QUEUEADMIN: THE EFFECTS OF AN ADVANCE QUEUE MANAGEMENT

SYSTEM ON BARBERSHOP ADMINISTRATION

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Kinnis K. Gosha

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VITA

Kinnis Gosha is the son of Judy Gosha. He was born on November 10, 1982, in Phenix City, Alabama. He graduated from Central High School in Phenix City. Kinnis entered Albany State University immediately following his high school graduation and received a Bachelor of Science in Computer Science in May 2005. That following fall Kinnis entered Auburn University. He is currently working diligently to meet the requirements of a Masters of Science in Computer Science at Auburn University.

THESIS ABSTRACT

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Queue Management has been a problem for many years in many domains including the Financial, Health Care, Public and Retail Sectors. In this age of technology it is not only important to organize the existing queue, but to gather statistics about the queue in order to identify trends that could be anticipated. For many barbershops, these needs are not addressed in a sophisticated manner. This study will suggest that a Queue Management System such as QueueAdmin will improve the satisfaction of a shop's customers as well as their barbers.

The tool used in this study, QueueAdmin, is a database driven, online application to manage the different waiting list of a barbershop. In order to provide better functionality and to maximize use of all the information collected, QueueAdmin has three interfaces: the Administrative interface, the Employee interface and the Customer interface. Instead of limited these interfaces with standard keyboard input, they will

multi-modal using touch screen technology as well as wireless web interface for use with cell phones and Personal Digital Assistants (PDAs). This makes it a robust solution to an existing practical problem.

ACKNOWLEDGEMENTS

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1. INTRODUCTION

Dr. David Maister, author and former Harvard professor, is one of the world's leading authorities on business management. In a 2006 blog, on his website DavidMaister.com, Maister discussed an article he wrote over twenty years ago entitled, "The Psychology of Waiting Lines." In this article, he gave eight propositions about how people experience waiting and what businesses can do to make a wait feel less onerous. The proposition that this paper focuses on is: Uncertain Waits Are Longer than Known, Finite Waits. Maister states that, "Clients who arrive early for an appointment will sit contentedly until the scheduled time, even if this is a significant amount of time in an absolute sense (say, thirty minutes). However, once the appointment time is passed, even a short wait of, say, ten minutes, grows increasingly annoying. The wait until the appointed time is finite; waiting beyond the point has no knowable limit"[1].

An Auburn University Associate Professor observed this proposition while waiting to get his weekly haircut at his local barbershop. This revelation was the inspiration for the design of the Advance Queue Management tool named, QueueAdmin. QueueAdmin is a web-based, queue management tool that allows customers to enter themselves in a queue and barbers to update the queue as customers finish having their hair styled. In order to complete this task, QueueAdmin uses a relational database management system (RDBMS) and powerful server-side scripting language. This gives customers insight on where their positions in the queue are and an estimate on how long

it will take for them to reach the top of the queue. In addition to assisting customers, QueueAdmin also improves the performance of the barbers and managers. The barbers will be able to focus on styling the customer's hair instead of keeping track of who entered the shop first. Managers will be able to view statistical data about different customer trends. This will assist management in knowing how to staff personnel for peak and non-peak times.

The hypothesis was: through the implementation of QueueAdmin at this local barbershop, customer satisfaction, barber satisfaction and the barber performance would increase. Customers who participated in the study were first given an information sheet describing the study. Next, they were asked to create an account and add themselves to the waiting list. Then, those who chose to do so checked the status of the waiting list as they waited. After the customers were called to the barber's chair and received their haircut, they were asked to complete a survey which asked about their experience. The findings of the study consisted only of the results from the survey.

The rest of this thesis is organized as follows: Chapter 2 consists of a literature review, which discusses queues, queueing theory, queueing models, queue areas, queue management systems and the psychology behind waiting lists. A definition of the research problem along with a synopsis of the literature review is presented in Chapter 3. The experiment details and analysis are included in Chapter 4. Chapter 5 houses future works and conclusions.

