

Homework 12: Ethical and Environmental Impact Analysis

Due: Friday, April 14, at NOON

Team Code Name: RFID Xpress Group No. 10

Team Member Completing This Homework: Jared Suttles

E-mail Address of Report Author: jsuttles @ purdue.edu

NOTE: This is the last in a series of four “professional component” homework assignments, each of which is to be completed by one team member. The completed homework will count for 10% of the team member’s individual grade. It should be a minimum of five printed pages.

Evaluation:

Component/Criterion	Score	Multiplier	Points
Introduction and Summary	0 1 2 3 4 5 6 7 8 9 10	X 1	
Ethical Impact Analysis	0 1 2 3 4 5 6 7 8 9 10	X 3	
Environmental Impact Analysis	0 1 2 3 4 5 6 7 8 9 10	X 3	
List of References	0 1 2 3 4 5 6 7 8 9 10	X 2	
Technical Writing Style	0 1 2 3 4 5 6 7 8 9 10	X 1	
TOTAL			

Comments:

1.0 Introduction

The RFID Xpress system is a state-of-the-art product that utilizes RFID technology in order to add convenience and functionality to the retail shopping experience. The aim of the product is two-fold. First, it will be a replacement for the soon-to-be obsolete UPC standard. Second, it will provide a convenient self-checkout system for users, where their account information can be validated with an external database using a keyfob and a PIN number. Although the RFID Xpress system will present no threats to a customer's physical safety, numerous ethical and environmental factors need to be considered. There are also more factors that inherently arise from using a self-checkout system because of the lack of user supervision. All of these considerations will be discussed in the pages that follow.

2.0 Ethical Impact Analysis

The development of RFID Xpress has presented many interesting ethical questions. RFID technology as a whole is under fire from many sources because of privacy issues, as well as some more radical religious beliefs. Because RFID Xpress aims to bring this technology into all types of retail shopping locations, it will legitimately become a daily occurrence to interact with the technology, which means that these concerns must be considered with the utmost importance. There are also ethical issues that must be considered due to the possibility of identity theft and abuse of the self-checkout concept. As a system that allows users access to their store accounts without direct supervision, identity verification is integral to the security of customers' personal information.

2.1 RFID Privacy Considerations

Recently, RFID technology has taken on many negative connotations. It is being compared to "Big Brother" control [1], and in some radical religious circles, it is being referred to as the so called "mark of the beast [2]." Though commercial applications are not the main concern of these fears, privacy is still a huge issue. On a small scale, RFID technology can be used to identify specific items at a very short range by reading a unique serial number embedded in a small integrated circuit. On a larger scale, it can be used to track entire shipments of products around the United States and the world. This has major implications for privacy concerns in the coming years.

In theory, any RFID tag can be read from a reasonably long distance if the tag and the reader are compatible and powerful enough. This was considered when designing RFID Xpress, and it was determined to be a significant problem. First, an individual could effectively scan another's shopping cart and receive the serial numbers of all of the tags in the cart at that moment. This was only of minimal concern to us, since the serial number is unique to every individual item. Hence, without access to the main database, the serial number would be useless in determining any information about the products. However, it is a possibility that a person could place incorrect RFID tags on products or in other people's carts to trick the RFID Xpress into thinking that a product was a different item. Some solutions on the market today use either video or weight matching technology to make sure that the item being scanned corresponds to the RFID on it.

Because the tags are unique to each item, maintaining an inventory count is unnecessary, and the serial number may just be removed from the database once it is purchased. To prevent the possibility of items being unknowingly scanned after purchase, a solution was considered that involved adding a large magnetic pad to our design. This pad would be used to destroy the RFID circuit after the purchase was made. For this version of RFID Xpress, no video or weight verification is being done, nor are the tags being destroyed post-purchase, but they are all considerations for further iterations of the RFID Xpress system.

Another situation that is a very high risk to customers is the fact that by the same logic above, a malicious person could somewhat easily attain the unique serial number on a given keyfob used to identify a customer. This is a rather serious concern in this iteration, since a 4-digit PIN number is not unreasonable to guess or even just watch and record. If, however, the keyfob were coupled with some other, more secure, verification system, such as biometric scanning, then the likelihood of this occurring would decrease significantly.

There are also two oddities with the RFID Xpress system that will require user understanding, and thus documentation and warning stickers will be used to ensure that the users don't place the unit or themselves in danger. First, the 12 volt power supply will be fed to the thermal printer via an unused pin of the RS232 port. Hence, should a user attempt to connect a new printer to the port, they may encounter a situation where they are feeding 12 V into an inappropriate connection. A warning label will be placed near the port to remind them that it is a proprietary connection. Another connection that requires a warning label is the RJ45 Ethernet

connection. This first version of the RFID Xpress system uses a proprietary CAT5 Ethernet cable. This is due to a small mistake made in the PCB design. This will be corrected in further iterations, but for now, a warning label will alert the users not to use a standard or cross-over Ethernet cable in order to avoid malfunctions in the Ethernet communication.

3.0 Environmental Impact Analysis

The development of RFID Xpress has also brought about a few considerable environmental concerns. In the manufacturing stage, many environmentally sensitive procedures are used to produce the system. Energy usage was a concern during the normal operation of the system. Finally, the disposal of RFID tags has raised a great deal of concern in the United States as well as the world. The disposal of the RFID Xpress system may also pose some environmental challenges.

