shoulder harnesses were attached to a waist harness which could be manipulated to fit the user. When these components were joined, it enabled user testing of the harness mechanism. User testing indicated that the shoulder harness was effective but a little uncomfortable due to their height and sharp angles. In an attempt to address this issue we replaced the scalloped segments with a continuous length of padded foam, as can be seen during a user testing session in Figure 5.16.

Figure 5.13: *Full scale, wearable Bug Hug prototype*

Feedback from user testing with this iteration of the prototype indicated that the foam straps did not provide the same sense of security as the scalloped design, so the team decided to revisit the scalloped shoulder harness. The scalloped design was improved based on comments from user tests; changes included reducing the profile of the harnesses to improve comfort and adding a soft fabric cover to prevent abrasion on skin and clothing. This latest iteration of the prototype can be seen in Figure 5.14.

Figure 5.14: *The latest iteration of the Bug Hug prototype has slimmer harnesses and a fabric covering for comfort*

5.2.4.1 Learnings

The team conducted multiple user tests of the Bug Hug prototype throughout the Winter quarter. The team also facilitated a user testing session in which users could compare the different iterations of the Bug Hug prototype from throughout the Winter quarter, and were encouraged interact with each prototype and evaluate them in terms of functionality and comfort. Photographs taken during this session can be seen in Figures 5.15 and 5.16.

Figure 5.15: *User interacting with the scalloped Bug Hug prototype*

Major learnings from this meeting and other user tests included:

- Users indicated a preference for the articulated scalloped shoulder harnesses
- A slimmer profile was preferred
- Participants started looking for storage within the shoulder and waist harnesses
- The form-fitting harnesses left users with a feeling of security
- Users reported that the fitted harnesses encouraged better posture
- Putting on and taking off a container without traditional closed-loop straps proved to be quite challenging for users

Figure 5.16: *Users trying on the “foam harnesses” iteration of the Bug Hug Prototype*

6 Planning

6.1 Deliverables

In the Spring quarter, the following key prototypes, presentations, and documents will have to be delivered:

Table 6.1: *Spring quarter deliverables*

Deliverables	
Part-X Challenge	The team will have to completely finish a certain component of the final product. Ideally, it should be ready for EXPE.
Penultimate Integration	The final product should be 90% complete and, thus, nearly ready for EXPE.
EXPE System	The final product should be 100% complete and ready for EXPE.
EXPE Presentation	The team will have to create a presentation, a poster, as well as brochure to describe the final product. A booth will also have to be fabricated in the atrium of the Peterson building to present the product.
Spring Documentation	The team will have to create a comprehensive document that details the process that led to the final product.

6.2 Milestones and Project Timeline

A summary of the deadlines for the Spring quarter is given below. The deadlines correspond to the deliverables described in Section 6.1.

Table 6.2: *Milestones*

Part-X Challenge: April 17, 2014
Penultimate Integration: May 8, 2014
EXPE System: May 29, 2014
EXPE Presentation: June 5, 2014
Spring Documentation: June 10, 2014

A Gantt chart was created to track the progress of the project during the Spring quarter (see Appendix H). This chart has divided the tasks listed above further into sub-tasks in order to track the progress of each task. In addition, for comparison purposes, the Gantt chart has two streams: the planned timeline (in blue) and the actual progress (in red). This will allow the team to accurately track progress throughout the quarter. Lastly, it should be noted that a similar chart was also created for the Winter quarter and is provided in

Appendix H. The team found this chart to be an effective tool for observing and recording the project's progress throughout the quarter.

6.3 Distributed Team Management

Similar to the Fall quarter, prototypes from each country in the Winter quarter were complementary. Some prototypes, such as the Ergonomic Base, involved collaboration between teams. Each university team had a different project schedule and different deadlines. Constant communication occurred via e-mail, Google+ Hangouts, and Facebook. The team also continued using a Google Drive bulletin (shown in Figure 6.1) that is updated in real-time to monitor project progress and contributions from each team member.

Date	Location	Time	Writer	Contact	Description	Reviewed by					
						Caitlin	Jeff	Claire	Nikhil	Shelby	John
2/2/2014	Winter\Funktional Prototype\rfid\rfid4	15:56:00	Nikhil	ALL	Implemented RFID-based item tracker for part of the Funktional Prototype. I will try to make a video of this and post it on Drive.	Yes	Yes	Yes	Yes	Yes	
2/2/2014	Winter\Funktional Prototype	15:56:00	Nikhil	ALL	We created a block diagram of the Prototype (FunkyDiagram.pptx)	Yes	Yes	Yes	Yes	Yes	
2/2/2014	Winter\Funktional Prototype	23:14:00	Nikhil & Claire	ALL	Added a demonstration video of the RFID tracking prototype. Basically, you first register your items, then keep track of them. If an item is displayed on the screen, you need to put it in your container	Yes	Yes	Yes	Yes	Yes	Yes
3/2/2014	Winter\Weekly Team Meeting Notes	17:00:00	Caitlin	ALL	Added meeting notes for today's meetings	Yes	Yes	Yes	Yes	Yes	Yes
3/2/2014	Winter\Weekly Team Meeting Notes	21:25:00	Caitlin	ALL	I emailed Chedes with the final dark horse handouts from all three countries. She will let me know when she can meet but is in Colombia this week so on different time. I started a Meeting Notes sheet for this week's meeting with her.	Yes	Yes	Yes	Yes	Yes	Yes
3/2/2014	Winter\Funktional Prototype\1. Deliverables	21:26:00	Caitlin	ALL	Started Stanford's Handout for the FUNKtional prototype V1	Yes	Yes		Yes	Yes	Yes
6/2/2014	ME310 Totto	9:32:00	Miguel	ALL	I added a folder called italian projects, which compiles all of the Totto design projects developed in Milan by 11 different teams (Findigs, Prototping,etc) Very important to see!	Yes	Yes	Yes	Yes	Yes	Yes
6/2/2014	N/A	12:16:00	Nikhil	ALL	Moved Italian Projects to Reference Materials. I also moved Bag Journey Photos (Airport Travel) to Reference Materials	Yes	Yes	Yes	Yes	Yes	Yes
8/2/2014	FUNKtional Prototype\ForgetMeNot	1:31:00	Nikhil	ALL	Created an Android app using MIT App Inventor 2 to connect to Arduino using Bluetooth (TottoSmartContainerV4.aia). You can open the *.aia file only in App Inventor 2. This app is still a work in progress.	Yes		Yes	Yes		Yes

Figure 6.1: *Team Totto Google Drive bulletin*

The entire team had meetings twice a week. One was at the start of the week on Monday at 5 PM (Pacific Standard Time) and another was mid-week on Wednesday at 5 PM. The first meeting was internal with all student team members and the second was with the corporate liaison, Mercedes "Chedes" Moreno. Meetings were recorded via notes and generally consisted of brainstorming sessions, updates, and prototype feedback. The meetings at the start of the week were for making plans and decisions for what the team would be doing in the following week. The second meeting with Chedes was a feedback and query session with team members and the liaison.

6.4 Project Budget

During the Winter quarter, the entire team spent approximately \$3200 of the total budget on prototyping related materials. The expense spreadsheets are given in Appendix G.

During the Spring quarter, it is expected that the total spendings will be approximately 50% to 75% more than this quarter. The higher predicted expenditure can be attributed to the fact that a complete, pre-production level prototype will have to be fabricated for presentation at EXPE.

6.5 Reflections and Goals

Caitlin Clancy

Thanks again to Totto and to all of my teammates for a good winter quarter. I am excited to travel to Colombia to meet with the entire global team and finalize a plan for the spring quarter. As a team, we have incredible potential to develop a successful smart container for Totto. We have had some difficulties with all converging on one idea to pursue, but having the opportunity to all be together for a week in March will provide an ideal setting for collaboration. Bring on EXPE!

Leonardo Cuellar

This quarter was a good opportunity to explore previously untouched ideas. There were many concepts generated by the global team; this made the convergence process very challenging. I am really excited to meet with the whole team in Totto, and I hope that in Bogotá, the team is able to define a vision that all team members and Totto representatives accept. That week will be the most important stage of the project. Looking ahead, I am excited to meet my global team members and the Totto representatives, and I am eager to create a revolutionary product for Totto.

John Eggleston

I found this quarter to be incredibly productive in terms of researching through the design process. By using prototypes to gain insights, especially during the Dark Horse stage, we were able to make confident decisions leading towards the final vision for the Spring quarter. It was a lot of fun as well having immersed ourselves in the project and familiarizing ourselves with the industry. The team was able to work with the easy flow of familiar and capable colleagues, punctuated with lots of laughs and inside jokes.

Colin Giang

Compared to last quarter, our team has grown in strength. Winter has been a great quarter for prototyping. Through the three stages, we have generated multiple concepts and prototypes to converge to a final vision. The global team's support has been amazing, and working in remote locations has not been that difficult, since communication channels are always open with the team. I am very excited about heading to Bogotá and Cali and spending both social and work time with Totto representatives. This journey began six months ago, and it's unbelievable how far our team has come. After working for two quarters as a digital designer in a mechanical engineering and industrial design context, I have gained a tremendous amount of knowledge. With EXPE closing in on us, the team will strive to converge in Colombia and create a smart container for the future.

Shelby Grainger

I thoroughly enjoyed this winter quarter! We have been super-efficient in exploring a broad range of potential directions and are working really well together as a team. I feel the resolution and amount of valuable insights gained this quarter will be vital in creating a successful product and I look forward to the convergence stage in Colombia during the coming travel.

Jeffrey Infante

This quarter was a great continuation of our design process from the fall. It was really cool to see that the simple prototypes we created during the Fall quarter, such as the massaging bag and the security bag, remained relevant during the winter quarter and even into our final vision for the spring. I feel like that means all of the work we did in determining the critical experiences and functions of wearing a backpack paid off. I had a lot of fun this quarter exploring some of the weirder ideas that we had. I also really enjoyed the functional system prototype because I feel like it gave us our first real taste of what we can expect in the spring. My main goal for the spring quarter is of course to have a finished prototype ready for EXPE, but I also want to increase my knowledge of what goes into producing a complete product. Churning out low resolution prototypes every week is one thing, but I have a lot to learn about manufacturing and system integration in the context of a real product.

Claire Liao

The Winter quarter was a great lesson in prototyping and testing for our team. One of the biggest learnings we made as a team this quarter was to perform user testing often and with our actual users. We learned early on to take time to define exactly who our user was. In building the prototypes, we further learned that testing with other ME 310 students really limits the usefulness of our prototypes. In terms of design, through this quarter, I really feel much more confident about my ability to be creative and design a product. Through experiencing the ups and downs of the design process, I now better understand what it takes to really figure out what people want. There are still things that we could improve upon as a team. I think one of the major issues is effectively using our meeting time. Often, I felt we were working on non ME 310 related things or working independently. Next quarter, I hope we are able to effectively use our meeting time, have more discussions on prototypes, and build things as a team. It's been a fun period of exploration and convergence. I look forward to getting our hands dirty and actually making some physical products, refining our vision, and pulling together a fully functional product for EXPE in June!