2. LITERATURE REVIEW

2.1 QUEUES

A queue can be defined in several ways. One definition of a queue is, “A collection of items in which only the earliest added item may be accessed. Basic operations are add (to the tail) or enqueue and delete (from the head) or dequeue. Delete returns the item removed. This is also known as "first-in, first-out" or FIFO” [2]. This type of queue is a buffer abstract data structure. Another meaning of queue is, “a line of people or vehicles waiting for something” [3]. Both definitions are relevant to this thesis and will be explained in this review.

With the data structure meaning of queue, the most well known operation of the queue is the First-In-First-Out (FIFO) queue process. In a FIFO queue, the first element in the queue will be the first one out; this is equivalent to the requirement that whenever an element is added, all elements that were added before have to be removed before the new element can be invoked. Unless otherwise specified, the remainder of the article will refer to FIFO queues [4].

The other definition of queue, concerning a line of people or vehicles, will be explained in future details in section 2.2 entitled “Queue Area.” For now, think of a queue (figure 2.1) as a waiting line at a barbershop or the Department of Motor Vehicles.

2.1.1 QUEUEING THEORY

Wikipedia defines queueing theory as, ". . . the mathematical study of waiting lines (or queues)" [5]. These theories allows for the mathematical analysis of several related processes, including entering the queue, waiting in the queue and exiting the queue. Wikipedia continues to state that, "The theory permits the derivation and calculation of several performance measures including the average waiting time in the queue or the system, the expected number waiting or receiving service and the probability of encountering the system in certain states, such as empty, full, having an available server or having to wait a certain time to be served" [5]. This mathematic approach is appropriate in certain situations. Unfortunately, mathematics alone fails to model all real-world situations exactly. This restriction arises because the underlying assumptions of the theory do not always hold in the real world [5]. For example, mathematical models often assume an infinite queue capacity or no bounds on inter-arrival times, when it is quite apparent that these bounds must exist in reality. On the other hand, many times bounds to these models may exist and they can safely be ignored because the differences between the real-world and theory are not statistically significant. In response to those situations where the differences are statistically significant, alternative means have been devised. These means are often scenario-specific and may consist of computer simulations and/or experimental data [5].

Three types of queues are widely used involving queue theory. They include First In First Out, Last In First Out and Processor Sharing. In First In First Out, the item in the queue that has been in the queue the longest would be the first to be removed from the

queue. In First In Last Out, the item in the queue for the shortest amount of time would be the first to exit the queue. The Processor Sharing discipline serves all the items in the queue equally [5]. The theory used in this thesis will be explained further in section 2.1.2 Queueing Models.

2.1.2 QUEUEING MODELS

"In queueing theory, a queueing model is used to approximate a real queueing situation or system, so the queueing behavior can be analyzed mathematically. Queueing models allow a number of useful steady state performance measures to be determined, including: the average number in the queue, or the system, the average time spent in the queue, or the system, the statistical distribution of those numbers or times, the probability the queue is full, or empty, and the probability of finding the system in a particular state. These performance measures are important as issues or problems caused by queueing situations are often related to customer dissatisfaction with service or may be the root cause of economic losses in a business. Analysis of the relevant queueing models allows the cause of queueing issues to be identified and the impact of any changes that might be wanted to be assessed" [6].

"Queueing models are generally constructed to represent the steady state of a queueing system, that is, the typical, long run or average state of the system" [6]. In order to construct these models several steps must be taken depending on the nature of the system. They include identifying the parameters of the system, identifying the system states, and drawing a state transition diagram showing the probability of each state [6].

