Western University

Faculty of Engineering

ES 1050 – Engineering Design and Innovation Studio

Design Project III

Project III - Final Report

Studio 5

Group 9

Professor Southen

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By:
Kaylin Haill- ID #250659269
Dana Zagar- ID #250790176
Tyler Lacroix- ID #250824342
Eric Robinson- ID #250796248

Executive Summary

This report provides an overview of the steps and iterations that were used to develop the design of Restore the Link into a working, functional prototype. The purpose of this project was to design and produce a product that can be used to prevent or provide relief for a humanitarian issue. Restore the Link was created to reconnect families that have been displaced due to the effects of civil war and conflict. Many ideas were formulated during our brainstorming phase; these ideas were primarily focused on the group's capabilities in the programming and 3D printing aspects as well as the overall viability of each concept produced. After much discussion and aid from the creativity techniques such as mind mapping and 180-degree thinking, the next phase of the design process could commence. Using a simple plastic bracelet embedded with an RFID tag along with a console that can read an RFID tag, Restore the Link was our creative solution to the defined problem. This product, after scanning the RFID tag stored within the bracelet, can store information such as gender, age, and location, and can tell the bracelet's owner where connected friends or family are located throughout the world.

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Introduction

When conflict arises, many innocent people are caught up in the disputes and are forced to flee from their homes. According to statistics kept by the United Nations High Commissioner for Refugees or UNHCR, 51.2 million people have been forcibly displaced from their homes worldwide, with 33.3 million being internally displaced and 16.7 million recognized as refugees (UNHCR: Facts and Figures on Refugees, 2014). Many people are separated from their families; it can take years to find them again. The processes of merely keeping count of how many people are in a camp lack any regulation and order, so finding a loved one through officials at the camp is nearly impossible. Being removed from one’s home is discouraging in itself, but being separated from one’s family is extremely disheartening. In an article written by the International Committee of the Red Cross (ICRC), the conflict in Somalia resulted in tens of thousands of people being separated from their families and has taken many internally displaced people (IDP) or refugees years to restore communication (Somalia: Restoring contact between families separated by conflict, 2013). When a family can be reunited, it sparks feelings of hope and courage for those involved and allows them to begin to heal from the conflict and hardships they have endured. Reunification of families can also boost refugee/IDP camp morale, and allow those in the camps to keep their dignity without having to move into the host country. The goal of this project is to connect refugees/IDP displaced from their families due to conflict.

Throughout the design process, several original concepts were considered. Ultimately, Restore the Link was chosen as the final design. Restore the Link allows people to locate their loved ones after an incident has occurred using a bracelet containing RFID technology. This design is considered to be a post-disaster emergency service, and would be offered to civilians in areas at risk as a precaution by a trusted global organization such as the ICRC. This allows families and groups to reunite in a shorter span of time.

In this report, each area of the Restore the Link solution is explored, including its take on the social, technical, and environmental aspects of the problem as well as iterations and innovations in its design.

Background

In a complex emergency, where many issues must be addressed in a short time frame, several mental and physical factors must be considered. In a refugee's situation, key influences on their well-being include the physical necessities they are provided, the degree of emotional support they have access to, and the overall environment of the camp they are staying in.

Basic necessities for refugees and IDP, including food, water, housing, and sanitation, have to be rationed in camps in order for a sustainable and orderly system to work. Overcrowding a camp has a devastating domino effect on its temporary residents. It results in less food and water rationed to each individual, which over time turns into chronic malnutrition and dehydration. This leaves refugees, especially children, vulnerable to various illnesses and diseases. The lack of fresh foods like fruits and vegetables also leaves refugees deficient in essential nutrients, leading to chronic diseases and permanent damage especially to children. Camps also begin to deteriorate at an exponential rate when a black market of rations is established within a camp. This begins by individuals leaving a camp and getting a new ration card from another camp under a different name. Overcrowding also results in shelters being filled above capacity, which accelerates the spread of disease, significantly reduces an individual's privacy and produces poorly constructed shelters. In turn, this leads to increased blood pressure, anxiety, and stress levels in the inhabitants of the camp (Unite for Sight). No solutions to overcrowding have been effective, and unfortunately this is speeding up the health decline of residents within the camp. Unless the conflict ends, refugees have nowhere else to go ("Humanitarian crisis on outskirts of overcrowded Dadaab camp").

Amidst the toughest challenges within any situation, the most powerful emotional support comes from close family and friends. Without emotional support, individuals in these situations have a heightened feelings of fear, anxiety, and loneliness, which decreases morale of the camp and their productivity and motivation to get out of the unfortunate situation. Keeping families together during these difficult times is extremely important, but can also prove to be a challenge. The ICRC has put an online tracking service that uses a central database in place for large-scale emergencies. This idea was heavily influenced by the need for a database to organize refugees in the 1994 Rwandan genocide (Merkelbach, 2000). An estimated two million Rwandans were forced to become refugees, leaving thousands of children unaccompanied. The ICRC, in conjunction with various humanitarian aid agencies, decided to create a centralized database with the personal information of unaccompanied children under the age of 18. The database helped to reunite nearly forty percent (or over 20,000) of the children registered in the database to their families by 1997. The database did have several issues, such as complications with simple data inputs (names, important dates) and different standards of information collected by different agencies. Matching profiles using the central database also proved to be more effective than by a manual process, but it was not uncommon to fail to find matches due to the lack of or inaccuracy of information (Rojas, 2011). The centralized database system to reunite families could have been more effective if the family members had been linked in a central database before the crisis had occurred. This example shows that if prevention can be applied, families can find each other more quickly and the mental well-being of a camp as a whole would stay more intact.

A current solution introduced in 2011 is RapidFTR, an open source application that emergency relief workers use to record a child's name, photo, voice recording and details of the separation from their family. This information is collected, sorted, and uploaded to a secure central database shared with United Nations agencies and non-governmental organizations. Parents then consult the database to see if their children have been registered (UNICEF, 2013). The RapidFTR system speeds up the process of registering individuals in the central database from weeks and months to an instant, and is done over a highly secure network similar to that of mobile banking programs (WNN, 2013). The user-friendly and functional application was tested in 2012 in Uganda and again in 2013 in South Sudan and the Philippines, to moderate success (UNICEF, 2014). This application makes the registration process for refugees much faster, and provides a tracking system for the most vulnerable individuals in these situations (Shearlaw, 2013). It is also an open source application, which potentially makes it adoptable for different crises. However, there are several issues with this idea. Entering data is still a laborious process, excessive amounts of memory are required to store photos and voice recordings, and individuals may not trust an aid worker to take a photograph or voice record them in an environment wrapped in conflict. Although this application is a step in the right direction, a more powerful and trustworthy system must be put in place that gives the refugee more independence.

Problem Definition

The final problem definition for this project is *to connect refugees/IDP displaced from their families due to conflict.*

For this design project, the focus was primarily on conflict and civil wars in third-world countries. This has become a sizeable issue in society today and affects millions of people every year. There are endless negative aspects of conflict as an outcome of civil war, but the one issue narrowed down to, for this project, was the separation of people from their families and loved ones. During these types of conflicts, countless people are separated from each other, whether it be by being taken to different refugee camps, being injured, or captured. It can take years to reunite the people involved. Our problem definition solution is to fix this problem by making it easier for families to effectively and safely find each other and be reunited.

Project Specifications

Objectives	Constraints
- Original (Unique)	- Fit in 20x20x20 cm
- Compact	- Mass under 1 kg
- Accurate	- Cost less than $100
- Aesthetically pleasing	- Use less than 10W
- Last more than 5 years	- Safe and secure
- Easy to use	- Connect 4 users
- Inexpensive and easily distributed	- Durable and weatherproof
- Able to use in any language	

Objectives: It was important to our team to develop a unique design to display our creativity. Since the device will be worn often, an objective was to make it compact and minimalistic in design so there is no annoyance or discomfort to the users. Our third objective was to ensure that the device was accurate. The goal of the solution is to reunite people, so accuracy in location on this device was paramount. Next, we wanted to make it aesthetically pleasing. The design of the product should be attractive and appealing to both genders, especially because people will be wearing it as an accessory. The fifth objective generated was to have it last longer than 5 years. It is important to make the device last a long time, as we don't know how long people will be separated for or how long it will take them to reunite independently. The device will be distributed to a large number of people, who will be of all ages and intelligence levels; therefore, it must be simple and easy to use. Since the device is to be provided to many people, the design must be inexpensive and easily distributed. Finally, we wanted to be able to use it in any language, so that it can be distributed as widely as possible, to people of all ages and intelligence levels. All of these objectives were considered when brainstorming concepts.