Nikhil Pansare

This quarter was especially rewarding for me. The process of diverging (during the Dark Horse Prototype phase) and converging (during the Funky and Functional Prototype phases) allowed the team to explore new areas of the design space and, subsequently, create a functional prototype of an idea that the team previously considered infeasible. During every phase of the project, team members from all three universities communicated well with one another (using tools such as Google+ Hangouts). During the quarter, the team continued meeting in two groups, with each group having at least one member from each university. This led to more useful and productive meetings. The design process that was followed during the quarter proved successful and allowed the team to converge to a design vision. Lastly, each phase of the project was executed by the team as planned (for the most part), and the final results obtained were to the team's satisfaction. I am especially excited to begin fabricating the final, pre-production prototype for EXPE 2014.

Esteban Paya

This quarter was important for the project. The team developed prototypes that were highly divergent. The global team has worked very well, and I think the problems that we had in the past have now been overcome. We are working more as a team, and I am excited to meet the team in Bogotá. Meeting with Totto representatives will be important for the whole team, because this will help us improve our ideas and converge to a final vision. I am thankful to the global team, and I have learned a lot from each person. My goal for the next quarter is to help make a never-before-seen smart bag for Totto.

Miguel Posada

I have noticed that creating an innovative product is an extremely difficult process. During the quarter, I learned that innovation often involves failure; therefore, it has been hard to converge toward an idea that is both innovative and appealing to users. However, the global team has shown great potential to converge. The global meeting in Colombia represents a great opportunity to define the final aspects of our product and get some good ideas from the Totto design team.

Xiomara Ríos

This quarter was very important for the development of this project, because unconventional ideas were explored. I've always liked making fabric-based prototypes (i.e., cutting, gluing, sewing, etc.), so I've really enjoyed this aspect of the project. In this quarter, the group initially had some problems converging to a single idea, but fortunately we were able to arrive at a solution. I am very excited to see my global teammates in Colombia, and I hope to share great experiences with them. We have expectations and goals to define with regards to our final product. However, with the help of the Totto representatives, the team should be able to converge to a prototype that is meaningful to both the team as well as Totto.

7 Resources

7.1 Resources Consulted

The team would like to thank the ME310 Teaching Team from three Universities for their valuable feedback and advice at all stages in the project.

- Stanford - Prof. Mark Cutkosky, Prof. Larry Leifer, Dr. George Toye, Daniel Levick, Stephanie Tomasetta, and Aditya Rao.
- PUJ - Prof. Carlos Serrano, Maria Fernanda Camacho, Juan Pablo Garcia, and Dr. Jaime Aguilar.
- Swinburne - Dr. Christine Thong, Joakim Eriksson and Maria Kulse (Guest Lecturer for 3 weeks).

7.2 Vendors

7.3 Working Locations

7.3.1 Stanford

ME 310 Loft
416 Escondido Mall, Building 550, 2nd floor, Room 204
Stanford CA 94305-2232

PRL, Room 36
475 Via Ortega, Stanford, CA 94305
(650) 721-9472

7.3.2 Swinburne

Swinburne Design Factory
144 High St, Melbourne, Victoria, Australia, 3181.
www.sdf.org.au/

7.3.3 PUJ

Innovation Loft
Building PALMAS 2nd floor, CAP Laboratory

Table 7.1: *Vendors for Stanford, Swinburne, and PUJ*

Store	Address	Phone
SparkFun Electronics	6175 Longbow Drive, Boulder, CO 80301	303-945-2984
Jameco Electronics	1355 Shoreway Road, Belmont, CA 94002	1-800-831-4242
Amazon	1516 2nd Ave., Seattle, WA 98101	206-346-2992
Fry's Electronics	340 Portage Ave, Palo Alto, CA 94306	650-496-6000
Mountain View Surplus	1299 W El Camino Real, Mountain View, CA 94040	650-969-7700
Radio Shack	490 S California Ave Fl 1, Palo Alto, CA 94306	650-329-8081
Target	555 Showers Drive, Mountain View, CA 94040	650-965-7764
Anaconda	97 Chifley Dr, Preston VIC 3072	(03) 8470 0400
Jaycar Electronics	266 Sydney Rd Coburg	(03) 9384 1811
Macpac	312 Chapel St, Melbourne VIC 3181	(03) 9533 6964
Sams Warehouse	Shop 11, VIC 3070	(03) 9481 0770
Homecenter	Carrera 98 No 16 - 50 C. Cial. Jardin Plaza Mall	6858533
Jumbo cencosud Cali Valle de Lili	Carrera 98 No 16 - 50 C. Cial. Jardin Plaza Mall	331 00 00
MegaCentro	Cra 6 No 16- 47 - San Nicolas, Downtown Cali	880 19 02
Totto Store	Carrera 98 No 16 - 50 C. Cial. Jardin Plaza Mall	330 30 19

Calle 18 No 118250 (Cali)

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A User Testing Results, Stanford University

ForgetMeNot

ForgetMeNot is a personal assistant seamlessly incorporated into a bag. The system integrates daily schedules from a calendar to determine what the user should have and provides feedback if any item for a given activity is missing. Three phases of user testing was conducted along with the prototype development.

Phase I: Mobile Application Mock-up

Method 1

The team first demonstrated the functionality of the ForgetMeNot system by an app mockup and tested various reminding methods of reminding the user if he/she had forgotten an item (i.e., vibration, light, sound, and text message).

Molly, 24 This urban traveler wanted a bag that could talk to her and tell you what she is forgetting. She wants the bag to also sense location and be able to predict what she would need based on where she is headed. For example, on the way to the beach, she wants the bag to recognize that she does not have sunscreen and recommend the close and cheap nearby places where she can get that. If it were about to rain, she would want an umbrella. For the notifications, she wants the bag to be silent if she has everything and say, HEY if she needs to add something.

John, 24 He packs a backpack, a gym bag, and a lunch every day. He would really appreciate a confirmation text when he does have everything he needs, and the ability to check a master list of the items in the bag. He liked the self-packing bag but thought it would take a while to adjust and trust it. He would like the bag to check the status of all his electronics and charge everything by the morning. Is there a way to auto-pack and make it more ergonomic? For the notifications if something is missing, he wants a notification on the lock screen of his phone (not with lights or sounds).

Jake, 23 He was not initially excited about having something pack his bag for him. However, after talking through the procedure, he admitted that packing is not the issue for him but he would benefit from a system that makes sure he doesnt forget anything. He said that he is not a huge tech person but has some friends who would love the auto-pack. After the exercise, he was curious about how would it adapt to every situation? How would it go around and gather items?

Alex (Stanford student) He wondered what would happen if he put items in the bag that were not registered with the mobile app. He was interested in the idea of such a system and liked the idea that the system would be aware of the items in the bag. He preferred the vibration system or, in general, feedback that would result in physical discomfort.

Figure A.1: *ForgetMeNot Phase I User Testing - Alex*

Tourists from Japan and Korea They were interested in the idea. They were concerned with the weight of the bag and wondered if the additional components required for a complete prototype would make the bag too heavy. They also expressed concern regarding the screen on the bag; they wondered if it would be easily damaged and/or tampered with in crowded areas. They preferred the vibration system due to its subtlety.

Figure A.2: *ForgetMeNot Phase I User Testing - Japanese Tourist*

Leah (Stanford student) She was very excited about the idea. She would like the app to inform her of only the items she forgets, rather than a complete list of items she needs to carry.She preferred the vibration feedback system because LEDs would be less noticeable and voices or text messages would be too distracting.

Figure A.3: *ForgetMeNot Phase I User Testing - Leah*

Jayla (Student) She was also very interested in the idea and stated that she would use the system on a daily basis. She also preferred the vibration feedback system because of its subtlety.

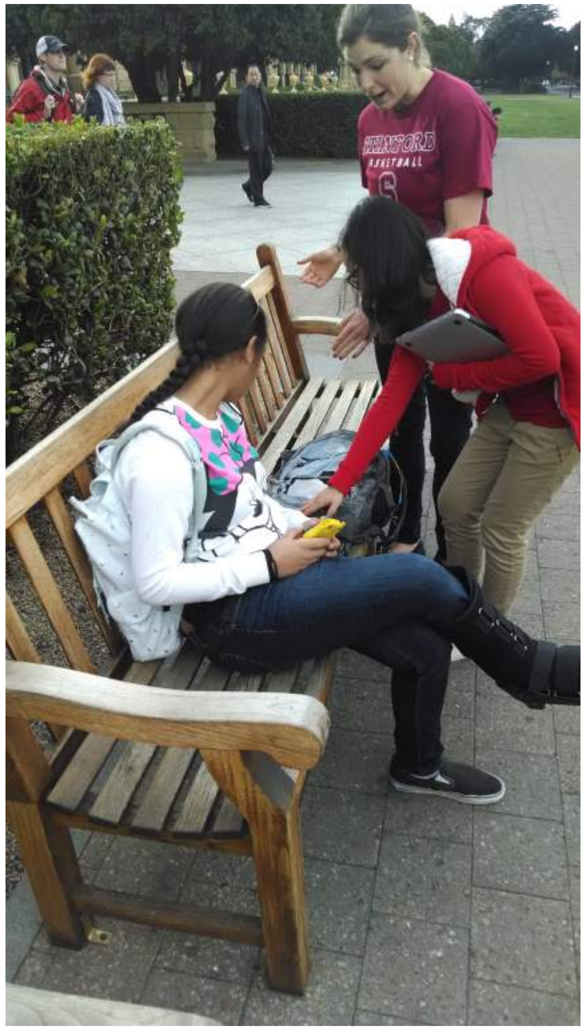


Figure A.4: *ForgetMeNot Phase I User Testing - Jayla*

Method 2

The team also sent text messages to users to remind them to take the items they needed for specific activities during the day.

22 Year Old Female, Student

- So I thought that a bag that could alert you would be interesting. I think that a reminder text could be more helpful, but I don't find that the test was helpful in simulating how the bag could be, because I imagine that the bag would better adapt to changed schedules: like you could press a button that meant you were ready to head to your next scheduled appointment.
- There were multiple texts that I felt were unneeded, but they weren't so many that I felt bothered by them.

- I think that my bag packing time was the same
- I forget things maybe a few times a month.
- I think the messaging system that was used to send text messages always sent them a minute or two late.
- If I were going to use the system, I'd like an unobtrusive light on the bag, sort of light the notification light that cell phones have. Green for "all good", red if I've forgotten something, orange if something is malfunctioning or something Also a text message to tell me which item.
- I think contextual reminders would be cool.
- Personally, I would want reminders every evening when I pack, and just a quick look at the green light on my bag would satisfy me in the morning or before an event.
- I want it to sync with my existing online calendar, but an app to input items is good too I guess. If the app syncs to a website that I could log into, that would be nice as well. I don't want to talk to my bag.

25 Year Old Male

- I like the idea of a bag that gives you notifications, but as the test went on I found myself thinking, I don't really need to be reminded. That being said I also tend to forget something about twice a week, so it was still nice to be sure I had everything I needed. I still think this is a useful tool, probably more so for someone traveling further then 10 minutes each way, like on a plane for example.
- The notifications didn't reduce my packing time, but instead were more like a way to double check that I had all of my desired possessions. Overall I think it is a useful tool for a bag to have as long as I could adjust the frequency of notifications.
- Prefer to get notifications before you leave for every activity or only when you forget an item. An app on your phone or sync with your existing online calendar.
- Receiving a notification before every event wasn't really helpful at all. Didn't feel that it reduced packing time at all. Contextual reminders would be a good feature.