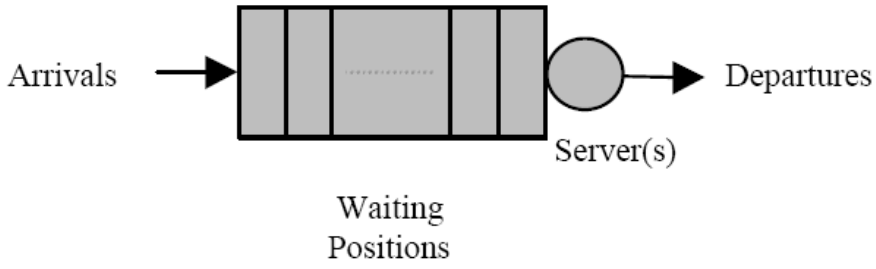

Figure 2.1 – Model of a Queue (Copyright 2002, Sanjay K. Bose)

There are three categories for these types of models based on the number of servers: single server queues, multiple server queues and infinite server queues. The first, single server queues, are very popular and are used in many facets including, business, industry, transport, telecommunications and computing. These are models where there is one server per queue and an item in the queue may have multiple queues to enter [6]. An example of this is a customer at a supermarket choosing between different registers.

The next are multiple server queues. These queues consist of two or more servers that are identical in serving a single queue of customers [6]. It may be unclear exactly what "identical" means. Using the supermarket example from the previous paragraph, the customer would have multiple servers (cash registers) but this would not be a multiple server queue because the servers are not identical. For example, some of the cashiers may be slower than others or certain lines may be longer than others.

"One observational insight provided by comparing queueing models is that a single queue with multiple servers performs better than each server having their own

queue and that a single large pool of servers performs better than two or more smaller pools, even though there are the same total number of servers in the system" [6].

Infinite Server queues make up the third and last category. "These are mostly used as a convenient theoretical model for situations that involve storage or delay, such as parking lots, warehouses and even atomic transitions. In these models there is no queue, as such, instead each arriving customer receives service "[6].

In this thesis, a mathematical model is used to show how customers arrive in the queue, wait in the queue and exit the queue. The discipline that our model uses is "First In First Out." This means that the customer who has waited the longest in line will be the next in line for an individual barber [6]. "First In Last Out" would not be logical because it would penalize customers for being early. Processor Sharing would not be possible in our domain because a barber usually accepts one customer at a time.

Our model does not show the capacity of the queue or the length of the wait list. The inter-arrival times for the queue are also left out of the model. In this domain, the hours of operation represent the window for entering the queue. Customers can only add themselves to the waiting list while the shop is open. The term of the wait inside the queue can not exceed the length in time that the shop is open. For example, a customer can not wait in line 10 hours if the shop is only open for 8 hours. The maximum number of customers that can wait in the queue is unknown. If someone wants to add himself to the waiting list and there is no seating available inside the shop, the customer is not required to sit in the shop and can find seating elsewhere. In a case where the time required to finish the customers haircut exceeds the shop's hours of operation, the barber

can (and probably would) extend the hours to seat all or some of the excess customers. Nevertheless, these situations are highly unlikely to exist.

In the case of server types, this study will be based on a single server queue. This classification was made because the servers, or barbers, are not identical. All barbers may cut hair, however they may not cut hair at the same rate or cut hair the same way. If barbers were truly identical, no customer would ever have a preference for a particular barber.

2.2 QUEUE AREAS

"Queue areas are places in which people in line (first-come, first-served) wait for goods or services" [7]. An example of a queue area would be the waiting room at a doctor's office or the ticket line at the movies. The two are similar, but have distinct differences that will be discussed in this section.

The main difference in the two examples is the types of queues. The bank example shows a physical queue while the doctor's office is an example of a virtual queue. Physical queues areas are formalized waiting areas where there is a physical line of customers waiting for one or more servers [7]. In the bank example, the area usually consists of a pattern of ropes to form a single line to see one of the bank tellers. The other type of queue area is the virtual queue. The virtual queue is a formalized waiting area in which customers are not required to arrange themselves in the physical order of the queue [7]. In the waiting room example customers are free to sit anywhere in the waiting room once they have signed in. Virtual queues are generally preferred over physical queues.

Maister states that, “occupied time feels shorter than unoccupied time” [8]. With waiting areas, customers are able to sit and read magazines, watch television or play with toys.