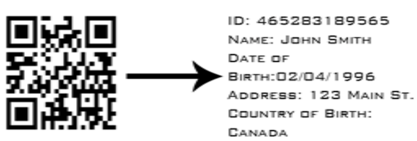
Constraints: The first three constraints were that the solution must fit in a 20x20x20 cm volume, must weigh less than 1kg, and must cost less than $100. These constraints helped to keep the device minimalistic and inexpensive. The design must use less than 10W of power to allow it to be used in areas with limited electricity. Our next constraint was to make it safe and secure. It must be subtle in appearance so as to not be easily noticed by rebels or people looking to abuse the product, and the database must be extensively protected to prevent hacking or misuse. Furthermore, we wanted our design to be able to connect a minimum of four users since our goal is reuniting families and loved ones, and four is the average number of people in a family. Our final constraint was for the device to be durable and weatherproof. Since this design will be used mainly in war zones with limited supplies entering and exiting, it must be durable in order to be effective. We took all these design constraints into careful consideration while developing ideas and possible solutions.

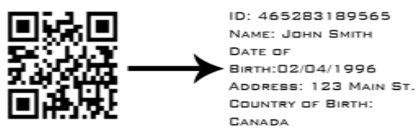
Evaluation

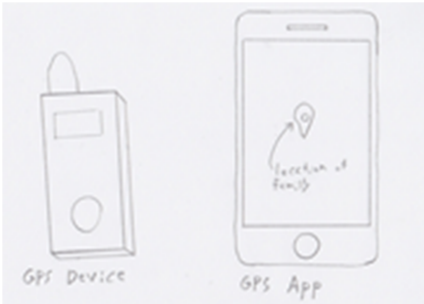
The criteria used in developing the final product were as follows:

1. **Project Constraints** – Does the product meet all the requirements of the assigned task and group goals? (i.e. cost, durability, aesthetics, power usage, etc.)
2. **Group Capability** – Does the group have the skill set to produce the designed product?
3. **Materials Needed** - Can the materials needed be purchased easily, and how?
4. **Safety** – Would the product be effective and safe to use?
5. **Ease of use** – Would the product be easy to use?

These criteria were applied to each concept, and it was decided that the RFID accessory choice met all of the criteria. Below are the “passes” or “fails” of each concept in the criteria used.

Concept	**Criteria Pass or Fail**	
1) QR Code (tattoo)  	✗	***Project Constraints:*** The use of ink would be relatively expensive, especially for mass production. Also, the code may fade over time, and the cost of the machines that make and read the tattoos would be quite expensive.
	✗	***Group Capability:*** QR tattoos would be difficult to produce as a prototype. To make a code that can be scanned properly, it would need a machine or stamp. A very high level of programming knowledge is required.
	✗	***Materials Needed:*** Although the ink used for coding would be easily accessible, gathering the materials to build machines that make and read QR codes as tattoos would be difficult.

	✓ ✓	***Safety:*** Relatively safe as a design. The code can be personalized and therefore unique for each holder. Relatively difficult to hack. ***Ease of use:*** Although the distribution and coding would be difficult, the scanning of the codes would be quite easy.
2) QR Code (stitched on clothing)  	✗ ✗ ✗ ✓ ✓	***Project Constraints:*** The stitching used for coding would be relatively inexpensive, especially for mass production. However, the code would not very durable on clothing, as it could possibly be torn off. ***Group Capability:*** QR stitching would be difficult to produce as a prototype. To make a code that can be scanned properly, it would need a machine or stamp. A high level of programming knowledge is essential. ***Materials Needed:*** Although the design would be difficult to complete, the stitching for the codes would be easily accessible. However, gathering the materials to build machines that make and read QR codes as tattoos would be difficult. ***Safety:*** Relatively safe as a design. The code can be personalized and therefore unique for each holder. Relatively difficult to hack. ***Ease of use:*** Although the distribution and coding would be difficult, the scanning of the codes would be quite easy.
3) Global Positioning System (GPS) as an app or device	✗	***Project Constraints:*** Production of a product using GPS would be quite costly. There should not be an assumption that everyone has a

	 ✓ ✓ ✗ ✓	phone or GPS tracking device, making this concept less effective ***Group Capability:*** A phone application could be produced within the skillset of the group. ***Materials Needed:*** All the materials needed, such as a phone, or software needed for programming are readily available. ***Safety:*** This design is the least safe of the concepts, as using global positioning to identify a location is not secure and personal. ***Ease of use:*** Relatively easy to use. This concept has the potential to be user friendly.
4) Global Positioning System (GPS) as an accessory 	✗ ✓ ✓ ✗ ✓	***Project Constraints:*** Production of a product using GPS would be quite costly. ***Group Capability:*** An accessory with GPS capability could be produced within the skillset of the group. ***Materials Needed:*** All the materials needed, such as bracelets or necklaces, or software needed for programming are readily available. ***Safety:*** This design is the least safe of the concepts, as using global positioning to identify a location is not secure and personal. ***Ease of use:*** Relatively easy to use. This concept has the potential to be user friendly.
5) Radio-Frequency Identification (RFID) as an implant	✓	***Project Constraints:*** Extremely inexpensive to make and mass produce. The concept is original and the RFID chip is very durable in that it does not run on battery life.

 	✗ ✓ ✗ ✗	***Group Capability:*** Building an implanted RFID chip meant for human flesh would be a difficult task. ***Materials Needed:*** The group has access to the programs and 3D printed objects needed to produce this design. ***Safety:*** This design is moderately safe. Modifications can be made to the coding to provide a safer database to prevent hacking. The safety of an implant is questionable, especially in areas where AIDS and contaminated tools are in abundance. ***Ease of use:*** RFID chips are easy to scan, but people may not allow a chip to be implanted in their skin.
6) Radio-Frequency Identification (RFID) as an accessory  	✓ ✓ ✓ ✓	***Project Constraints:*** Extremely inexpensive to make and mass produce. The concept is original and the RFID chip is very durable in that it does not run on battery life. ***Group Capability:*** Building an accessory and console with RFID reading technology is within the group's skillset. ***Materials Needed:*** The group has access to the programs and 3D printed objects needed to produce this design. ***Safety:*** This design is moderately safe. Modifications can be made to the coding to provide a safer database to prevent hacking. Also, certain accessories such as a bracelet or necklace can be quite subtle in appearance.

	✓	***Ease of use:*** RFID chips are easy to scan, and the accessory is intended to be easy and comfortable to wear.

Description of Final Design

Our final design is Restore the Link. Restore the Link provides a platform to reconnect refugees to their friends and family. RFID bracelets will be worn by civilians in at risk areas. The RFID chip in the bracelet links the user to their vital personal identification information stored in a centralized database. When the bracelet is scanned, their profile is stamped at that date and location of the scan. They also have access to their “linked” members personal information and location, allowing families and friends to locate each other more easily. There are two physical devices to this solution: the bracelet and the console. There are several components of the console; each will be discussed.

Bracelet

- Before the crisis occurs, every person in an area at risk will be given a bracelet by a trusted global humanitarian organization such as the UNHCR or the ICRC. Each bracelet will be embedded with an Radio-Frequency Identification (RFID) tag. Each tag will contain a 10 digit key to the user’s account. The RFID tags chosen are passive tags; they do not require their own power source and therefore do not need to be recharged. The bracelets will made made of silicone rubber since this material is flexible, inexpensive on this small scale, stable, heat-resistant, and waterproof (see more detail on material selection in Multidisciplinary Aspects).

Console

- The refugee camp will have at least one console each, depending on the influx of refugees. The console will house the electronic components. The console is comprised of a polycarbonate case, Raspberry Pi and RFID reader.

Case

- The case has been 3D modeled to fit all the components inside a rectangular prism with dimensions 70x90x25 mm. The 3D model can be viewed in Figure 3.

RFID Reader

- Each console will contain an RFID Reader. The passive RFID tag is briefly activated by the radio frequency scan of the reader. The electrical current is very small, just enough for transmission of the 10 digit (ID) key stored on the tag. This key is passed on to the Raspberry Pi.

Raspberry Pi

- The Raspberry Pi is a credit card-sized single-board computer. It will conduct all the processing in this product. It will display the GUI to a monitor and receive the ID from the RFID Reader.

Database

- There will be a single centralized database. This database will contain the name, date of birth, address, gender, the people who they are connected to, and the history of when and where they have checked in. It would give the console this information, as needed.