Phase II: RFID Scanner and Mobile Application

In Phase II, the team asked random users to try our prototype and phone app. The user was asked to register and place items into the bag by following the instructions that appear on the app.

24 Year Old Male, Student

Figure A.5: *ForgetMeNot Phase II User Testing - 24 Year Old Male, Student*

"I felt having the RFID tags attached to my items would be creepy"
"Registering items will take too long. I really would want something faster."
"Maybe the app could have voice control for registering items. Kind of like Siri."

26 Year Old Female, Visitor

Figure A.6: *ForgetMeNot Phase II User Testing - 26 Year Old Female, Visitor*

“I would put in one thing at a time anyway so scanning isnt really an issue”
“Im worried that it would miss small items if I just drop them in.”
“Maybe the cell phone case could have the RFID tag built in.”

Two Male Visitor from France

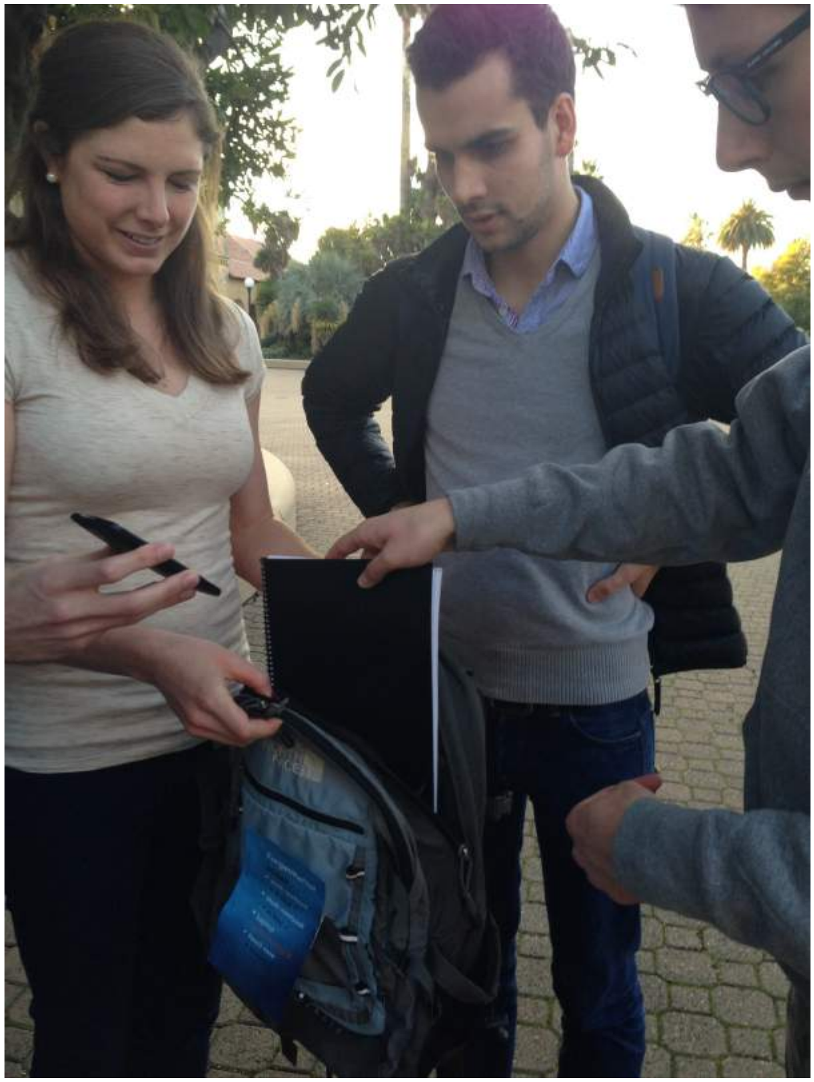


Figure A.7: *ForgetMeNot Phase II User Testing - Two Male Visitor from France*

"As long as it can be fast, putting one item in at a time would be no problem."
"I would like to be able to register all of my classes to the agenda."
"You should do a partnership with the bookstore to have them carry items with RFID tags already included."

Phase III: Fully Integrated System with Vibration Feedback

In Phase III, the team performed day-long user tests with fully-integrated prototypes. Vibration feedback, voice control, and data storage functions were added to the system. User's activities were recorded using a Google Fusion Table.

Chris, 24 year old graduate student

Figure A.8: *ForgetMeNot Phase III User Testing*

User's phone got disconnected with the microcontroller the night before testing, and we stopped the test to diagnose the problem. The problem was caused by the Bluetooth transceiver not being well-exposed. The team, thus, decided to mount the transceiver outside; this seems to have resolved the problem.

B User Testing Results, Swinburne University

The Bandolier Bag

User 1, Age 22, Male, Student

Interactions:

- Packs bag on the body
- Confused as to which shoulder to put prototype on. Settles on left shoulder.
- Rotated device various times before finding/selecting the right pocket
- Twists the bandolier in both directions to access items.

Observations:

- Users' neck was bent
- Awkward movement. Struggled to get into prototype
- Objects flopped around with the draw cord
- Bottle falls out. Not secure enough - pocket was not distinctive enough
- Filled individual pockets with more than one object

Concerns:

- Security is an issue
- Closed pockets would be more useful
- Items are not secure enough (stability)
- Not comfortable - too stiff
- Double ended pockets would give multiple access points
- Items are too revealed to the public
- Can I run and feel my items are secure enough?
- User currently puts items he defines as "must be easily accessible in his pockets"

User 2, Age 28, Female, Student

Interactions:

- Confused which shoulder to put prototype on
- Puts device on then takes it off to pack it
- Tries device on in a variety of ways settles on the right shoulder
- Twisted bandolier both directions to access items
- Two handed operation

Observations:

- Analyzes pockets
- Awkward feeling
- Cool
- Rests hands on sash
- Device slips off shoulder
- Enjoys the ability to attach and detach pockets

Concerns:

- The user likes to see all her items at once and feels less secure with items on her back that she can't see (like in a traditional backpack)
- Items are not secure enough (stability)
- User thinks that only one strap could make it easier to slip off when moving (Two may be better)
- Feels more secure with a backpack as items are completely contained - but is not an everyday backpack user

User 3, Age 27, Male, Teaching Assistant

Interactions:

- Confused which shoulder to put prototype on
- Wears device on right shoulder, then switches the left
- Uses the elastic and positions phone close to ear so he can use it as a hands free device
- Does a similar thing with drink bottle positions it close to mouth and suggests a straw (hydro pack device)

Observations:

- Feels inside the different pockets (tactile)
- Has a hard time fitting an object in pockets. Settles for adjustable elastic pockets
- Feels over shoulder for objects before twisting the bandolier
- Easy to remove items but harder to put them in
- Device slips off his shoulder

Concerns:

- Items are not secure enough (stability)
- Likes elastic pocketing system but worries about security
- Would change the positioning of object and rotation of the device dependent on context (eg. on a train his wallet would be in front of him but would feel comfortable going for a jog with it behind him)
- Suggests zippers as he feels they add more security
- Participant states that he is constantly checking his pockets to reassure himself that he has got everything - can this device help with this issue?
- Would like the device to be more tapered to the body
- Security is an issue

User 4, Age 35, Female, Professor

Interactions:

- Confused as to which shoulder to put prototype on
- Packs device on ground
- Struggles to pack objects in hard pockets
- User feels that it is more natural to move device up and over the shoulder
- She looks down and rotates the device up
- Used a system of hierarchy to position items in device

Observations:

- Picks up bag and analyzes the complete product
- Puts device on, device falls to ground, participant steps out
- Struggles to find that right pocket for keys
- Filled individual pockets with more than one object
- Checks where items are on device
- Uses a two handed twist action
- Items are easily removed but harder to put away
- Reaches around back before twisting the bandolier to pull device around
- Device slips off shoulder

Concerns:

- Items are not secure enough (stability)
- Feels unstable when twisting bandolier 360 degrees around the body, thought would it be more beneficial to spin half or quarter the distance
- Wants height adjustability
- could there be both static and movable pockets?
- Security factor - would feel comfortable having phone on back and wallet on hip
- Areas of interest for pocket position - the hip zone, along the zip line, underside, inside the outer side of device
- Security is an issue

User 5, Age 50, Male, Workshop Assistant

Interactions:

- Confused as to which shoulder to put prototype on
- Puts device on, finds the correct, comfortable positioning
- Packs the device off the body
- Wears pack on left shoulder
- Phone most commonly used so he puts that on his thigh
- Twists the bandolier both directions to access items.

Observations:

- Visually looks over the entire device

- Struggles to find pockets that his belongings comfortably fit into
- Once device was packed, participant removes and then reassesses the priority and positioning of items; Phone, keys
- Hangs device over arm when packing
- Reaches to the center and hip pocket most of the time
- Rotates device down and pulls it up also
- Reaches around back before twisting the bandolier

Concerns:

- Items are not secure enough (stability) and it would be easy for people to steal from them
- Participant thinks he could get used to this device and that he would enjoy using it
- Likes having pocket designed for specific items
- Participant doesn't like the elastic pocket - previous experiences with them have not been the best
- Enjoys the shape of the device as he can see himself using the sling as a place to rest his hands and lean on
- Security is an issue

User 6, Age 25, Male, Student/Cyclist

Interactions:

- Confused as to which shoulder to put prototype on
- Puts device over right shoulder, then changes to left shoulder, and back to right shoulder
- Likes to use the little pockets
- Participant found it easy to interact with phone and read messages on the device

Observations:

- Holds the bandolier with one hand
- Notices a lot of vibration when riding bike
- Reaches around back before twisting until later in the test
- Rests hands on sash

Concerns:

- One handed operation due to riding bike - needs device to be more secure and stable on the body
- Items are not secure enough (stability)
- Water bottle would be one main object that this participant would like to access whilst on the go
- Does not normally access items out of back when riding, other than his water bottle
- Doesn't like to display all his personal items to the public
- Would like the device to be more tapered to the body
- This participant really enjoyed using the elastic pocketing system on the bag
- Security is an issue

Learnings

We observed that the following comments were consistently mentioned by users:

- Confused as to which shoulder to put prototype on
- Twists the bandolier in both directions to access items
- Filled individual pockets with more than one object
- Sense of awkwardness
- Rests hands on sash
- Device slips off shoulder
- Reaching around back before twisting bandolier
- Security is an issue
- Items are not secure enough (stability)

We gathered the following insights from observing the users:

- Double ended pockets would give multiple access points
- Items are too revealing to the public
- Most users had a hierarchy of items
- The user likes to see all her items at once and feels less secure with items on her back that she can't see
- Participant states that he constantly checks his pockets to reassure himself that he has got everything - can this device help with this issue?
- User feels unstable when twisting device 360 degrees around the body, thought would it be more beneficial to spin half or quarter the distance
- Could there be both static and movable pockets?
- Areas of interest for pocket position - the hip zone, along the zip line, underside, inside the outer side of device
- Participant enjoys the shape of the device as he can see himself using the sling as a place to rest his hands and lean on
- Can this device be operated one handed?

Big Box Prototype

Pre-Test Questions

1. Tell us what you think about using bags/backpacks?
2. How do you currently interact with your own bag/backpack?
3. Do you feel that this interaction can improved?
4. How do you feel about a vocal user interface?
5. How do you feel about automatic devices such as automated doors?
6. Do you like pets?