Queueing can be a boring, stress-filled and time consuming activity. Long waits usually make customers more likely to get really upset if they feel like there has been a breach in the queue. This could happen in the event that a customer allows another customer to enter the queue in front of them instead of at the bottom of the queue (or end of the line). This is known as “cutting line” [7]. In this situation, both the person already in line and the person attempting to enter the line need individual service. Another breach is the same as “cutting line,” but the person entering the queue is not in need of a separate server. An example of this would be a husband allowing a wife to join him in line at the supermarket and they both would only have one group of items. Depending on the situation, region or individuals involved, different people may allow for different breaches to a queue.

In the following study, the queue at a barbershop is traditionally a virtual queue. Customers sit in a waiting area and are entertained by newspapers, magazines, television or just good conversation. In the barbershop domain, the ethics concerning the queue is that customers should not allow other customers to add themselves to anywhere except to the end of the queue. Traditionally, this becomes difficult to monitor if customers are allowed to leave out of the waiting area.

2.3 QUEUE MANAGEMENT SYSTEMS

Every domain has a method of handling queues. This method is called Queue Management [9]. However, some domains need more sophisticated systems for managing

queues. These situations require Queue Management Systems (Q.M.S). Queue Management Systems can be reactive or proactive. Reactive systems just organize the existing queue. Proactive systems consist of a "queue management statistics gathering system, so that trends can be identified and anticipated" [9].

"Queue Management Systems work by streamlining front-end operations into centralized contact points, enabling managers to monitor and set performance thresholds" [9]. In a barbershop, the centralized contact points are when the customer adds himself to the queue, when the customer is called by the barber to the barber chair, and when the customer is finished with his haircut.

These systems can also provide solutions for both types of waiting environments, physical waiting areas and virtual waiting areas. Both client requirements and queueing environments are an essential part of designing the most cost-effective queueing solution. This determines how the system will be used on a daily basis to maximize efficiency and organize queues [9].

QueueAdmin is a proactive Queue Management System used in this thesis. Important statistical information is captured and stored in QueueAdmin's database. Every time a customer passes any of the three centralized contact points, a record is added to the database of QueueAdmin containing a timestamp of the time the point was breached.

3. PROBLEM STATEMENT

From the checkout line at the supermarket to the stop light during a morning commute, waiting in line is an everyday part of life. Some waits can be harmless like in a line to purchase chips from the snack machine. Others waits can mean the difference between life and death like being on a waiting list for the donation of a vital organ. At times, waiting is not only irritating, but can be dangerous. Just recently, the problem with waiting in lines took center stage when several incidents were reported where consumers where stabbed, robbed, beaten, trampled and shot partially due to long lines for the debut of Sony's Playstation III Game Console [10].

Although not widely publicized, the wait at the local barbershop can be stressful as well. The traditional system of keeping a mental wait has it flaws. These flaws where observed by Auburn University Associate Professor referred to in this paper as Doc. Part of Doc's weekly routine included his Saturday morning haircut at his local barbershop (referred to in this thesis as Neighborhood Barbershop) in Auburn, Alabama. During his time in the barber chair he was able to notice many problems that owner, let's call him John, was having managing his waiting list.

The first problem was that customers would sometimes leave the barbershop after noticing how many people were in line when they arrived at the shop. Customers would usually assume the possible wait time for themselves without knowing which individuals

seated were actually customers. The second problem was that customers could not estimate their wait times because they did not know the barber preference or the service needed of those customers who were already seated in the shop. Some barbers had longer waits than others do the distribution of customers and the services they desired. The third problem occurred when a customer left the shop momentarily and another customer entered the shop while they were gone. The later customer would assume that the earlier customer is after them in the waiting list. This would cause an irritable confrontation depending on the individuals involved. The forth problem arose because barbers served as the judges of who was next in line. This forced the barber's attention away from grooming customers to monitoring the line of people waiting and handling disputes. John felt that the more focused the barber was on the customer he was attending to, the better quality the customers haircut would be. He also felt that the time to administer the cut would be reduced as well. The last problem was in the domain of administration. John needed assistance in making decisions that would shorten the wait times of the customers of his shop. What John lacked was statistical data that showed patterns in wait times from customers who patronized his shop. This information would also help him choose more cost-efficient ways of scheduling barbers and the overall hours of operation for the barbershop.