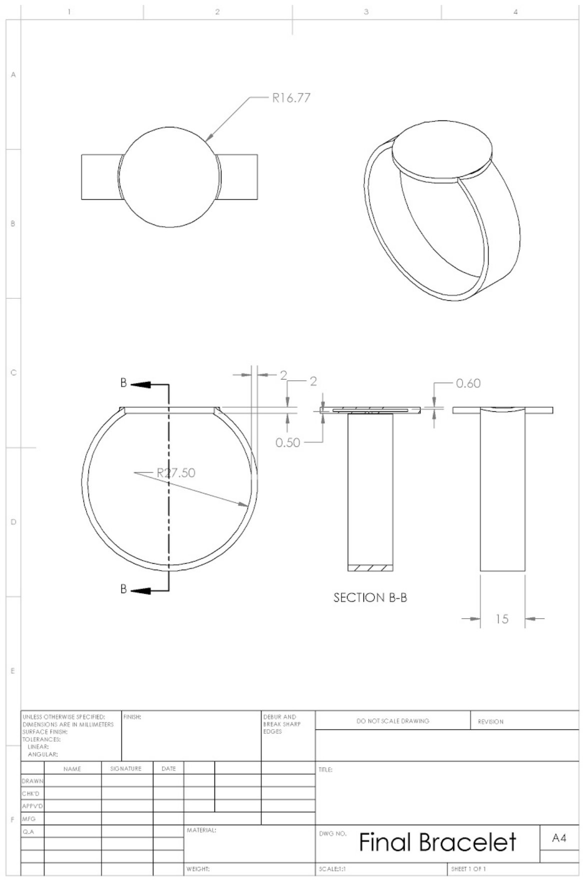
GUI

- The console will have an easy to use Graphical User Interface. When the console is idle, it will display the message “Please Scan Your Link”. When a user scans their link by tapping their bracelet against the console, it will automatically log them in using the 10 digit key found on their bracelet. It will display their name, and the people in which they are linked to. By clicking on one of the names, the information of that person may be obtained. In the information page, the user may click “View History” to view where and when that person has logged in. The history of the chosen person’s location is geographically represented on a map using Google Maps’ free API.

Design Drawings

Bracelet - Final Design

Figure 1



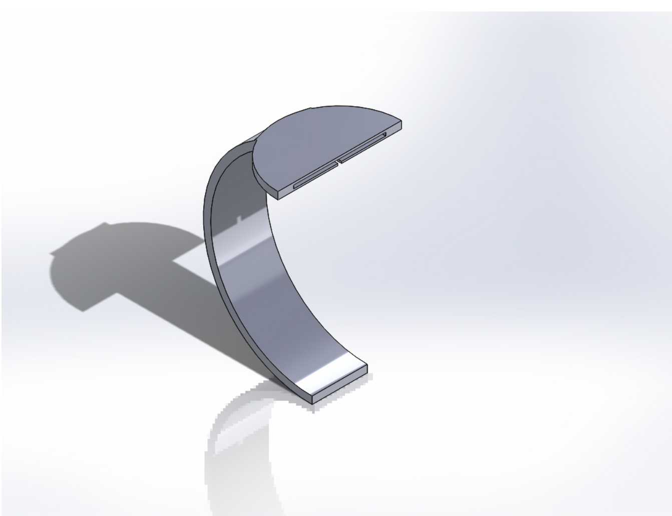


Figure 2(a)

FIgure 2(b)

Console - Final Design

Figure 3(a)

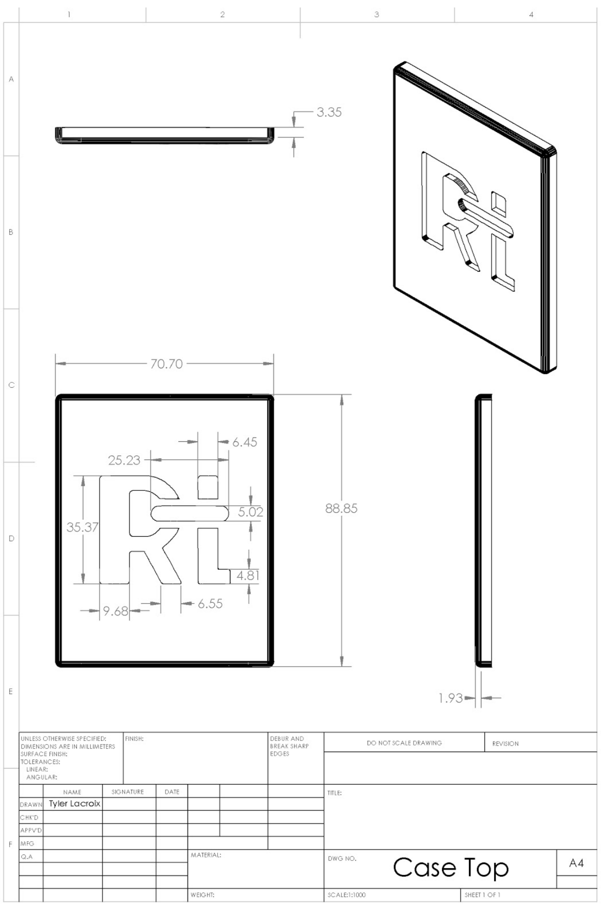


Figure 3(b)

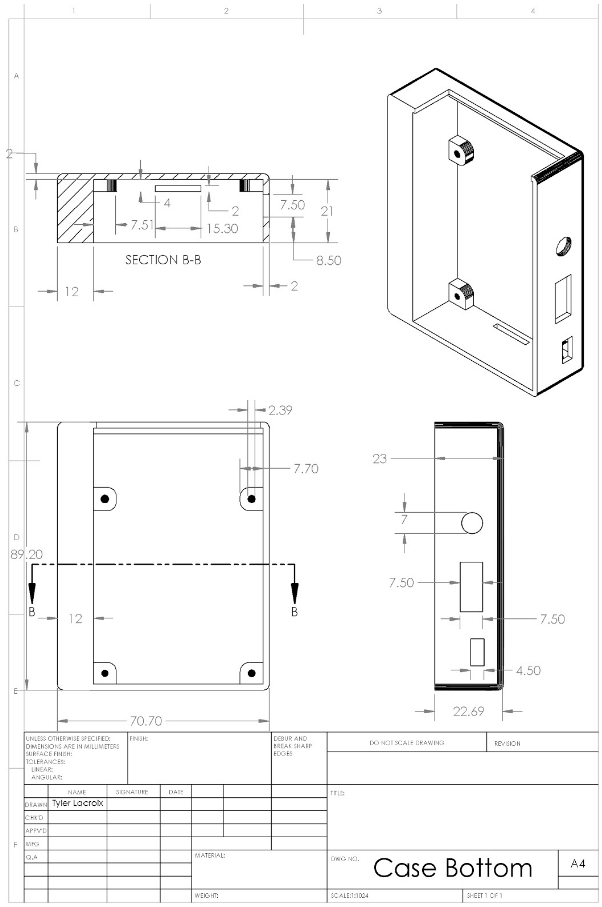


Figure 4(a)

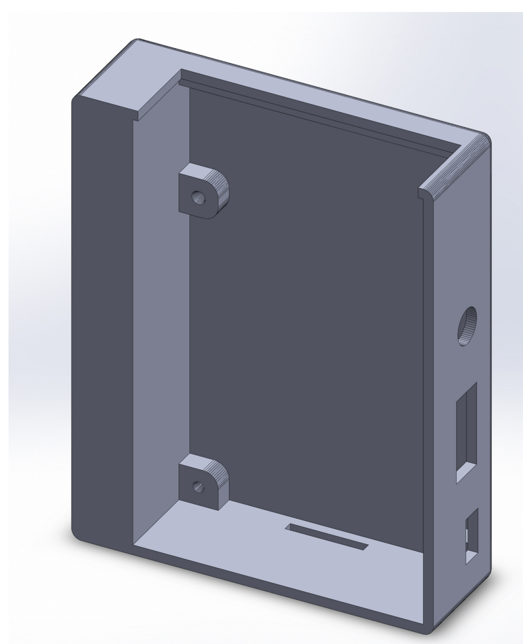


Figure 4(b)

Description of Prototype

Once we had chosen a concept, a prototype could be manufactured. During the process of concept selection, it was important to create something affordable. It became evident to our group that we had many of the skills, tools, and resources to build a fully functional prototype. The next step was to gather the supplies. These included:

- Raspberry Pi
- Parallax Serial RFID Reader
- Logic Level Converter
- PLA Plastic
- RFID Tags

(The full list, including prices, can be seen in Appendix II- Cost Breakdown)

The bracelet was 3D modelled (See Figure 1) and printed using 4 grams of PLA plastic. The case was 3D modelled as well (See Figure 3) and printed using 28 grams of PLA plastic. The Parallax Serial RFID Reader was chosen as the RFID reader since it was affordable and used a serial connection to communicate. A 3.3v to 5v Logic Level Converter was used for communication between the Raspberry Pi (3.3v) and the Parallax Serial RFID Reader (5v). Raspbian, an operating system based on Debian, was installed on the Raspberry Pi. To display the GUI, a local Python web server using the microframework Flask was used. The content was loaded on the Kiosk mode in the Chromium browser. The various pages were programmed in HTML with CSS for styling. The dynamic content was loaded with Javascript. For the database, the open-source database mySQL was chosen as it is powerful, efficient, and free. We created three tables: one to store the user’s data (such as name, address, etc.), one to store the links between the users and one to store the history of where and when the users have checked in. (See Appendix VI for more detail on the database.)