Post-Test Questions

1. Did you like the Big Box prototype? Why or why not?
2. What would you change about the prototype?
3. How do you feel about communicating with a container that has a personality?
4. Would you feel comfortable interacting with this prototype in a public space?
5. If the bag was destroyed after the test would you feel unhappy?
6. If you were to use this container for a prolonged period of time, do you think you would develop a relationship with it?

C Prototype Details

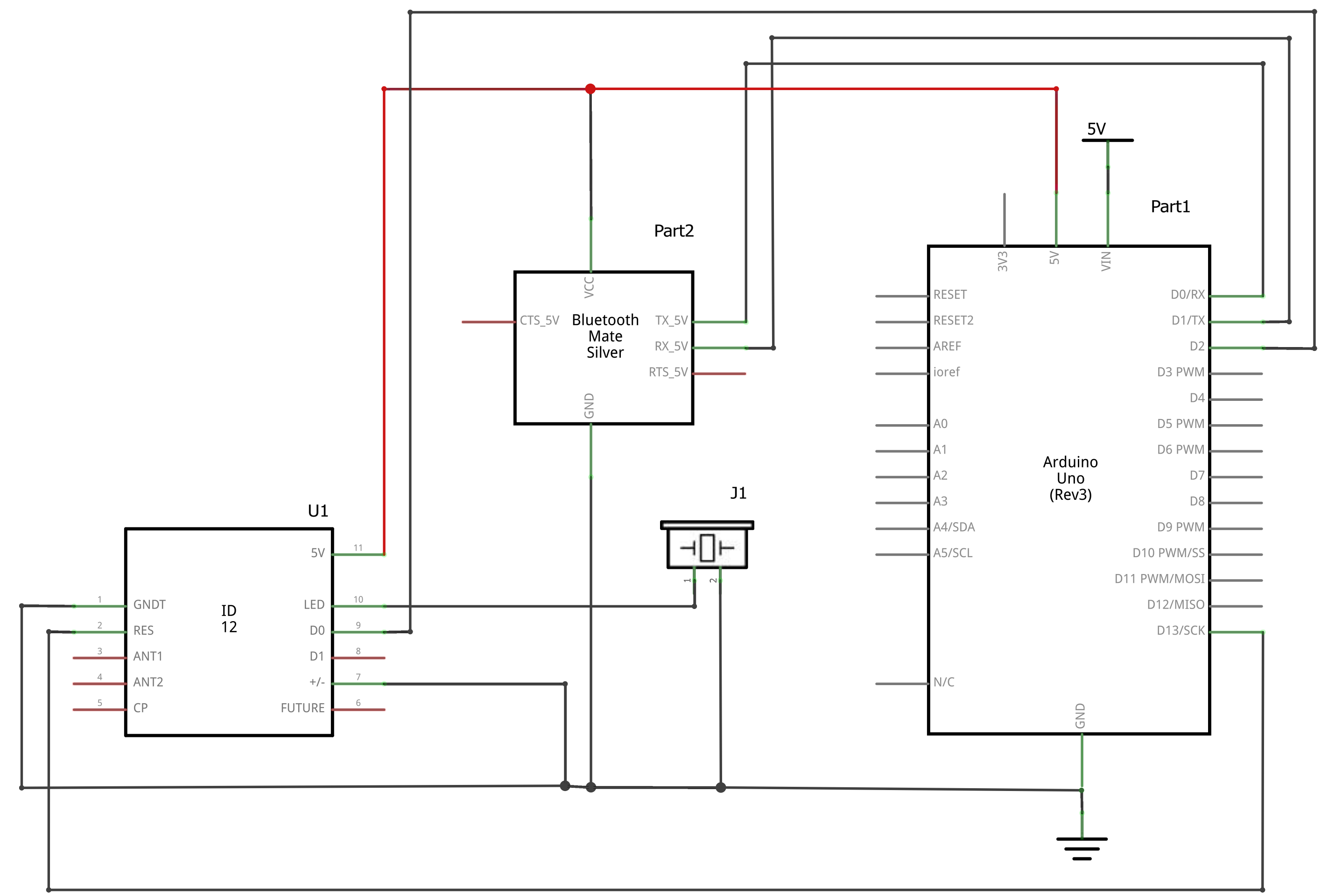
The Jugar Bag

Details regarding the functionality of the Jugar Bag are given below:

- User Profile
  - The user can create a profile at the Totto store or at home (self-service)
  - Different profiles can be created (e.g., skier, biker, coffee lover, etc.)
- Gamification
  - Achievements or badges would be earned for buying locally grown food products, using public transportation, etc.
- Rewards
  - Physical additions to the bag
  - Discounts at participating stores
  - Public transport discounts
  - Rewards earned increases with the age of the bag
- Social Networking
  - Online social platform similar to Foursquare
  - Information could be transferred via an Internet connection

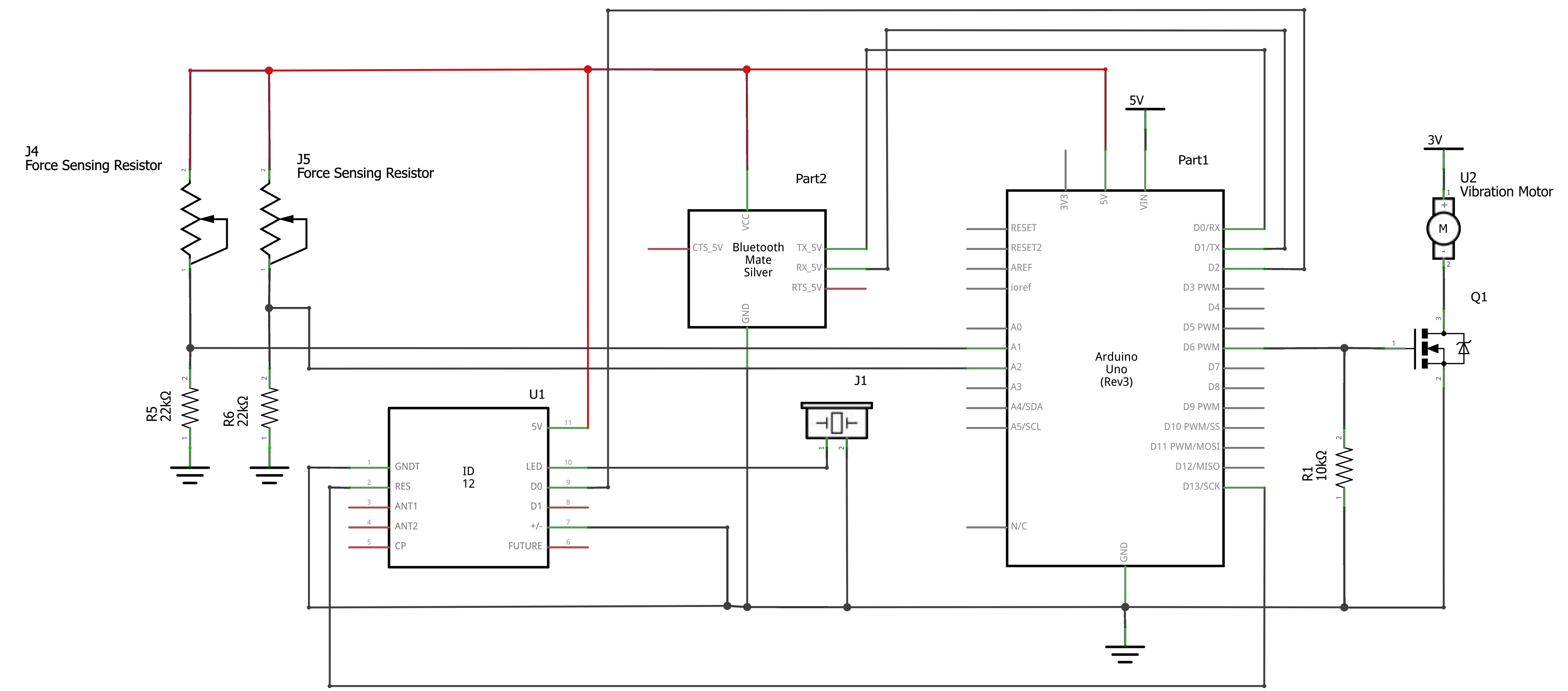
D Circuit Schematics

Appendix begins on following page.



ForgetMeNot Circuit	
Project	Totto "Smart" Bag
Filename	RFID-Schematic.fzz Rev 1
Date	09 Mar 2014 20:41:34 Sheet 1/1

fritzing



ForgetMeNot Circuit

Project	Totto "Smart" Bag		
Filename	RFID-Schematic.fzz	Rev	2
Date	09 Mar 2014 20:41:34	Sheet	1/1