Because of Doc's immense experience in Human Centered Computing and database systems, it was evident to him that John needed an electronic Queue Management System to solve his current dilemma. Doc knew the technology, as well as the logic, that would be needed in order to build a customized tool. The Queue

Management System that would be created to solve these problems would be known as QueueAdmin.

4. EXPERIMENT AND ANALISYS

4.1 INTRODUCTION

The primary objective of this study is to analyze customers and barbers reactions to an electronic queue management system for use in a barbershop setting. In order to explore this objective a tool named QueueAdmin was created. QueueAdmin's primary function was to manage the waiting list for both customers and barbers. With the use of QueueAdmin, this study set out to successfully show that an electronic queue management system would increase the grooming experience for customers and barbers alike.

4.2 DEVELOPMENT OF QUEUEADMIN

The inspiration behind the development of QueueAdmin came about during an epiphany that Doc had during one of his weekly haircuts at Precision Cuts. After discussing the problems that store owner, John, was having he began to identify initial requirements for the system. The tool had to address the five problems mentioned earlier in Section 3. The first three problems were based off the lack of information customers had about who was in line, which barber they preferred and what services they sought. QueueAdmin solved these problems by adding two functions to the homepage (figure 4.1) of the tool. The first option allows the customer to view the current roster of

everyone who is on the waiting list (figure 4.2). Next to each person's name or nickname is the name of the barber that they prefer. Those customers who wanted the first available barber would show a status of "No Preference." This roster of customers is ordered from the person that has been in line the longest amount of time, to the customers who has been in line the shortest amount of time. This gives the customer all of this information with one touch of the screen or click of the mouse.