The total cost of the console prototype was $73.23.

Innovations and Creativity

Creating an innovative solution to a complex problem within humanitarian crises required a large amount of time brainstorming and using various methods such as 180-degree thinking, both individually and in a group setting, at various points in the design process. The process began with a mind map, which ultimately helped the group decide that the focus would be on civilians in areas of conflict and war. After writing a list of possible issues for civilians in areas of conflict as a group, the group came up with the idea of reuniting families that have been separated due to conflict. Discussing the primary goals of our project as well as doing intermediate research individually allowed the group to grasp a heightened understanding of the issue and confirm that it was a feasible option for this project. The problem definition that was reached was to connect refugees/IDP displaced from their families due to conflict.

After each member individually brainstormed for several days, two ideas were presented from each person within this issue. These ideas were also put into a mind map, to make the comparisons easier to do (Appendix I-A). Using a Go - No Go chart (Appendix I-B) allowed the group to narrow down the concepts to three solutions, using six essential criteria that addressed the appearance, cost, longevity, safety, distribution, and independence of each solution. A design matrix (Appendix I-C) was then used to further narrow down the solutions by ranking the importance of each criteria. The safety of the user was deemed the most important. After putting the final three solutions through the matrix, the RFID bracelet was the highest scoring solution.

As the solution began to take form, more issues needed to be addressed by creative and effective alternatives. Using 180 degree thinking in this situation proved to be an extremely useful tool, as it allowed the group to see various issues that were not initially considered, such as lack of a power source and Internet connection in remote or third-world regions where refugee camps could potentially be situated. Doing research on existing innovations proved to be useful as well, as the group considered applying it to existing cell phone/bluetooth/bracelet technology such as the Vive bracelet (Doan, 2014). However, this could potentially diminish the security of the database, and the innovation should not make the incorrect assumption that the majority of these people or aid workers would have functioning cell phones in emergency situations.

As the group continued to innovate and brainstorm future innovations, it was realized that the feasibility of the Restore the Link solution being implemented in areas at risk was significantly higher than the level the group had set out to achieve. Several future innovations could push the design of Restore the Link above and beyond its original capabilities. The first innovation would make this solution as independent as possible by using a solar-powered console piece. This would make the entire solution independent of an external power source, which would allow the solution to be implemented in areas where electricity is scarce or non-existent. Using fingerprint technology was another improvement the group discussed. This innovation would be used as a backup mechanism to access an individual's profile. It is another unique way to identify someone and to add another level of authenticity and security to the interface. The third innovation was utilizing Facebook's *Internet.org.* This would allow the database to run in remote and third-world areas at a relatively low cost. Another innovation would be to allow families to register non-local Links using a photo identification and name look-up within the database or using the Bluetooth 'linking' function demonstrated in the Vive bracelet (Doan, 2014). Lastly, a high level of encryption on the database would also ensure that the Restore the Link solution would not compromise the user's safety or personal information.

The applications of the Restore the Link solution could eventually go beyond its primary function of reuniting families. Non-governmental organizations and the United Nations could potentially apply this technology to keep track of the number of refugees in a camp. This would be a breakthrough in the design and implementation of refugee camps, as it would drastically reduce the rates of overcrowding and the detrimental effects that accompany it.

Restore the Link is innovative and creative because of its consideration of the user, as well as the wide range of applications it could potentially encompass in the future. It fulfills the three basic characteristics of an innovative product: it is desirable, addressing an unmet need and is user-friendly; feasible, is possible to implement from a technical and administrative standpoint; and viable, once economies of scale are reached by mass production and distribution of the solution. If a solution to a problem cannot grow and evolve, it does not become a positive force of change. The adaptability and simplicity of the Restore the Link solution sends it above and beyond a normal emergency service by creating a user-friendly, safe, and personal communication between loved ones in an emotionally compromising situation.

Multidisciplinary Aspects

The material selection for each component of the Restore the Link design had to be selected carefully, to adhere to the objectives and constraints outlined at the beginning of the project. The material of the bracelet and the console had to be able to work with their respective functionality. For prototyping purposes, both the bracelet and the casing on the console were 3-D printed using polylactic acid (PLA) biopolymer. This material would not be ideal for some third-world regions the solution would be used in, as the temperatures could climb above 45 degrees Celsius, the lower range of the glass transition temperature that would transform the material into a softer plastic ("Overview of materials for Polylactic Acid (PLA) Biopolymer"). Any deformation of the bracelet or the console could potentially pose a threat to the technology housed within it. Any specific information not cited in this section was retrieved from the CES Material Database.

Bracelet

In the final design, the bracelet would be produced using silicone rubber. The bracelet, as outlined by the objectives and constraints, must be durable, weatherproof, and last longer than five years. Silicone rubber is a waterproof, elastic, inert material that would have the ability to house the RFID tag within it securely. Within its working temperature, -55 degrees Celsius to 120 degrees Celsius, the silicone rubber bracelets could serve the user for 10 to 20 years if necessary ("Silicone Rubber: The Definitive Guide", 2014). Silicone rubber is a high cost, high performance material. This material's price ranges from $10.80 to $12.90 CAD/kg. Because the average mass of the final bracelet design (see Figure 1) is only approximately 7.09 grams, the high cost of silicone rubber is rendered negligible as each bracelet would only cost $0.78 CAD. Silicone rubber would be a suitable material for the final bracelet design for its ability to withstand extreme temperatures and its chemical stability. Its maximum service temperature is 227 to 287 degrees Celsius, which is well above the possible heat it could be exposed to. This material would also be ideal for the bracelet because it is has a translucent transparency, so it can be manufactured to look as subtle as possible on the user's wrist. The material also has an elongation of 80% to 300% strain, so it can stretch to fit a variety of wrist sizes. Although silicone rubber is not recyclable currently, the rest of its material properties make it a perfect material to mass produce and distribute to various climatic regions worldwide.

Console

The console had several additional constraints compared to the bracelet, as it houses the Raspberry Pi computer and other additional technology vital for the Restore the Link solution to be successful. The Raspberry Pi's application processor can run between -40 degrees Celsius and 80 degrees Celsius, while its LAN9512 port is functional from 0 degrees Celsius to 70 degrees Celsius ("Raspberry Pi FAQs"). The casing on the console also has to withstand small impacts during the distribution process, and be relatively cheap to manufacture. In summary, the casing component of the console had to have a low level of thermal conductivity, a low cost, and a high degree of toughness. After making several comparisons on CES, the material most suited to the needs of the console was polycarbonate. Polycarbonate, or PC, is an engineering thermoplastic that displays better mechanical properties than cheaper “commodity” plastics. The typical uses for PC are in instrument casing, safety helmets, and electrical switchgear. Its cost ranges from $4.79 - $5.28 CAD/kg. Since the average mass of the console casing is 65.96 g, the cost of the material for one unit would be $0.33 CAD, an extremely low cost. PC has a fracture toughness ranging from 2.1 - 4.6 MPa*m^0.5, which is satisfactory for low impact collisions and drops. It is a good thermal and electrical insulator, and has a low thermal conductivity of 0.189 - 0.218 W/m*degrees Celsius. One important aspect of this material selection is that the casing is recyclable, allowing the final design of Restore the Link to be a sustainable solution with reusable components.

Design Iterations

Throughout the design process, the design of Restore the Link evolved and changed according to the technical and social challenges that arose. Most of the iterations on the original design of the Restore the Link solution were technical iterations on the code planning of the user interface and the database, allowing the program to be more efficient and user-friendly. The physical components of the project were also iterated for the prototype, due to the restriction on materials and structures that could be 3D printed.

The iterations made on the database structure were numerous as the group expanded on the solution. A major iteration that needed to be made on the original structure near the beginning of the project was to normalize the database. This practice of creating proper database structures allows the information to be organized, retrieved and updated more efficiently by separating pieces of primary information into separate tables. After normalizing the database, the group realized the need for an administrative page since the organizations running the registration of Restore the Link would have a difficult time updating and registering profiles without one. The administrative options allow the administrator, with a type-in password, to add links to an existing user's profile, edit a user's personal information, register new users, and set a static location for the console from an existing drop-down menu (eg. Ottawa).

The original code planning for the user interface was very simplistic, but was iterated frequently throughout the design process to make the program as user-friendly as possible. The original coding had been planned to be a native, all-in-one C++ application, but this idea was discarded quickly due to complications with the Graphical User Interface (GUI) and buttons in particular. This was instead achieved by using the Chromium web browser in conjunction with a local Python web server so HTML and CSS could be utilized to create an aesthetically-pleasing, user-friendly GUI. Another major iteration on the interface was the communication between the physical RFID tag reader and the web browser, which would have initially gone through the C++ application in the first phase of the design. Making this connection efficient was extremely important for the design to be functional. After testing out several different approaches, a block of JavaScript code was used to prompt the RFID tag reader for a tag until an RFID key was returned.