fritzing

E Source Code

Appendix begins on following page.

```
/**************************************************
*  smartCart.ino
* This program runs the Mobile SmartCart prototype.
* Last Modified: 1/23/2014 (NP)
**************************************************/
#include <Stepper.h>

int draw1 = 1;
int draw2 = 1;
int draw3 = 1;
int sendPin = 13;

// Stepper motors
#define STEPS 200
int forButtonPin = 4;
int leftButtonPin = 7;
int rightButtonPin = 12;
int forButtonState = 0;
int leftButtonState = 0;
int rightButtonState = 0;
Stepper motLeft(STEPS, 8, 9, 10, 11);
Stepper motRight(STEPS, 2, 3, 5, 6);
int motorGo = 0;

int  leftGo;
int  rightGo;

// Force sensors for drawers
int topShelf = A0;
int midShelf = A1;
int botShelf = A2;
int  topShelfVal;
int  midShelfVal;
int  botShelfVal;

// LEDs
int topLED = A3;
int midLED = A4;
int botLED = A5;

//

void setup()
{
  pinMode(sendPin, OUTPUT);

  // Stepper motors
   motLeft.setSpeed(50);
   motRight.setSpeed(50);
  pinMode(forButtonPin, INPUT);
  pinMode(leftButtonPin, INPUT);
  pinMode(rightButtonPin, INPUT);

  // LEDs
  pinMode(topLED, OUTPUT);
  pinMode(midLED, OUTPUT);
  pinMode(botLED, OUTPUT);

  //Serial.begin(9600);

}

void loop()
{
   topShelfVal  =analogRead(topShelf);
```

```
  if (topShelfVal < 100) {
    digitalWrite(topLED, HIGH);
    draw1 = 0;
  }
  else {
    digitalWrite(topLED, LOW);
    draw1 = 1;
    }

   midShelfVal  =analogRead(midShelf);
  if (midShelfVal < 100) {
    digitalWrite(midLED, HIGH);
    draw2 = 0;
  }
  else {
    digitalWrite(midLED, LOW);
    draw2 = 1;
   }

   botShelfVal  =analogRead(botShelf);
  if (botShelfVal < 100) {
    digitalWrite(botLED, HIGH);
    draw3 = 0;
  }
  else {
    digitalWrite(botLED, LOW);
    draw3 = 1;
   }

  if ((draw1 == 1)&&(draw2 == 1)&&(draw3 == 1)) {
    motorGo = 1;
    digitalWrite(sendPin, HIGH);
    }
  else {
    motorGo = 0;
    digitalWrite(sendPin, LOW);
    }


  //motorGo = 1; // TEST


   forButtonState  =digitalRead(forButtonPin);
  if  ((forButtonState  ==HIGH)&&(motorGo == 1)) {

     leftButtonState  =digitalRead(leftButtonPin);
     rightButtonState  =digitalRead(rightButtonPin);

    if  (leftButtonState  !=HIGH) {
      motRight.step(-1);
      }

    if  (rightButtonState  !=HIGH) {
      motLeft.step(1);
     }

    //Serial.println(leftSpeed);

   }
}
```

```
/**************************************************
*  rfid_Vib6.ino
* This program runs the ForgetMeNot system.
* Last Modified: 2/26/2014 (NP)
**************************************************/
#include  <SoftwareSerial.h>
#include <EEPROM.h>

// Absolute min and max eeprom addresses. Actual values are hardware-dependent.
// These values can be changed e.g. to protect eeprom cells outside this range.
const int EEPROM_MIN_ADDR = 0;
const int EEPROM_MAX_ADDR = 511;

int RFIDResetPin = 13;
int sensorPin1 = 1;
int sensorPin2 = 2;
int VibrationPin = 6;
int delayTime = 500;
int itemCount = 0;
int numItems = 0;
int aqCount = 0;
int k = 0;
int ad = 0;
boolean  stillRead  =true;

String tags[20] = {};
String items[20] = {};
boolean in[20] = {0};
boolean ignore[20] = {0};

const int BUFSIZE = 13;
const int inLocation = 442;
const int igLocation = 476;
char  buf[BUFSIZE];
char  numItemsChar  ='0';
char   tagString[BUFSIZE];// 12-character RFID code + null character

boolean  itemDone  =false;
boolean  allDone  =false;
boolean  readThis  =true;
boolean  numKnown  =false;

SoftwareSerial mySerial(2,3);  // RX, TX

void setup(){
  Serial.begin(9600);
   mySerial.begin(9600);
  pinMode(VibrationPin, OUTPUT);
  pinMode(RFIDResetPin, OUTPUT);
  digitalWrite(RFIDResetPin, HIGH);

  // Read EEPROM to see if there are tags saved
  do {
     stillRead = eeprom_read_string(ad, buf, BUFSIZE);
    tags[k] = buf;
    if (tags[k].length() < 12) {
      break;
      }
    ad = ad + 13;
    k++;
   }while (stillRead);

  if (k != 0) {
     allDone =true;
    numItems = k;
```

```
    // Load in[] data
    for (int h = 0; h < k; h++) {
      if (EEPROM.read(inLocation+h) == 1) {
         in[h] = 1;// in is true
      }
      else {
         in[h] = 0;// in is false
      }
      if (EEPROM.read(igLocation+h) == 1) {
         ignore[h] = 1;// ignore is true
      }
      else {
         ignore[h] = 0;// ignore is true
        }

      }
  }
  else {
    Serial.println("Welcome to Totto ForgetMeNot. Press the microphone, and say the number of items you w
    }

}

void loop(){
    // Get number of items from user
    if (!allDone) {
      while ((Serial.available())&&(!numKnown)) {
         numItemsChar = (char)Serial.read();
         numKnown =true;
         numItems = numItemsChar -'0'; // convert numItemsChar to int and store in numItems
      }

      // Get tag codes and corresponding item names from user
      while (aqCount < numItems) {
        Serial.print("Please scan tag number ");
        Serial.print(aqCount+1);
        Serial.println(".\n");
        while (tags[aqCount].length() == 0) {
          scanTag();
          if (strlen(tagString) == 12) {// strlen does not include null character
              tags[aqCount] = tagString;// Store tag
             strcpy(buf,tagString);
              eeprom_write_string(13*aqCount,buf);// Store tag in EEPROM
            EEPROM.write(inLocation+aqCount,2);  // 1 => in, 2 => out; store "out"
            EEPROM.write(igLocation+aqCount,2);  // don't ignore
           }
          delay(500);
        }
         itemDone =false;
        Serial.println("Tag scanned! Press the microphone once again, and say the item corresponding to t
         resetReader();// Reset reader to scan another tag
         clearTag(tagString);// Clear tag variable
        while (mySerial.read() != -1);// Clear mySerial buffer (-1 => no more data)

        while (Serial.read() != -1);// clear Serial buffer (-1 => no more data)
        while (!itemDone) {
          while (Serial.available()) {
              char readChar = (char)Serial.read();
              if (readChar ==='\n') {
                 itemDone =true;
                continue;
              }
              else {
                 items[aqCount] += readChar;
              }
```

```
            }
        }
        Serial.println("Item registered!\n");
        while (Serial.read() != -1);// Clear Serial buffer
         aqCount++;
      }
      if ((items[numItems-1].length() != 0)&&(tags[numItems-1].length() != 0)) {
         allDone =true;
        Serial.println("Great! All items have been registered.\n");
        Serial.println("$\n");
      }
    }

    else {
       scanTag();
        checkTag(tagString);//Check if it is a match
        clearTag(tagString);//Clear the char of all value
        resetReader();//reset the RFID reader
      if(checkLeaving()){
         VibrationAlarm();
      }
       checkIgnore();

    }

}

void(* resetFunc) (void) = 0;// declare reset function at address 0

void checkIgnore(){
  char IncomingChar;
  int IgnoreItem;
  while (Serial.available()) {
    IncomingChar = (char)Serial.read();
    if (IncomingChar !='0' && IncomingChar !='$')  {// If it's not a '0' and not a '$'
       IgnoreItem = IncomingChar -'0'; // convert IncomingChar to int and store in IgnoreItem
       ignore[IgnoreItem - 1] = !ignore[IgnoreItem - 1];
      if (ignore[IgnoreItem - 1]) {
        EEPROM.write((igLocation+IgnoreItem-1),1);  // save ignore = true
      }
      else {
        EEPROM.write((igLocation+IgnoreItem-1),2);  // save ignore = false
      }
    }
    else if (IncomingChar =='$') { // Reset system
        eeprom_clear();// clear the EEPROM
      for (int index = 0; index < numItems; index++) {
         in[index] = 0;// clear in[]
         ignore[index] = 0;// clear ignore[]
      }
        resetFunc();// reset the program
      }
  }
}

int checkLeaving() {//Returns true when the user is wearing backpack (force sensors) and an item is out
  int ItemOut =false;
  int PersonMoving =false;
  int sensorValue1 = 0;
  int sensorValue2 = 0;
  int j = 0;
  while (j < numItems) {
    if(in[j] == 0 && ignore[j] == 0 ) {// if some item is out of the bag
       ItemOut =true;
      break;
```

```
    }
    j++;
  }
   sensorValue1  =analogRead(sensorPin1);
   sensorValue2  =analogRead(sensorPin2);

  if (sensorValue1 > 50 || sensorValue2 > 50)   {// force sensing resistor
     PersonMoving =true;
  }
  if (ItemOut  ==true && PersonMoving ==true){
    return true;
  }
  else
    return false;
}

void VibrationAlarm() {
  digitalWrite(VibrationPin, HIGH);
  delay(500);
  digitalWrite(VibrationPin, LOW);
  delay(500);
}

void scanTag() {
  int index = 0;
  boolean reading =false;

  while(mySerial.available()){

    int readByte = mySerial.read(); //read next available byte

    if(readByte == 2) reading =true; //begining of tag
    if(readByte == 3) reading =false; //end of tag

    if(reading && readByte != 2 && readByte != 10 && readByte != 13){
      //store the tag
       tagString[index] = readByte;
       index ++;
    }
  }

}

void checkTag(char tag[]){
  if(strlen(tag) == 0) return; //empty, no need to contunue

  int j = 0;
  while (j < numItems) {
    if(compareTag(tag, tags[j])){  // if matched tag j, do this
      Serial.write(byte(j+1)); // Send item number
       in[j] = !in[j];
      if (in[j]) {
        EEPROM.write(inLocation+j,1);  // save in = true
      }
      else {
        EEPROM.write(inLocation+j,2);  // save in = false
        }
      delay(500);
      break;
    }
    j++;
  }

}
```

```
void resetReader(){
  digitalWrite(RFIDResetPin, LOW);
  digitalWrite(RFIDResetPin, HIGH);
  delay(150);
}

void clearTag(char one[]){
  for(int i = 0; i < strlen(one); i++){
    one[i] = 0;
  }
}

boolean compareTag(char one[],String two){
  if(strlen(one) == 0) return false; //empty

  for(int i = 0; i < 12; i++){
    if(one[i] != two[i])return false;
  }

  return true; //no mismatches
}

/*****************************************************************************************/
/************************************************
EEPROM Clear
Sets all of the bytes of the EEPROM to 0.
************************************************/

void eeprom_clear() {
  // write a 0 to all 512 bytes of the EEPROM
  for (int i = 0; i < 512; i++) {
    EEPROM.write(i, 0);
    }
}

/*****************************************************************
Returns true if the address is between the
minimum and maximum allowed values, false otherwise.

This function is used by the other, higher-level functions
to prevent bugs and runtime errors due to invalid addresses.
*****************************************************************/

boolean eeprom_is_addr_ok(int addr) {
  return ((addr >= EEPROM_MIN_ADDR) && (addr <= EEPROM_MAX_ADDR));
}

/************************************************************************
Writes a sequence of bytes to eeprom starting at the specified address.
Returns true if the whole array is successfully written.
Returns false if the start or end addresses aren't between
the minimum and maximum allowed values.
When returning false, nothing gets written to eeprom.
************************************************************************/

boolean eeprom_write_bytes(int startAddr,const byte* array,int numBytes) {
  // counter
  int i;

  // both first byte and last byte addresses must fall within
  // the allowed range
  if (!eeprom_is_addr_ok(startAddr) || !eeprom_is_addr_ok(startAddr + numBytes)) {
    return false;
  }
```

```
  for (i = 0; i < numBytes; i++) {
    EEPROM.write(startAddr + i, array[i]);
  }

  return true;
}

/*********************************************************************************
Writes a string starting at the specified address.
Returns true if the whole string is successfully written.
Returns false if the address of one or more bytes fall outside the allowed range.
If false is returned, nothing gets written to the eeprom.
*********************************************************************************/

boolean eeprom_write_string(int addr,const char* string) {

  int numBytes;// actual number of bytes to be written

  //write the string contents plus the string terminator byte (0x00)
  numBytes = strlen(string) + 1;

  return eeprom_write_bytes(addr, (const byte*)string, numBytes);
}

/*************************************************************************************************
Reads a string starting from the specified address.
Returns true if at least one byte (even only the string terminator one) is read.
Returns false if the start address falls outside the allowed range or declare buffer size is zero.

The reading might stop for several reasons:
- no more space in the provided buffer
- last eeprom address reached
- string terminator byte (0x00) encountered.
*************************************************************************************************/

boolean eeprom_read_string(int addr,char* buffer,int bufSize) {
  byte ch;// byte read from eeprom
  int bytesRead;// number of bytes read so far

  if (!eeprom_is_addr_ok(addr)) {// check start address
    return false;
  }

  if (bufSize == 0) {// how can we store bytes in an empty buffer ?
    return false;
  }

  // there is room for the string terminator only, no reason to go further
  if (bufSize == 1) {
    buffer[0] = 0;
    return true;
  }

  bytesRead = 0;// initialize byte counter
  ch =EEPROM.read(addr + bytesRead);// read next byte from eeprom
  buffer[bytesRead] = ch;// store it into the user buffer
  bytesRead++;// increment byte counter

  // stop conditions:
  // - the character just read is the string terminator one (0x00)
  // - we have filled the user buffer
  // - we have reached the last eeprom address
  while ( (ch != 0x00) && (bytesRead < bufSize) && ((addr + bytesRead) <= EEPROM_MAX_ADDR) ) {
    // if no stop condition is met, read the next byte from eeprom
    ch =EEPROM.read(addr + bytesRead);
```