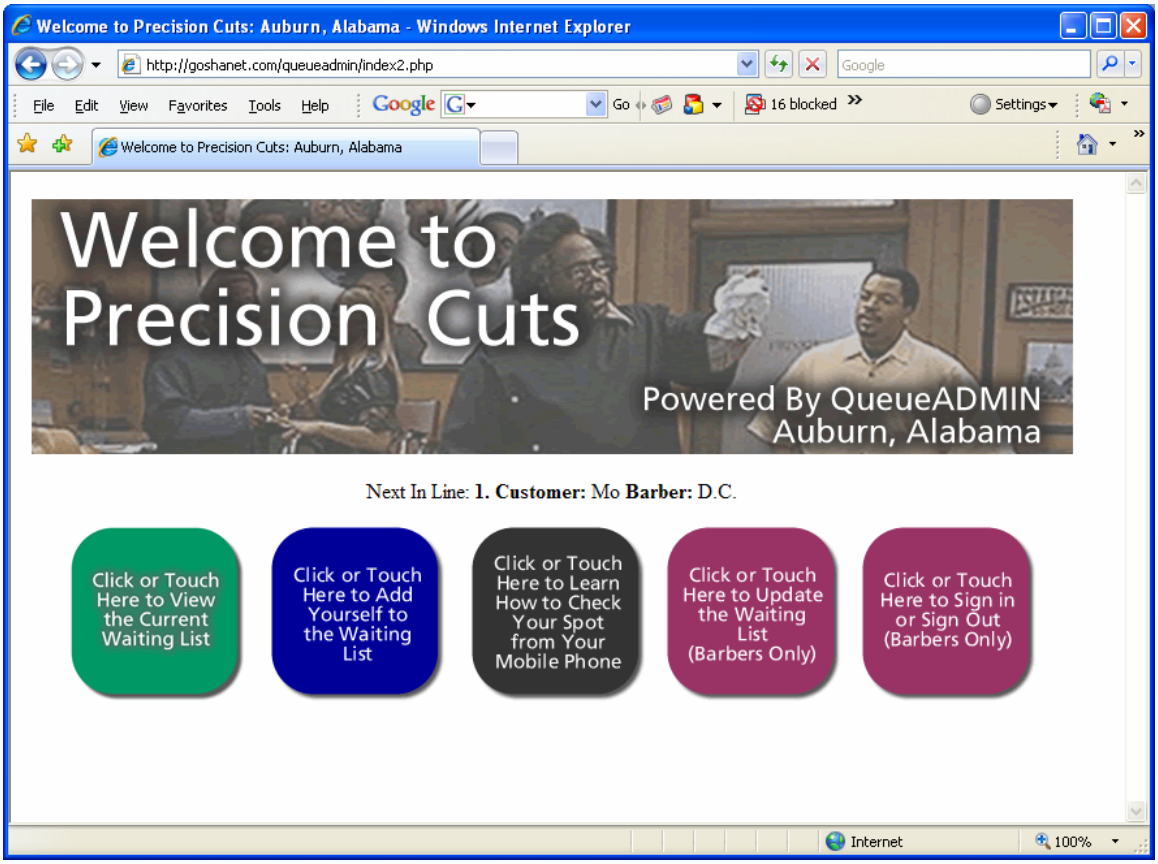

Figure 4.1 – Screenshot of the homepage of QueueAdmin

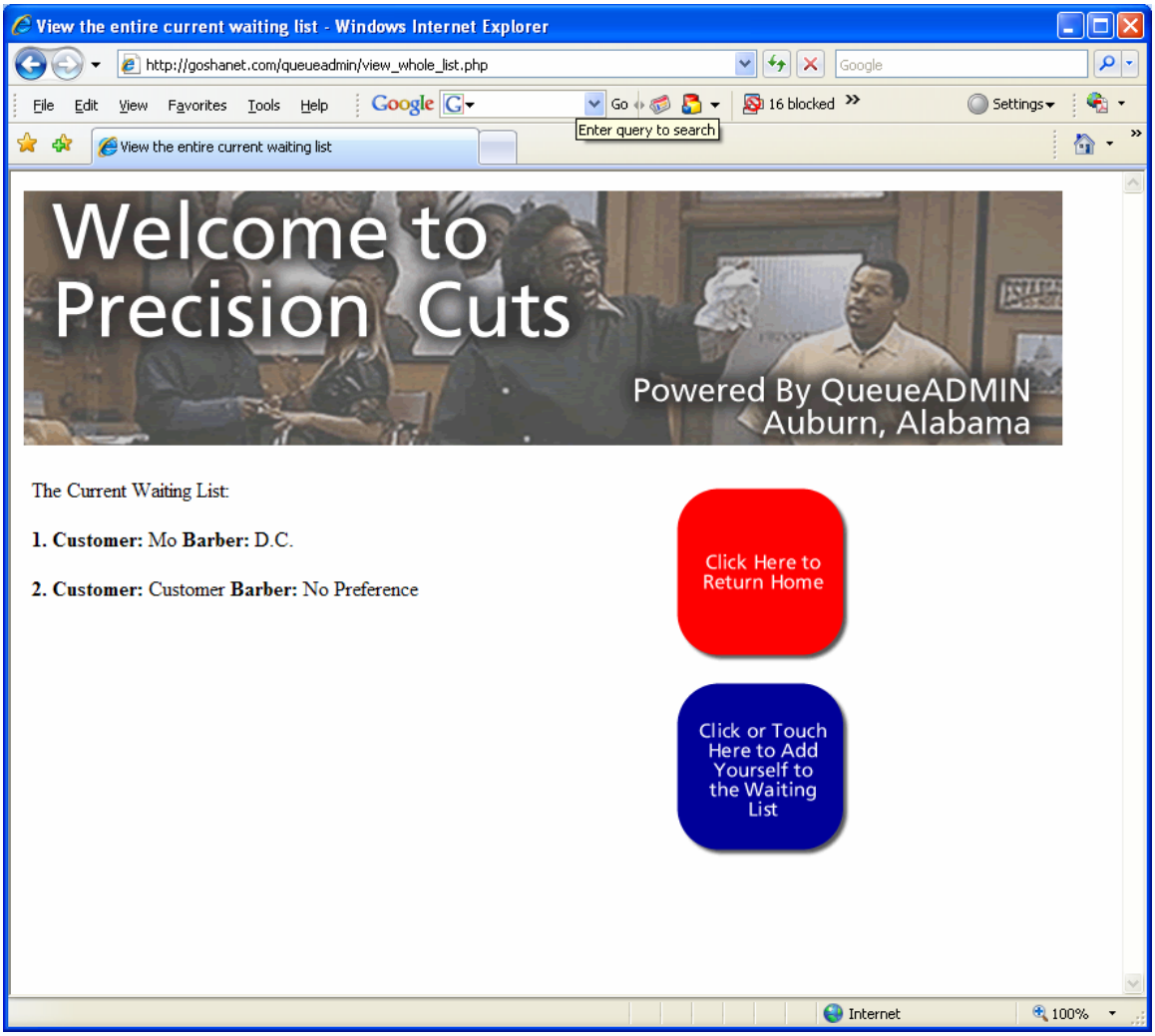

Figure 4.2 – Screenshot of the Waiting List Page for QueueAdmin

The next option a customer has is to add him or herself to the waiting list. If the customer would like to add themselves to the list immediately after viewing the current waiting list, they can choose the icon located on the same screen as the current waiting list. If not they can just select the second icon on the home screen. Once this icon is selected the customer sees a form (figure 4.3) with three fields to enter.

The first field is the name or nickname that the customer would like shown to those who use the system. The second field is a listing of all the names or nicknames of

the barbers that are on duty at that particular moment. The third field is the listing of all the available services that the shop offers. Once the customer fills out the form they have the option to update themselves to the waiting list by touching or clicking the button named “Update.” If a customer attempts to submit the form without filling out each field, QueueManager will give them an error message (figure 4.4) letting them know what field was forgotten. Once a customer selects the “Update” button, the customer is directed to a confirmation screen that shows the information entered in the waiting list. Here the customer has the option of viewing the current waiting list or returning to the home page.