The console, which housed the Raspberry Pi computer and other technical components, was iterated several times as well. Originally, a solid open ended box was virtually constructed using the design software, SolidWorks. When attempting to 3D print the object, the top of the console would collapse as the 3D printer could not mold the roof steadily enough to cool in the proper position. The console was redesigned with the top and sides/bottom done separately. In addition to the new structure, the Restore the Link logo was engraved into the top of the console to make it more aesthetically pleasing. During prototyping, the initial RFID reader bought from SparkFun did not scan consistently well, and ended up fatally malfunctioning during testing. It was replaced with a Parallax RFID Card Reader. This component ended up working consistently and efficiently, and scanned the RFID tags in a matter of seconds.

Conclusion

The outcome of the design process was a fully functional prototype that allows the user to be registered, updated, and checked in to the database in a user-friendly way. The design was constructed primarily from software components such as Python and mySQL scripts, as well as several basic hardware components such as a Raspberry Pi and RFID. The design process included a series of steps that took place over approximately 3 months.

The goal of this project was to identify a humanitarian crisis and innovate an engineering solution to help provide relief. The first step was to specify the crisis and problem. Various creative techniques were used such as 180 degree thinking and brainstorming. After some further research, we decided to focus our efforts on a civil crisis and to help people forced into chaos. A mind map was then created and from this, our team chose to develop a solution to reconnect refugees or IDP scattered in various camps.

The next step was to perform the necessary background research. This project required a vast amount of background research to understand the difficulties that refugees face. Millions of people are forcibly displaced from their homes when conflict arises, and thousands are being separated from their families. Our research revealed that there were previous attempts to help reconnect families through the use of a centralized database. However, these solutions were put in place after the crisis had occurred and required a vast amount of manual processing. While these solutions had some success, the centralized database system could have been more effective if the family members had been linked in a central database before the crisis had occurred. This prevention could allow families to find each other more quickly and the mental and physical well-being of the camps would improve. There are other issues with the current solutions explored in our research, including laborious data entry and gaining trust from individuals to photograph them in areas of conflict. Although the current solutions are a step in the right direction, a more powerful and trustworthy system must be put in place that gives the refugee more independence.

The third step was coming up with several design alternatives based on this concept. Individual brainstorming, group brainstorming and concept generation exercises such as 180-degree thinking were conducted. A mind map (Appendix I-A) was generated and seven concepts were identified. These design alternatives were sketched to provide a visual representation of each idea. In the next step, we developed the objectives and constraints as a team. A set of criteria using our objectives and constraints was developed. Using this criteria, a Go/No-Go screening process and a design matrix were used to eliminate design alternatives. The fifth step involved identifying our primary design, which was the “RFID accessory” concept. This concept was then renamed later to “Restore the Link”.

There are two physical devices to this solution: the bracelet and the console. Each bracelet is embedded with an RFID tag. The console is comprised of a case, Raspberry Pi computer and RFID tag reader. In the following step, we determined the exact details of the prototype by discussing the various components such as the aesthetics as well as code planning. Next, the work remaining schedule was developed and the various tasks were divided equally amongst the team members.

The next step involved creating or purchasing the required components. 3D modelling and printing were used to create the physical casing of the console as well as the bracelet. The iteration process was repeated until a functional prototype was created. The majority of the iterations on the original design of Restore the Link were technical iterations. The code planning and the database were iterated several times. These iterations allowed the program to be more efficient and the user interface to be more user-friendly. Iterations on the physical components of the project were also made due to the limitations on the materials and structures that could be 3D printed.

During group and prototyping activities, we attempted to include engineering science into our design in a unique way. Many lessons were learned as a result of several problems that arose during these activities. From a social perspective, getting the team together and meeting at a certain time became an issue. The group did not end up meeting up as much as was required for the collaboration to be efficient, which resulted in some miscommunication and inefficiency during individual work periods. The division of work could have also be handled more dynamically, to allow for a more even workload for each individual. It was helpful for two people to focus on marketability and two to focus on technicality. The overall project and experience could have been further enhanced by having each pair observe the other. Asking people outside the group about the idea and explaining the idea to them was extremely helpful in grasping the full design and identifying issues.

While the prototype was functional, there were many ways to improve the final design. In the final design, the bracelet would be produced using silicone rubber and the case would be produced using polycarbonate, which adhere to all objectives and constraints outlined at the beginning of the project. Improvements to this solution were a solar-powered console piece for an independent power source, fingerprint technology as a backup mechanism to access an individual’s profile, and an automatic change in the language used on the interface based on the user. To improve the interface, a touchscreen could be used rather than a mouse. Registration could be done more rapidly by using accurate speech recognition technology to allow people to sign up themselves. This technology could even go beyond its primary function of reuniting families and be applied to keep track of the number of refugees in a camp. This would be a breakthrough in the management of refugee camps, and would dramatically reduce the probability of overcrowding and the detrimental effects that accompany it.

Restore the Link, as a final product, would directly impact the lives of millions of people worldwide affected by conflict by allowing them to be reunited with their friends and family.

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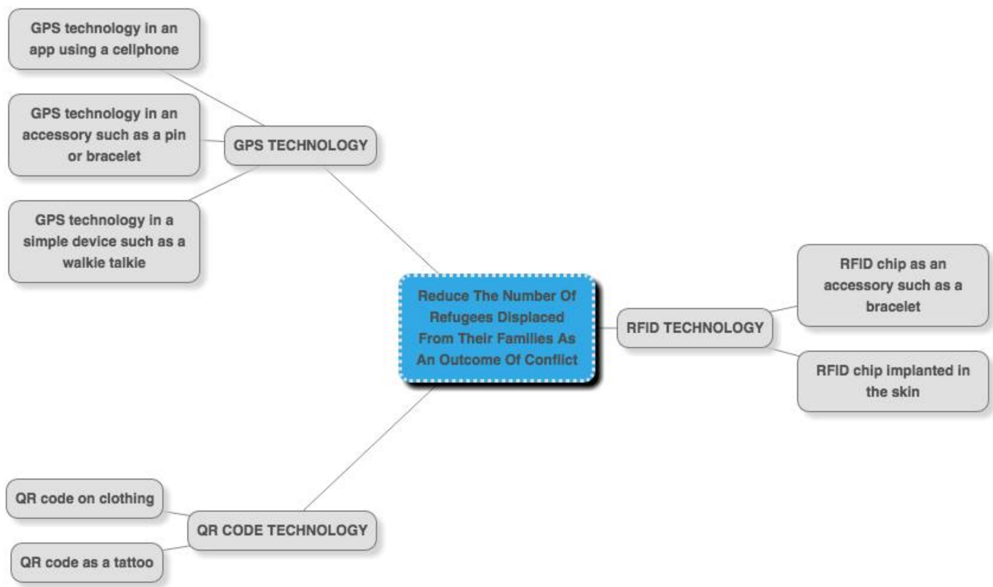
Appendix I - A. Concept Map



Appendix I - B. GO/NO-GO

GO/ NO GO Objectives and Constraints

1. Will the solution appear subtle/ minimal?
2. Will the solution be inexpensive enough to be distributed for mass amounts of people?
3. Will the solution be weatherproof, durable and long lasting?
4. Will the solution compromise (potentially) the safety of the users?
5. Can the product be easily distributed?
6. Is the solution independent of any other device?

GO/ NO GO Concept List

1. GPS technology using a cellphone app
2. GPS technology as an accessory
3. GPS tracking device
4. RFID accessory
5. RFID chip embedded in skin
6. QR code as a tattoo
7. QR code on a piece of clothing

Concept	Objective/ Constraint						
	1	**2**	**3**	**4**	**5**	**6**	**Overall**
1	GO	GO	MAYBE	NO GO	NO GO	NO GO	NO GO
2	NO GO	NO GO	GO	NO GO	MAYBE	GO	NO GO
3	NO GO	NO GO	GO	NO GO	MAYBE	GO	NO GO
4	GO	GO	GO	MAYBE	GO	NO GO	GO
5	GO	NO GO	GO	NO GO	GO	NO GO	NO GO
6	GO	NO GO	GO	MAYBE	GO	NO GO	GO
7	GO	MAYBE	NO GO	MAYBE	GO	NO GO	GO

Appendix I - C. DECISION MATRIX

→ Concepts #4, #6, and #7 were chosen as our final concepts from the GO/ NO GO chart. These concepts are then evaluated using our decision matrix below:

Objectives/ Constraints	1	2	3	4	5	6	Total	Weight	Concepts		
									4	6	7
1	1.00	1.50	0.67	0.50	1.50	1.00	6.17	0.15	1	1	1
2	0.67	1.00	0.67	0.50	0.67	2.00	5.51	0.14	1	-1	0
3	1.50	1.50	1.00	0.67	1.50	2.00	8.17	0.20	1	1	-1
4	2.00	2.00	1.50	1.00	2.00	2.50	11.00	0.27	0	0	0
5	0.67	1.50	0.67	0.50	1.00	1.00	5.34	0.13	1	1	1
6	1.00	0.50	0.50	0.40	1.00	1.00	4.40	0.11	-1	-1	-1
						Totals-->	40.59	1.00	0.51	0.23	-0.03

** Therefore, the most important objective/ constraint is #4: Will the solution compromise (potentially) the safety of the users? and the least important objective/constraint is #6: Is the solution independent of any other device?