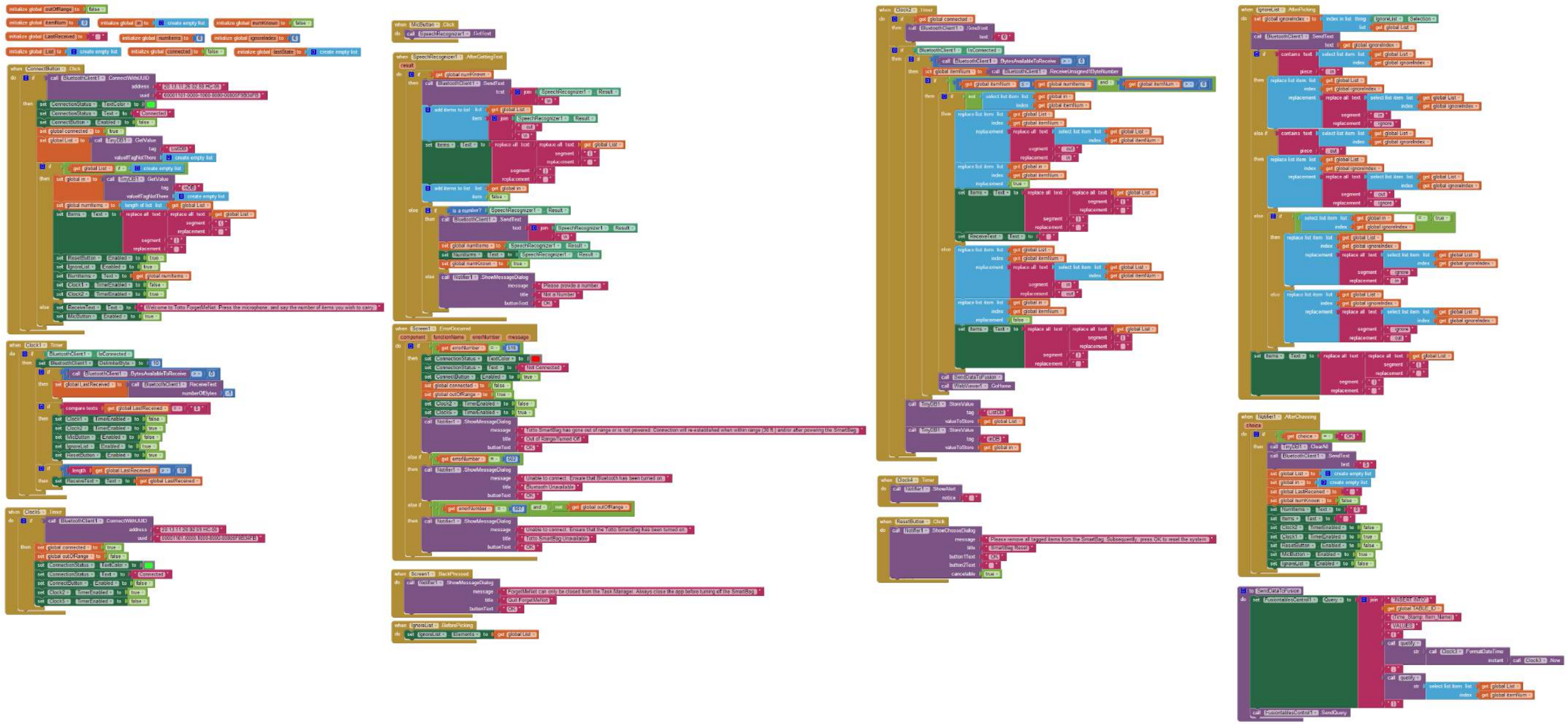
```
      buffer[bytesRead] = ch;// store it into the user buffer
      bytesRead++;// increment byte counter
  }

  // make sure the user buffer has a string terminator, (0x00) as its last byte
  if ((ch != 0x00) && (bytesRead >= 1)) {
    buffer[bytesRead - 1] = 0;
  }

  return true;
}
```

F App Inventor Block Diagram

Appendix begins on following page.



G Budget Spreadsheets

Appendix begins on following page.

ME310 Expenses Spreadsheet - Winter Quarter AY14

Team Name: Team Totto (Stanford)

Budget Monitor: Daniel Levick/Stephanie Tomasetta/Aditya Rao

Reference*	Purchaser	Date	Vendor Name	Description of Expense	Pre-tax Amount	Shipping & Handling (if any)	Amount Incl Sales Tax
	Claire Liao	1/12/2014	The Home Depot	Casters and door guide for SmartCart Dark Horse Prototype (DHP)	$16.90		$18.42
	Claire Liao	1/12/2014	Ace Hardware	Glue sticks for SmartCart DHP	$8.99		$9.78
	Nikhil Pansare	1/13/2014	McMaster-Carr	Acrylic, hook-and-loop fasteners, hinges, and nylon for DHP (PCard)	$49.38	$7.06	$60.75
	Claire Liao	1/19/2014	Pololu	Wheels and wheel mounting hubs for DHP V2.0	$17.44	$10.95	$28.39
	Claire Liao	1/20/2014	Jameco Electronics	Motor drivers, battery charger, force sensing resistors, graphics LCD, push-button, and piezo buzzer for DHP V2.0	$60.55		$66.02
	Claire Liao	1/20/2014	McMaster-Carr	Acrylic sheets for DHP V2.0	$20.26	$6.72	$28.75
	Claire Liao	1/21/2014	McMaster-Carr	Acrylic sheets for DHP V2.0	$20.26	$6.72	$28.75
	Jeffrey Infante	11/23/2013	Amazon	Miyashi Massaging Pillow for Critical Experience Prototype	$10.54		$11.14
	Jeffrey Infante	11/23/2013	Amazon	Kensington Bluetooth Tracker for Critical Experience Prototype	$19.83		$20.97
	Claire Liao	1/25/2014	SparkFun	Muscle Wire and Flexinol for Funktional Prototype	$15.30	$11.39	$26.69
	Cailtin Clancy	1/31/2014	Target	Frisbee (to improve design space in the Loft)	$3.99		$4.34
	Claire Liao	1/31/2014	Amazon	Wireless Bluetooth transceiver for Funktional Prototype	$15.93		$15.93
	Claire Liao	2/2/2014	SparkFun	RFID tags for the Funktional Prototype	$19.75	$4.11	$23.86
	Claire Liao	2/3/2014	Consulate General of Colombia	Colombian visa fee (1st portion)	$50.00		$50.00
	Claire Liao	2/4/2014	Stanford Postal Store	Shipping fee for Colombian visa documents	$11.26		$11.26
	Claire Liao	2/4/2014	85 2nd Street Parking (SF)	Parking fee (to park vehicle near Consulate General of Colombia)	$10.00		$10.00
	Caitlin Clancy	2/4/2014	iTunes	TouchOSC, v1.9.3 (app for Funktional Prototype)	$4.99		$5.39
	Claire Liao	2/4/2014	N/A (Mileage)	Drove to San Francisco to apply for Colombian visa	$47.46		$47.46
	Claire Liao	2/4/2014	Consulate General of Colombia	Colombian visa fee (2nd portion)	$105.99		$105.99
	Claire Liao	2/10/2014	Stanford Bookstore	9-volt batteries for Funktional Prototype	$11.98		$13.03
	Claire Liao	2/17/2014	Target	Handbag and backpack for Functional Prototype	$67.98		$73.93
	Claire Liao	2/17/2014	Fry's Electronics	Power bank, ribbon cable, and wire for Functional Prototype	$34.16		$37.15
	Claire Liao	2/17/2014	Amazon	Micro USB to HDMI MHL adapter for connecting smartphone to TV	$8.99		$8.99
	Claire Liao	2/19/2014	PRL Room 36	Shrink wrap for Functional Prototype	$2.00		$2.00
	Claire Liao	2/21/2014	Jameco Electronics	Hall sensors, NiMH 9-V battery, and battery charger for Functional Prototype	$25.68		$27.60
	Nikhil Pansare	2/25/2014	Fry's Electronics	Battery holder and batteries for Functional Prototype	$8.57		$9.32
	Claire Liao	2/27/2014	Baja Fresh	Fajitas for SUDS	$475.94		$517.58
	Caitlin Clancy	2/27/2014	Michaels	Plaster wrap for prototyping	$9.99		$10.86
	Caitlin Clancy	2/28/2014	SparkFun	Electronics guidebook, LEDs, fiber optic fabric, conductive fabric, conductive thread, LilyPad Arduino, light pipe, and wire strippers for prototyping	$107.45	$20.63	$128.08
	Caitlin Clancy	3/7/2014	SparkFun	LilyPad sensors, LEDs, and design kit (PCard)	$108.65	$15.72	$124.37
	Nikhil Pansare	3/7/2014	LinkSprite	UHF RFID reader, antenna, and tags (PCard)	$206.22	$10.77	$216.99
				Total			$1,743.79
				Available Balance from Fall	----------	----------	$433.06
				Winter Allocation	----------	----------	$3,000.00
				Available Balance	----------	----------	$1,689.27

*RPO Number, Requisition Number, iOU Transaction Number

*Funds unspent at the end of Fall carry forward to Winter quarter

*Décor budget: Up to $75/year of the team project budget may be spent on loft decor items

*Administrative Survival Guide can be found at: http://wikibox.stanford.edu/13-14/index.php/Resources/AdminSurvivalGuide1314

Please see your Budget Monitor (TA), George Toye or Manny Hundal if you have questions. Thanks!

ME310 Swinburne Expenses Spreadsheet

Remember to scan and save all reciepts on drive - label the scans with a description of the purchase

Australian Prices Already include 10% GST (taxes)

Team Name: Team Totto

Budget Monitors: John, Colin and Shelby

Reference*	Purchaser	Date	Vendor Name	Description of Expense	Projected Expenses	Cost	Shipping & Handling (if any)	Sum
	Team	**All year around**	**Swinburne internal printing**	**Printing**	$200.00			
				Fall Quarter				
	John	27/11/13	Sams Warehouse	Vacpacks: 2 x Large, 1 x Extra Large	$18.00	$18.00	$0.00	$18.00
	John	4/12/2013	Jaycar electronics	Wireless bike light indicator kit	$29.95	$29.95	$0.00	$29.95
	John	4/12/2013	Jaycar electronics	Catalog	$3.95	$3.95	$0.00	$3.95
	John	4/12/2013	Anaconda	Raincoat	$14.95	$14.95	$0.00	$14.95
				Winter Quarter				
					$0.00	$0.00	$0.00	$0.00
				Sewing machine + needles & threads	$526.93	$526.93	$0.00	$526.93
				JOHN TO INPUT	$0.00	$0.00	$0.00	$0.00
				JOHN TO INPUT	$0.00	$0.00	$0.00	$0.00
				JOHN TO INPUT	$0.00	$0.00	$0.00	$0.00
				Sheet of Polycarbonate	$30.00	$30.00	$0.00	$30.00
				Spring Quarter				
				Final Prototype	$2,500.00	$0.00	$0.00	$0.00
					$0.00	$0.00	$0.00	$0.00
					$0.00	$0.00	$0.00	$0.00
					$0.00	$0.00	$0.00	$0.00
				Travel				
	Students	5/3/2014	Doctors	Injections & doc	$1,122.90	$1,122.90	$0.00	$144.00
	Swinburne	20/3/14 - 1/4/14	STA	Plane Tickets to Colombia	$2,591.92	$2,591.92	$0.00	$2,591.92
	Swinburne	20/3/14 - 1/4/14	STA	Plane Tickets to Colombia	$2,591.92	$2,591.92	$0.00	$2,591.92
	Swinburne	20/3/14 - 1/4/14	STA	Plane Tickets to Colombia	$2,591.92	$2,591.92	$0.00	$2,591.92
	Swinburne	TBD	STA	Accommodation x4	$1,800.00	$0.00	$0.00	$0.00
	Swinburne	TBD	Swinburne	Daily allowence	$1,500.00	$1,500.00	$0.00	$1,500.00
					$0.00	$0.00	$0.00	$0.00
					Estimated Cost			Real Cost
				Total	**$15322.44**			**$10,043.54**
				Allocation	$20,000.00			$20,000.00
				Available Balance	$4677.56			$9,956.46

*RPO Number, Requisition Number, iOU Transaction Number

*Funds unspent at the end of Fall carry forward to Winter quarter

*Total Allocation of $20,000 AUD

Please see your Budget Monitor (TA), Jokke if you have questions. Thanks!