3.1 Manufacturing Considerations

RFID Xpress consists of an LCD, Keypad, RFID Reader, Thermal Printer, and a PCB mainboard. Not only is the mainboard a PCB, but there are also PCBs in all of the other components. PCB fabrication involves many steps that produce hazardous byproducts, and these materials must be handled and disposed of carefully [3]. Though the RFID Xpress design team is not directly responsible for PCB fabrication, it is important to select a reputable and environmentally friendly fabrication company to manufacture the printed circuit boards. RFID Xpress was designed to minimize PCB board size, which will help to reduce the amount of industrial waste generated during the manufacturing process. Surface mount parts were used in almost every possible location, and the PCB was redesigned multiple times to compact the placement of the parts and to minimize the trace lengths.

3.2 Normal Operation Considerations

During the normal operation of the RFID Xpress, there are no major environmental issues to consider. Of course, the system aims to conserve energy as much as possible. Hence, it uses a minimal supply voltage that can power the entire system. The system also disables all unused functionality in order to conserve energy.

Another slight concern during normal operation is customer exposure to radio frequency radiation. The RFID reader, though rather weak, is still a considerable source of radiation. The design uses passive RFID tags, which means that the power to transmit the tags serial number is provided by the radio frequency radiation coming from the reader. There has been much discussion and research done to determine the long term effects of RF exposure, and the basic consensus is that while RF radiation is inherently capable of causing damage to human and animal body tissue, the levels of radiation being produced by most products are nominal enough to be considered safe [4]. The level of RF radiation emitted from a typical RFID tag is well below that of a typical cellular phone, and can hence be assumed to be as safe, if not safer than that technology, which has been thoroughly shown to be harmless to humans [5].

3.3 Recycling and Disposal

There are two cases to consider for recycling and disposal of the RFID Xpress system. The first and perhaps easiest to handle is the disposal of the actual system itself. When a retail store decides to upgrade to a newer system, or in the unlikely event that a failure causes the company to replace the product, average disposal methods for e-waste should be sufficient to ensure the safety of the environment. Due to the lead and mercury that can be present in the PCB, solder, and certain components of the current design, the main board and components on it must be disposed at special facilities [6]. A sticker will be placed inside the packaging, as well as on the main board, suggesting that the owner recycle the PCB with a reputable company. The provided documentation will also suggest the recycling of the PCB, as well as everything else in the system, with reputable companies.

The second case to consider is the disposal of the RFID tags themselves. An RFID tag is simply a small electronic circuit that is powered through RF radiation. The problem that this poses is that the metal in the circuit can cause damage and contamination in existing recycling systems for plastic, glass, and other products [7]. The current standard tags (UPC labels) are completely harmless, but RFID tags being attached to every product in a super market will cause significant issues to these existing recycling establishments. On the positive side though, the system is designed to use passive RFID tags. Since passive tags don't actually contain batteries, they can be disposed of in standard landfills and using standard procedures. Conversely, should

active RFID tags ever be implemented, they do contain small batteries that must be disposed of properly.

4.0 Summary

The RFID Xpress system presents many ethical and environmental concerns. Due to the nature of RFID technology, the convenience can potentially be offset by the potential loss of privacy. There are also a few proprietary connectors that could easily be mistaken for their standard partners, and hence appropriate warning labels and documentation will be provided to avoid problems. As with most electronic devices, there are significant environmental concerns brought about by the manufacture and disposal of components. RFID tags themselves can also cause many complications with existing recycling and waste disposal systems. All of these concerns have been taken into account when designing the RFID Xpress system, and have been handled to the best degree possible.

List of References

- [1] RFID Journal, Mark Roberti (Editor), “*Big Brother's Enemy*”, July 21, 2003, <http://www.rfidjournal.com/article/articleview/509/1/1/>.
- [2] Wired News, Mark Beard, “*RFID: Sign of the (End) Times?*”, Mar 02, 2006, <http://www.wired.com/news/technology/0,70308-0.html>.
- [3] Virginia Waste Minimization Program, Vol. 1 Issue 9, “*Fact Sheet: Printed Circuit Board Manufacturers*”, Oct 24, 1995, <http://es.epa.gov/techinfo/facts/vdwm/va-fs6.html>.
- [4] FCC, Office of Engineering and Technology, “*Radio Frequency Safety FAQs*”, Jan 09, 2006, <http://www.fcc.gov/oet/rfsafety/rf-faqs.html>.
- [5] Cisco Systems, “*Wireless Systems and RF Safety Issues*”, 2005, http://www.cisco.com/en/US/products/hw/wireless/ps4570/products_white_paper09186a0080088791.shtml
- [6] Joint Service Pollution Prevention Opportunity Handbook, “*Printer Circuit Board Recycling*”, May 2003, http://p2library.nfesc.navy.mil/P2_Opportunity_Handbook/2_II_8.html
- [7] Tutorial-Reports.com, “*Impact of RFID Tags on Recycling*”, <http://www.tutorial-reports.com/wireless/rfid/environment/recycling.php?PHPSESSID=958c9a20c3affc755e9e1a12f2550aa9>
- [8] Association for Automatic Identification and Mobility, “*eWaste: Environmental & Recycling Issues*”, Sep 28, 2005, http://www.autoid.org/metatraffic2/track.asp?mtr=/presentations/2005/eWaste_REG_Frontline_20050928.ppt (Specifically Slide 26)