**Therefore, the concept that best suits our objectives and constraints is concept #4: the RFID accessory and this becomes our chosen concept.

Appendix II: Cost Breakdown

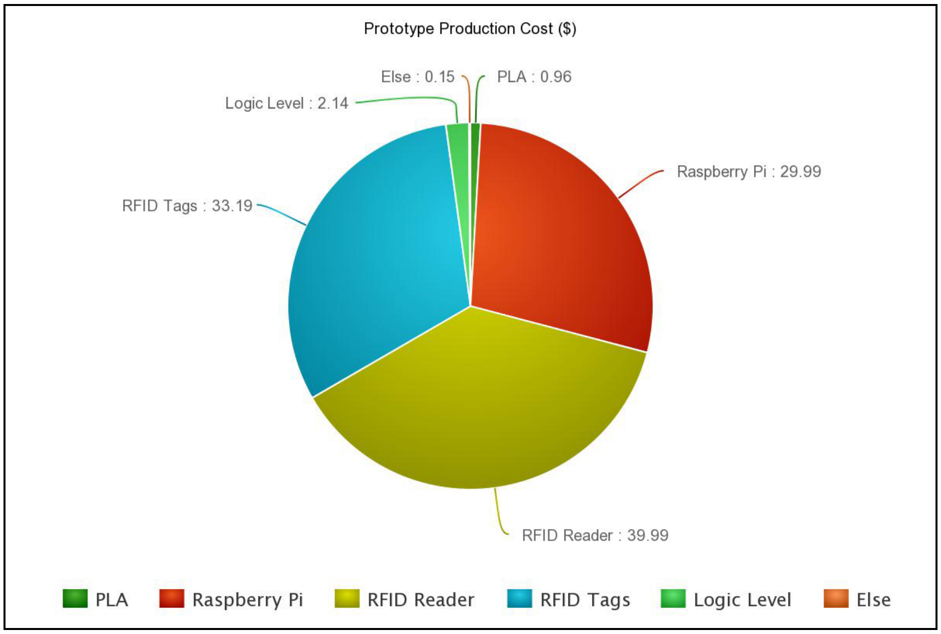
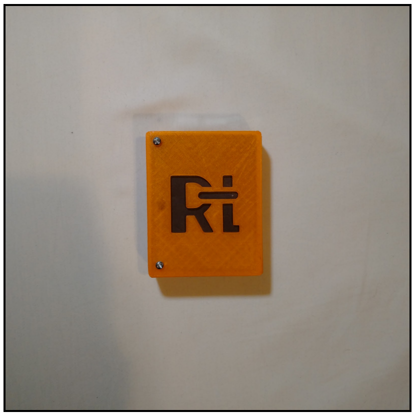
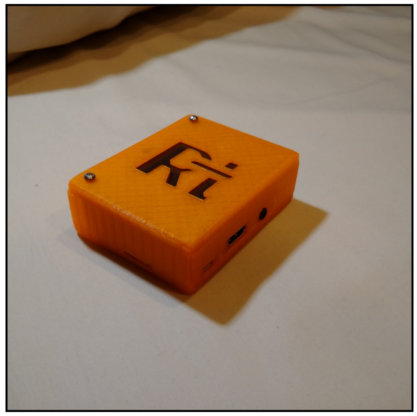


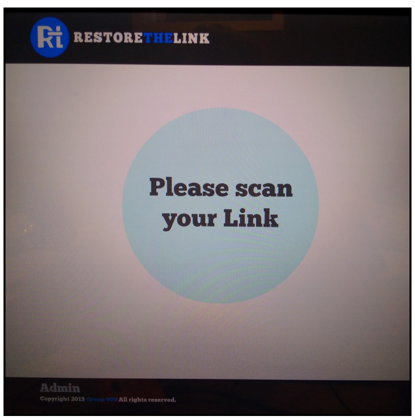
Table 1: Final Parts List and Cost Breakdown

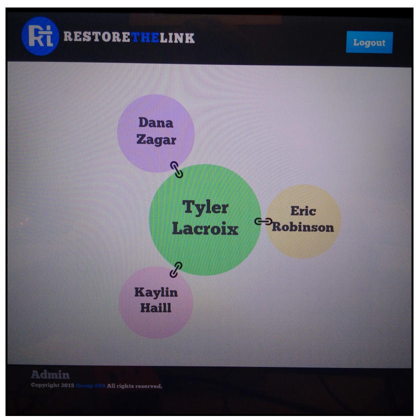
Part	Cost
• 3D Case (28 grams of PLA plastic) • Bracelet (4 grams of PLA plastic) • Raspberry Pi • Parallax Serial RFID Reader • Logic Level Converter • 10x RFID Wristbands • RFID Tags • Wires • Solder • Screws	• $0.84 • $0.12 • $29.99 • $39.99 • $2.14 • $31.80 • $1.39 • $0.10 • $0.05 • Free
Total	$106.42