ME310 Expenses Spreadsheet - Fall Quarter AY14

Team Name: Team Totto (PUJ)

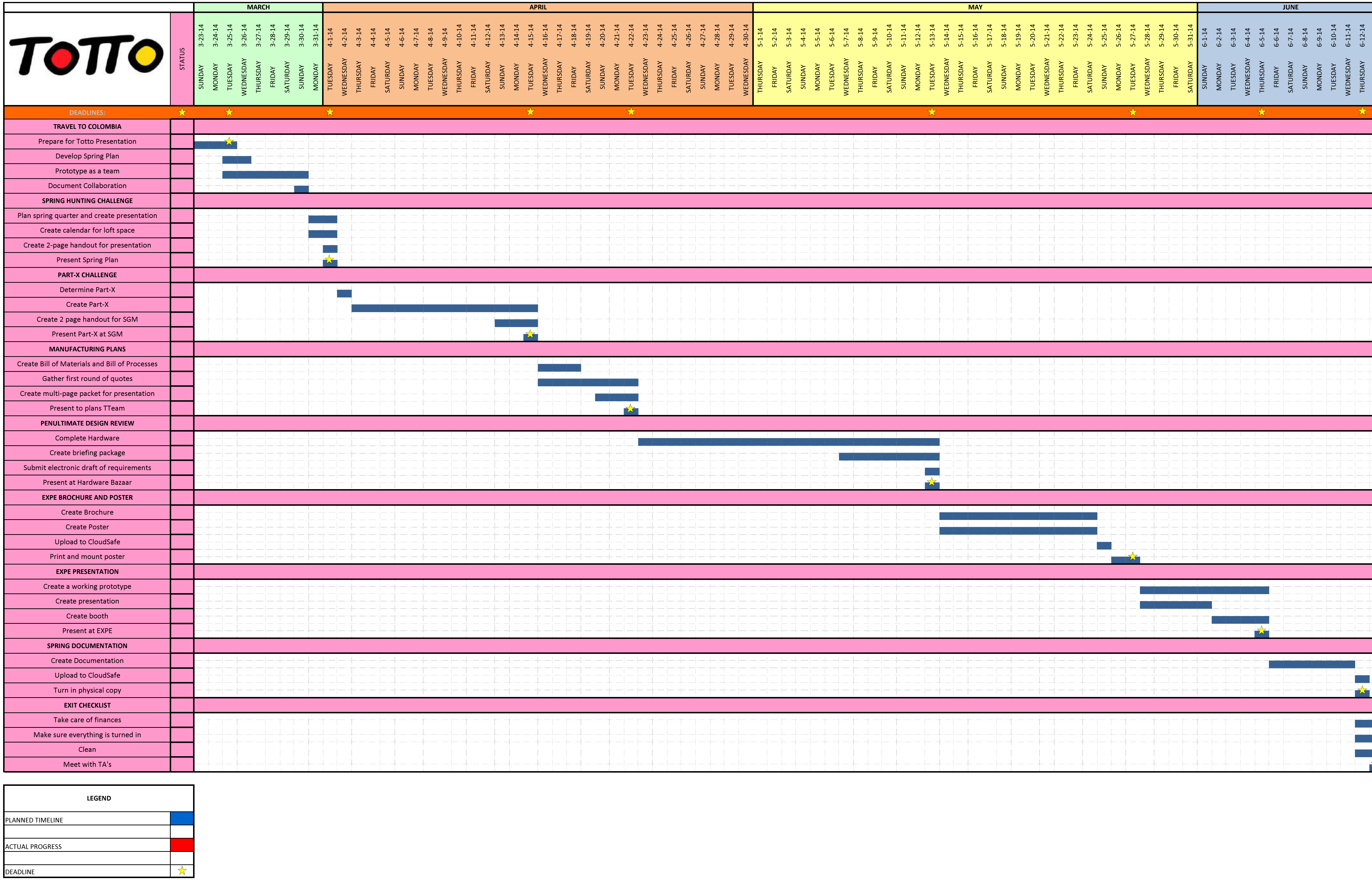
Currency COL COP

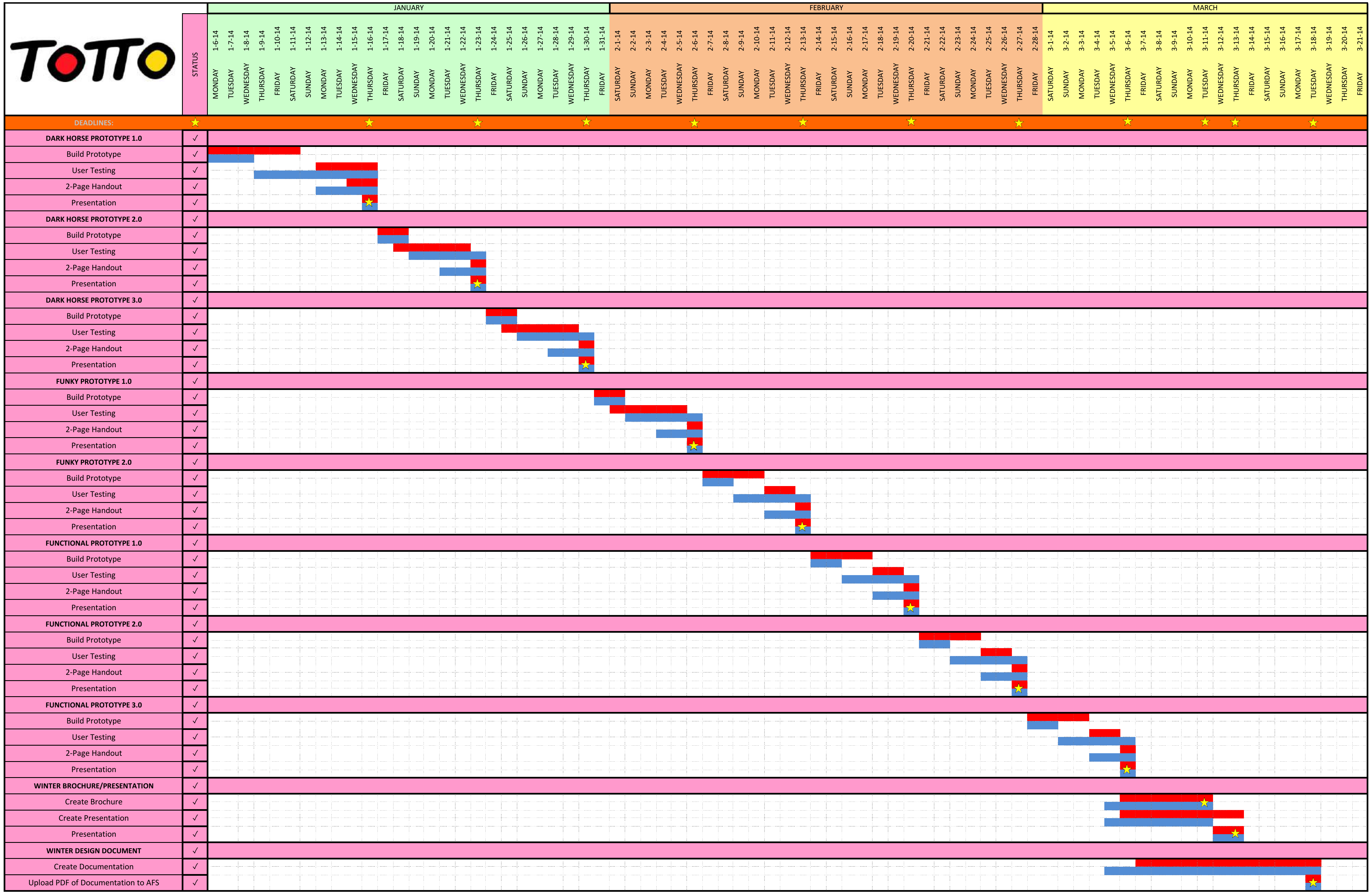
Reference*	Purchaser	Date	Vendor Name	Description of Expense	Pre-tax Amount	Shipping & Handling (if any)	Amount Incl Sales Tax
	Esteban Paya	1/15/2014	Panamericana	Two rechargable batteries for maxwell bag	$305.800,00		$305.800,00
	Miguel Posada	1/20/2014	Totto	One bag pack for maxwell bag	$99.900,00		$99.900,00
	Xiomara Velazco	1/21/2014	Homecenter	bag of ergonomic prototype	$86.700,00		$86.700,00
	Esteban Paya	1/21/2014	Rapicosturas	sewn for maxwell bag	$12.000,00		$12.000,00
	Esteban Paya	1/21/2014	Electronica Trade Center	Leds	$20.750,00		$20.750,00
	Miguel Posada	1/21/2014	Electronica Trade Center	Arduino	$87.050,00		$87.050,00
	Miguel Posada	1/22/2014	Jolly Joker	prints on the bag	$40.000,00		$40.000,00
	Miguel Posada	1/24/2014	Electronica Trade Center	9v battery for arduino	$17.100,00		$17.100,00
	Miguel Posada	1/24/2014	Planeta Electronic	LRD	$7.800,00		$7.800,00
	Miguel Posada	1/25/2014	Sastreria y clinica de ropa	sewn for maxwell bag	$8.000,00		$8.000,00
	Miguel Posada	1/27/2014	Electronica Trade Center	9v battery for arduino	$15.700,00		$15.700,00
	Esteban Paya	1/29/2014	Electronica Trade Center	Electronic stuff such ass leds, resistences, wire and others	$15.700,00		$15.700,00
	Esteban Paya	1/31/2014	Printer Outsourcing	Dark horse handout printing	$12.000,00		$12.000,00
	Esteban Paya	1/31/2014	PUJ	Funky printing	$7.900,00		$7.900,00
	Esteban Paya	2/04/2014	el Si	leather for pre funky	$19.470,00		$19.470,00
	Esteban Paya	2/04/2014	Homecenter	tape, silicone,moorings	$68.900,00		$68.900,00
	Esteban Paya	2/04/2014	Rapi costuras	SEwn for functional	$51.490,00		$51.490,00
	Esteban Paya	2/07/2014	Homecenter	attachment system materials	$29.900,00		$29.900,00
	Esteban Paya	2/12/2014	Homecenter	hooks and packing rings	$34.850,00		$34.850,00
	Xiomara Velazco	2/24/2014	La 14	platic bases and materials for funky	$106.200,00		$106.200,00
	Xiomara Velazco	2/26/2014	Printer Outsourcing	functional handout printing	$16.500,00		$16.500,00
	Xiomara Velazco	2/26/2014	La rebaja	plaster	$22.200,00		$22.200,00
	Xiomara Velazco	2/26/2014	Homecenter	modules	$167.950,00		$167.950,00
	Xiomara Velazco	2/27/2014	Totto	modules	$92.700,00		$92.700,00
	Xiomara Velazco	2/27/2014	Maniquies y tapizados roma	woman and man dummies	$150.000,00		$150.000,00
	Leonardo cuellar	3/03/2014	La rebaja	plaster	$8.950,00		$8.950,00
	Leonardo cuellar	3/04/2014	ishop	module	$23.600,00		$23.600,00
	Leonardo cuellar	3/04/2014	Washington	laser cutting	$27.800,00		$27.800,00
				Total			$1.556.910,00
				Fall Allocation			
				Available Balance			

Please see your Budget Monitor (TA), Juan David Ariza if you have questions. Thanks!