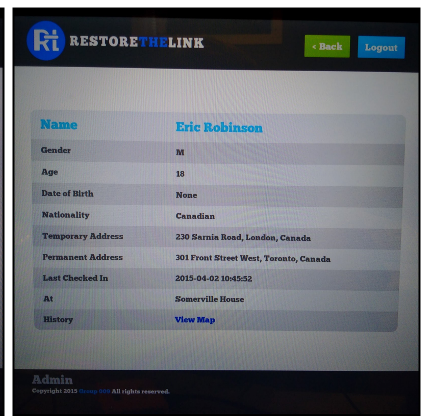
Appendix III: Pictures

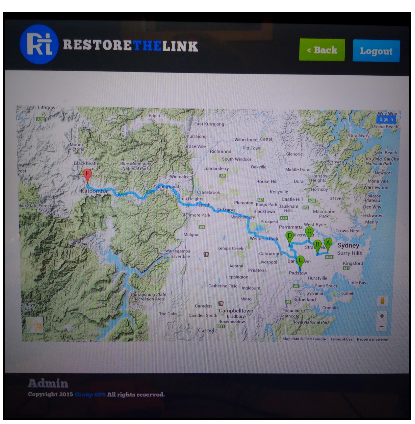


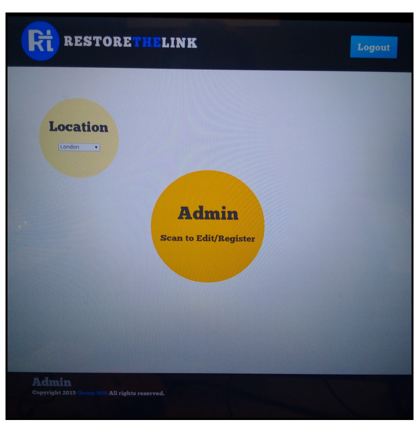


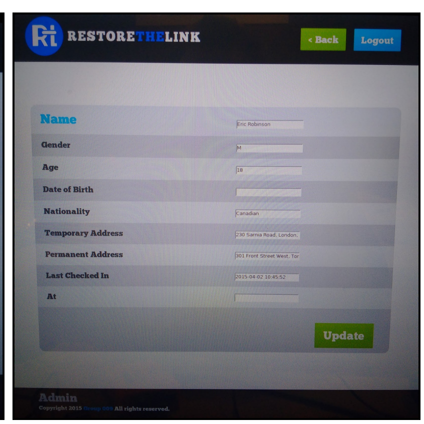












Appendix IV: Initial Drawings

Bracelet - Initial Design

FIgure 5

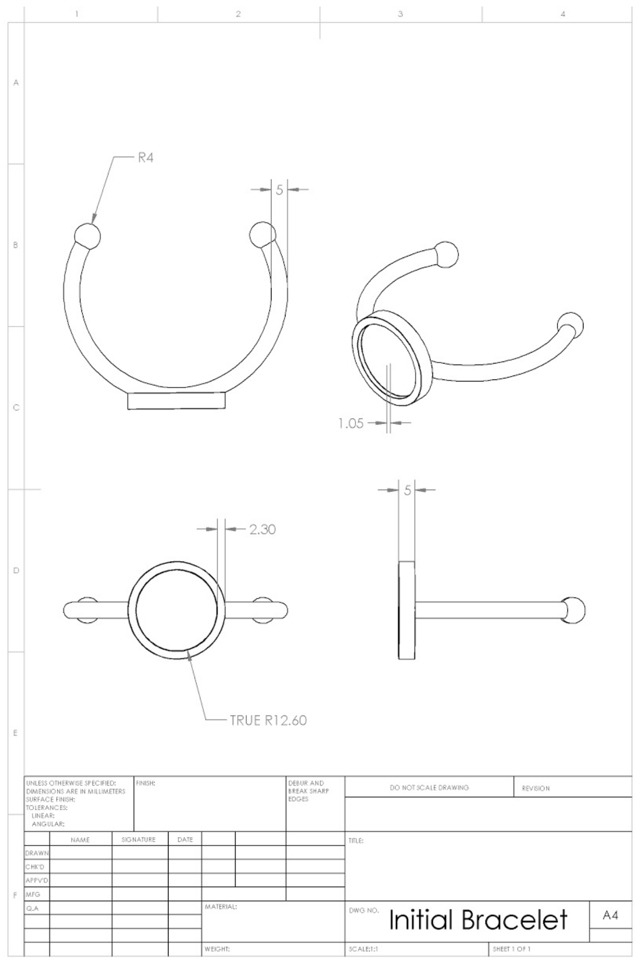
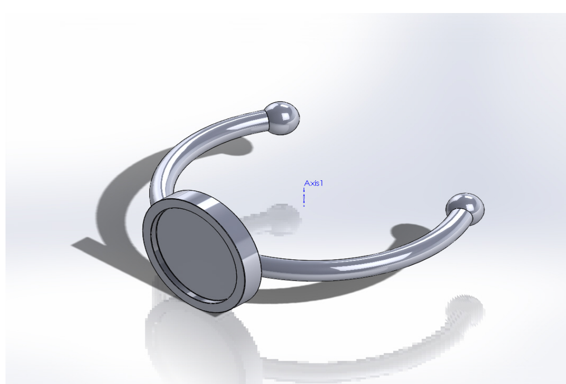


Figure 6



Console - Initial Design

Figure 7

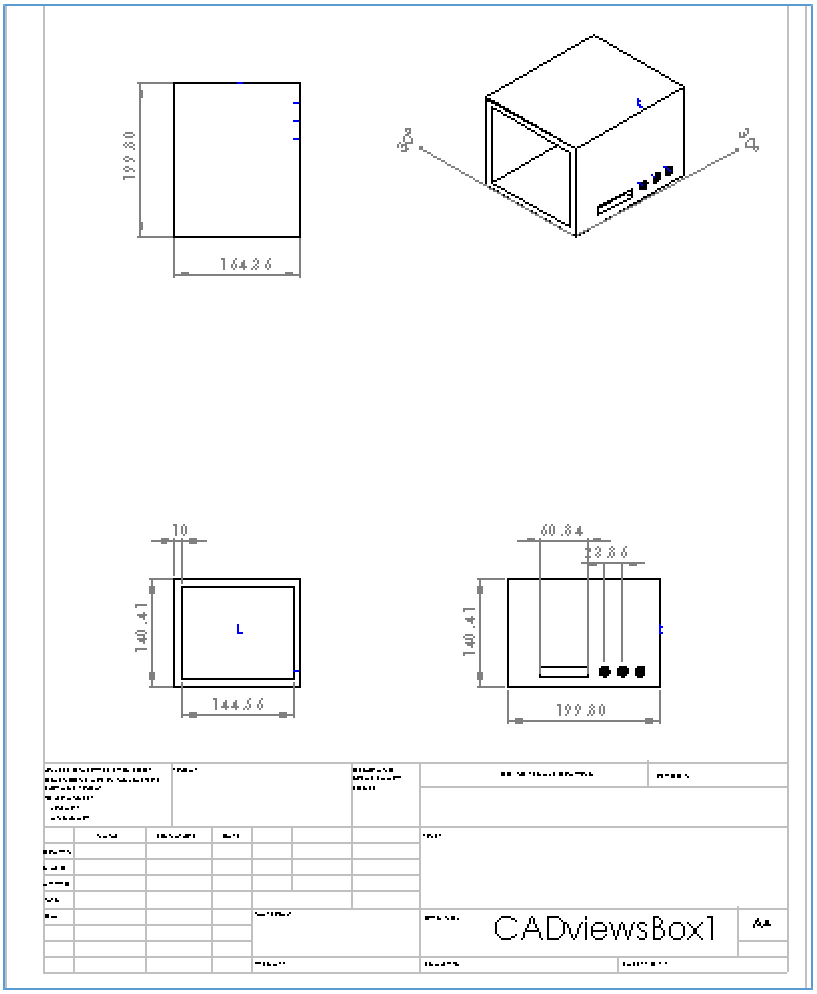
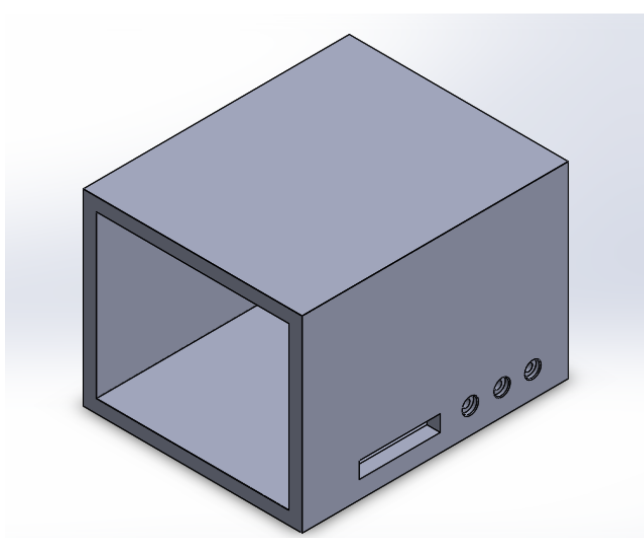


Figure 8



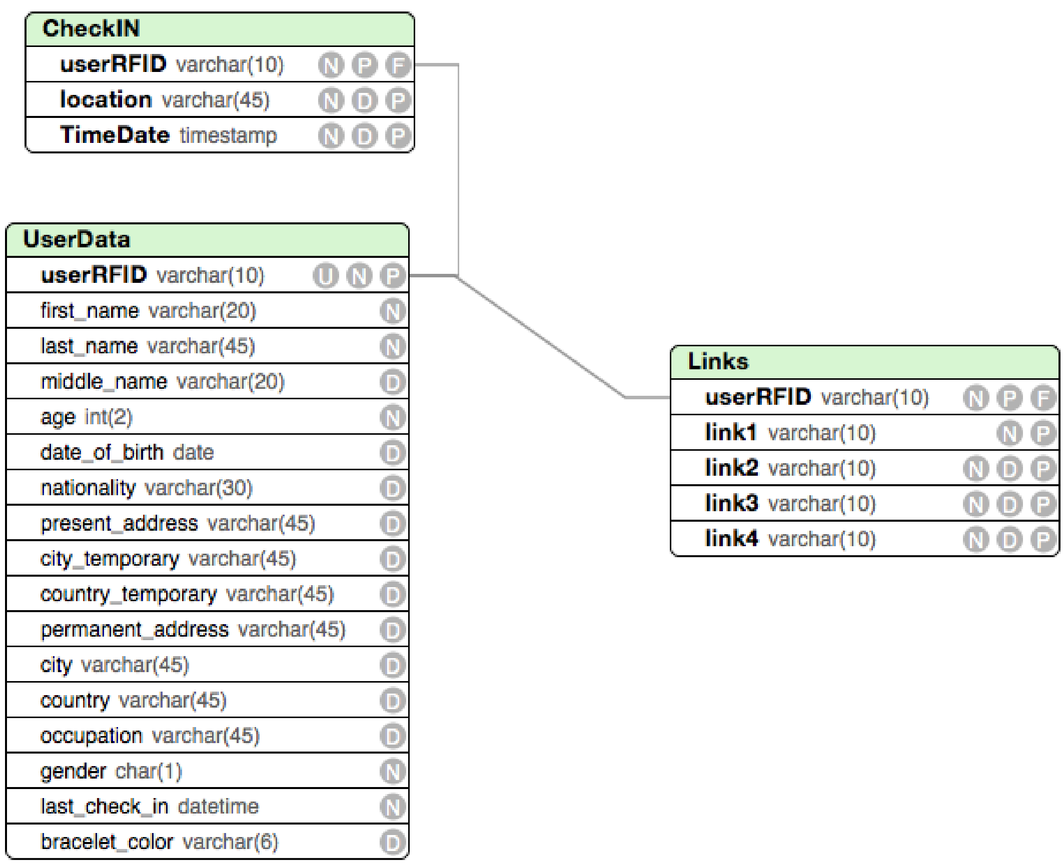
Appendix V: Code

An Open Source GitHub Repository has been created from this project. The code may be viewed at https://github.com/UWO-Group-9/RestoreTheLink.

The breakdown of the languages used is as follows:

Language	Lines of code
HTML	348
CSS	219
Python	144
Javascript	57
Total	**768**

Appendix VI: Database Structure



Appendix VII: Work Request Form

ES1050 WORK REQUEST FORM

TO BE FILLED OUT FOR STORES, UMS AND ELECTRICAL SHOP REQUESTS

GREY INDICATES A REQUIRED FIELD

STUDIO# 05 | TEAM# 9 | DATE: 2015/02/13

TEAM MEMBER NAMES:
Tyler Lacroix
Dane Bazar
Kaylin Hall
Eric Robinson

PROJECT DESCRIPTION: RFID BRACELET + READER, REFUGEE CAMP

CONTACT EMAIL: dbazar@uwo.ca

ALTERNATE EMAIL: tlacroi2@uwo.ca

CONTACT PHONE:

FACULTY ADVISOR: J. SOUTHEN

NATURE OF REQUEST

WORK OR MATERIALS REQUIRED: (PLEASE ALLOW 1 - 2 WEEKS TURN-AROUND FOR SHOP REQUESTS)

10 RFID TAGS, PART # 32397

SPECIAL CONSIDERATIONS - (E.g. WATER, CHEMICAL, PRESSURE, HEAT, ELECTRICITY):

DOCUMENTATION PROVIDED: | CAD FILES PROVIDED:

CONSULTATION DETAILS:

First year design project

ADVICE GIVEN:

BILLING DETAILS

COST OF MATERIALS: | COST OF LABOUR: | TOTAL COST:

STUDENT REMARKS:

SIGNATURE AUTHORIZING WORK TO BE DONE OR MATERIALS PURCHASED (TEAM MEMBER)

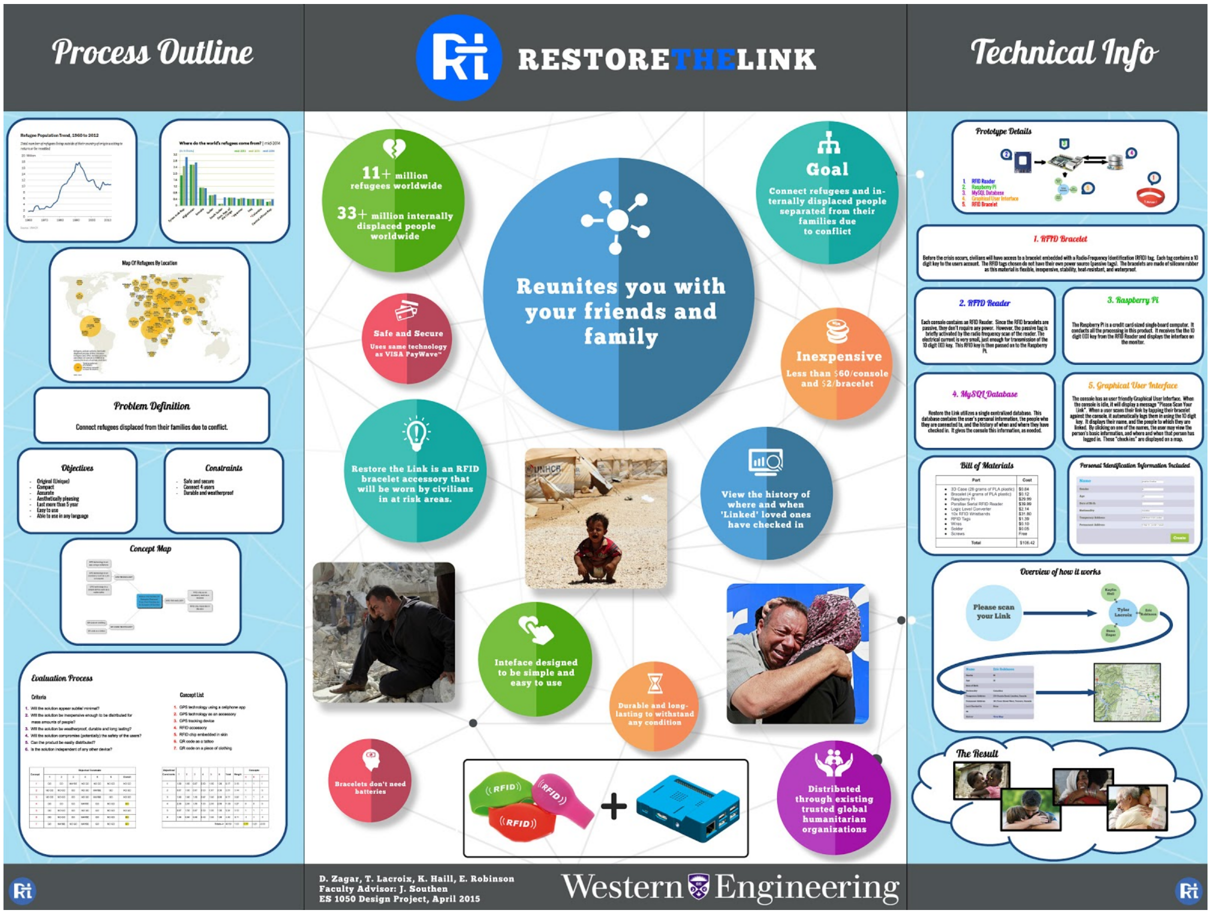
EXPECTED CHANGES FOR NEXT VISIT:

NEXT VISIT DATE: | PARTS REQUIRED BY:

STUDENT FEEDBACK

REMARKS:

Appendix VIII: Poster and Product Specification Sheet



Technical Specifications: Software

Raspbian, a free operating system based on *Debian* (a Linux distribution), was installed on the Raspberry Pi to run the necessary applications listed below.

A local Python web server allows the Graphical User Interface (GUI) to be displayed on the monitor.

The various pages of the interface were programmed in HTML, with CSS for styling. The content is loaded onto the web browser *Chromium* in “Kiosk Mode”.

The microframework *Flask* was used to connect the HTML files to the local Python web server script.

The RFID tags are initially loaded using Python. *JavaScript* was used to establish communication between this Python script and the HTML files.

MySQL, a powerful, free, open-source database application, was used to create the central database. The database was normalized, which resulted in three tables: User Data, Links, and History (time and location of the user's last check-in).

Statistics:

\- -
HTML ----- 348 lines of code
CSS ----- 219 lines of code
Python ----- 144 lines of code
JavaScript ---- 57 lines of code
\- -
Total ----- 768 lines of code

Technical Specifications: Hardware

The *Parallax RFID Tag 25mm 125kHz* contains the 10-digit unique identifier key for each user, placed within each bracelet.

The *Raspberry Pi* is a credit card-sized single board computer, used to connect the hardware listed below to the interface and run the interface.

The *Parallax Series RFID Reader* is the primary input, reading the RFID tags.

The *GPIO (general purpose input/output)* pins of the Raspberry Pi are utilized to connect the RFID reader to the Raspberry Pi.

The GPIO pins of the Raspberry Pi run on 3.3 volts, while the RFID reader runs on 5 volts. A *Bi-Directional Logic Level Converter* enables communication between these two devices by safely stepping down 5 volts to 3.3 volts and stepping up 3.3 volts to 5 volts simultaneously.

To explore the interface, any common USB mouse and keyboard can be used. A keyboard is only required for administrative activities.

The inexpensive *Canakit Raspberry Pi Wi-Fi Adapter* connects the console to the Internet. As a backup, an ethernet connection is also supported on the Raspberry Pi.

An *HDMI-HDMI cable* connects the console to any monitor to output the Graphical User Interface.

To power the console, a *5V Micro-USB Power Source* is required. In the future, the console would ideally use solar power as the primary power source.

Appendix IX: Grade Distribution

Design Team Identification:

Studio Number: __________ Studio Instructor:_________________

Team Number: ___________

The undersigned agree to the following distribution of our Team Grade:

Design Team Member Name (please print): ____________________________
Percentage of Team Member Grade: _________
Signature of Design Team Member: ____________________________

Design Team Member Name (please print): ____________________________
Percentage of Team Member Grade: _________
Signature of Design Team Member: ____________________________

Design Team Member Name (please print): ____________________________
Percentage of Team Member Grade: _________
Signature of Design Team Member: ____________________________

Design Team Member Name (please print): ____________________________
Percentage of Team Member Grade: _________
Signature of Design Team Member: ____________________________

Design Team Member Name (please print): ____________________________
Percentage of Team Member Grade: _________
Signature of Design Team Member: ____________________________

As the Studio Instructor for this team, I approve the Grade Distribution above.

Signature of Studio Instructor: ____________________________