H Gantt Charts

Appendix begins on following page.


TOTTO
MARCH
APRIL
MAY
JUNE
STATUS
DEADLINES:
TRAVEL TO COLOMBIA
Prepare for Totto Presentation
Develop Spring Plan
Prototype as a team
Document Collaboration
SPRING HUNTING CHALLENGE
Plan spring quarter and create presentation
Create calendar for loft space
Create 2-page handout for presentation
Present Spring Plan
PART-X CHALLENGE
Determine Part-X
Create Part-X
Create 2 page handout for SGM
Present Part-X at SGM
MANUFACTURING PLANS
Create Bill of Materials and Bill of Processes
Gather first round of quotes
Create multi-page packet for presentation
Present to plans TTeam
PENULTIMATE DESIGN REVIEW
Complete Hardware
Create briefing package
Submit electronic draft of requirements
Present at Hardware Bazaar
EXPE BROCHURE AND POSTER
Create Brochure
Create Poster
Upload to CloudSafe
Print and mount poster
EXPE PRESENTATION
Create a working prototype
Create presentation
Create booth
Present at EXPE
SPRING DOCUMENTATION
Create Documentation
Upload to CloudSafe
Turn in physical copy
EXIT CHECKLIST
Take care of finances
Make sure everything is turned in
Clean
Meet with TA's
LEGEND
PLANNED TIMELINE
ACTUAL PROGRESS
DEADLINE



LEGEND	
PLANNED TIMELINE	(blue)
ACTUAL PROGRESS	(red)
DEADLINE	☆

I Winter Presentation

Appendix begins on following page.

TOTTO SMART BAG

A Backpack You Never Want to Be Without

ME 310, 2013-2014
Winter Presentation

Caitlin Clancy
Jeffrey Infante
Claire Liao
Nikhil Pansare

Meet the Team!

Challenge

TOTTO

Totto is a leading fashion brand in Latin America, offering backpacks, bags, clothing and accessories.

Design a **Smart** **Container**

that meets the **needs**

of the **urban traveler**

Challenge › Needs › Development › Requirements › Vision › Conclusion

Take a moment…

What are you carrying?

Has anything been stolen?

Did you leave your items at your seat?

What was the last thing you forgot?

TOTTO

Need of Comfort

How comfortable is your bag?

Challenge | Needs | Development | Requirement | Vision | Conclusion

Need of Tracking Items

What's in your bag?

Challenge | Needs | Development | Requirements | Vision | Conclusion

Need of Security

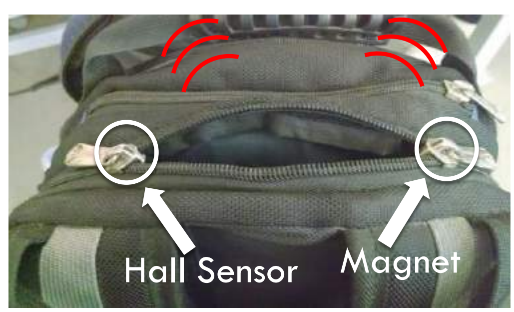
Worried about theft?

Challenge | **Needs** | Development | Requirements | Vision | Conclusion

Development

Totto Secure

Picking up bag causes alarm



Opening zipper causes alarm

Challenge | Needs | **Development Secure** | Requirements | Vision | Conclusion

Development

Comfort and Ergonomics

Bug Hug Bag

"I like the hugging close feeling to the body."
- Janni, 42

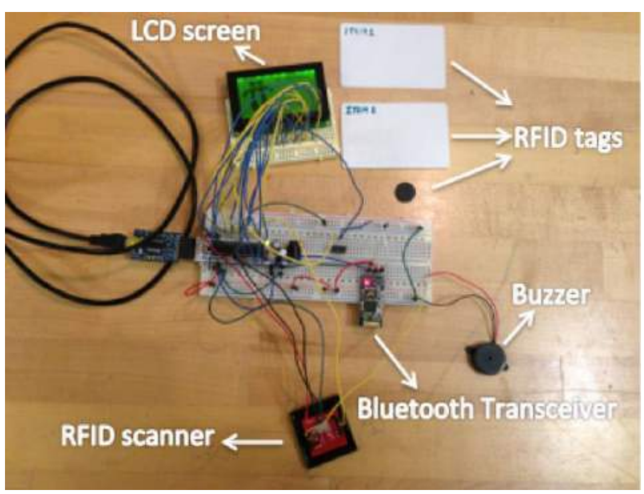
"Felt this design would work well in the high movement activity."
- Jack, 24

"I felt the prototype is a little bit complicated to put on, take off and adjust."
- Maya, 25

Challenge | Needs | **Development Ergonomic** | Requirements | Vision | Conclusion

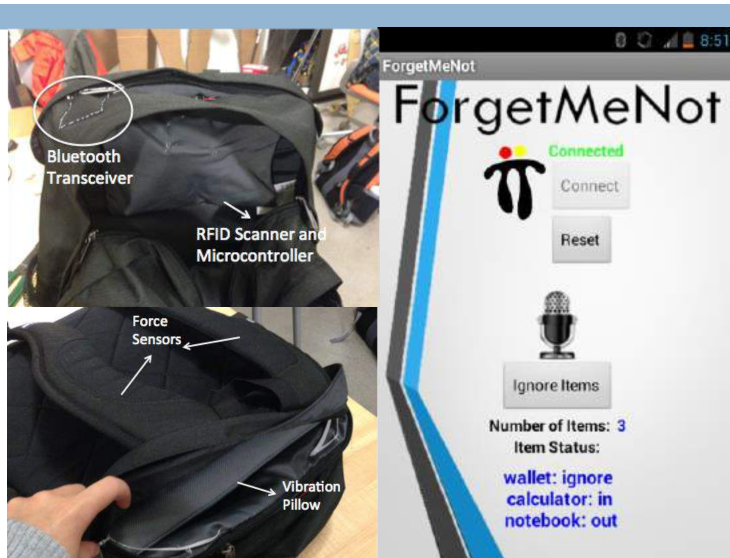
Development

ForgetMeNot (Initial)



Challenge | Needs | **Development Tracking** | Requirements | Vision | Conclusion

Development
ForgetMeNot (Integrated)

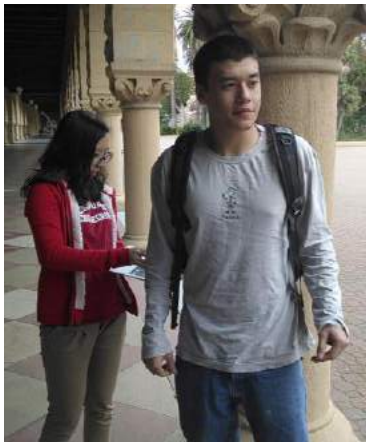


Challenge | Needs | Development Tracking | Requirements | Vision | Conclusion

Development
ForgetMeNot (Integrated)

Challenge | Needs | Development Tracking | Requirements | Vision | Conclusion

Development
ForgetMeNot (User Testing)



"It would be great to have a bag that's aware of its contents"
- Alex, 17

"I would like the bag to remind me of items I frequently forget"
- Leah, 20

Challenge › Needs › **Development Tracking** › Requirements › Vision › Conclusion

Design Requirements

- What we were given
  - "A smart container that meets the needs of the urban traveler"
- Expectations for EXPE prototype
  - Quick scanning of items
  - Rugged incorporation of electronics
  - Personalized ergonomic design

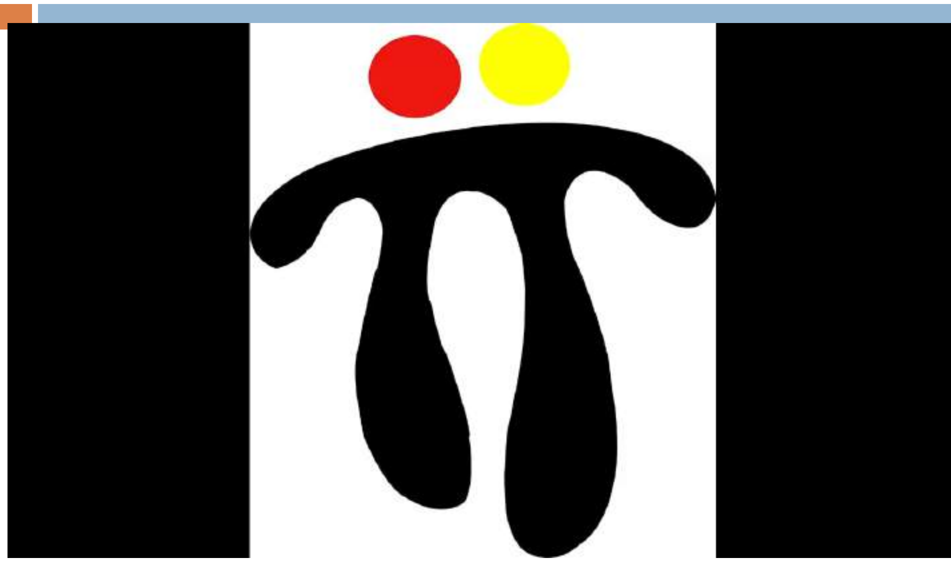
Challenge › Needs › Development › **Requirements** › Vision › Conclusion

Our Vision

Next generation bag that knows what you need, what you have, and what you forget while guarding against theft.

Challenge | Needs | Development | Requirements | Vision | Conclusion

Our Vision



Challenge | Needs | Development | Requirements | Vision | Conclusion

Conclusions & Future Work

- Conclusions
  - Developed numerous prototypes
  - Performed extensive need finding and user testing

- Future Work
  - Travel to Colombia
  - Integrate the vision into one product
  - Present our final product in EXPE (June 5, 2014)!

the Stanford design EXPErience ME 310

Challenge > Needs > Development > Requirements > Vision > Conclusion

Coming Soon…

Any Questions?