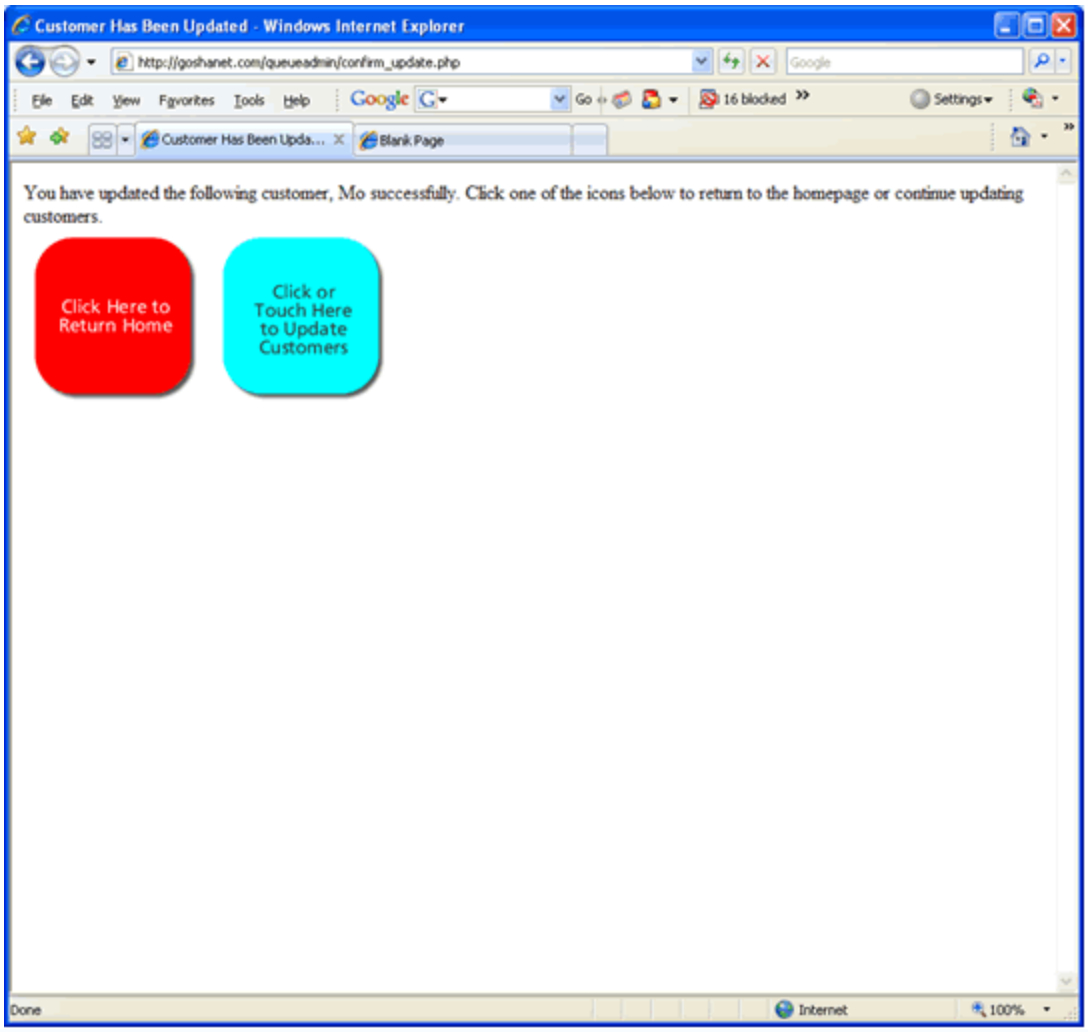

Figure 4.3 – Screenshot of the page used to add customers to the waiting list

Figure 4.4 – Message box that appears if a customer does not completely fill out the form to the system

One added feature of QueueAdmin was its waiting list page design for mobile devices such as personal digital assistants and cellular phone. This feature is very useful in two situations. The first is when a customer in line needs to temporarily leave the shop. Because they can access the current list from a mobile device they have some estimate of how much time they have before they need to be back in the shop before their turn is lost. The second situation is when a customer is curious about the current state of the waiting list before coming to the shop. The customer is able to see the entire waiting list without leaving the house or calling up to the shop. Customers who are interested in using this feature must take two steps. The first step is to select the middle icon from the home screen. The icon directs the customer to a page with the text that states, “To view the current waiting list from your mobile phone, open your phone web browser and go to http://goshanet.com/queueadmin/mobile/." Once a customer enters this information into there browser they are directed to a webpage that shows the same information a customer would see at the shop. The only difference is that the page at the shop has more images which would take longer and may be more expensive to download on a mobile device.

The fourth problem is based off the fact that barbers are the official judges of who is next in line. QueueAdmin makes this process easier by clearly displaying the waiting list so that barbers would know the next customer to call to the chair. In order for the waiting list to stay current, it is required that all barbers dismiss customers as they complete their cut, and update customers as they are seated to begin there cut. QueueAdmin allows barbers to complete these tasks in only a few simple steps. The first step is done as soon as the barber arrives at the shop. Because QueueAdmin only allows

customers to choose from barbers that are currently in the shop, it is imperative that barbers sign into the system upon their arrival. From the home screen the barber would select the fifth icon. This directs the barber to a page that asks for a password. A password is necessary to ensure that customers do not tamper with barber specific options. If the wrong password is entered, the user will be redirected to an error page that informs the user that the wrong password has been entered and gives them the option to return to the homepage. Once the correct password is entered, the user is directed to a page that shows two menus (figure 4.5). The first are barbers that are marked as absent. In order to sign in one of these individuals, the barber would select the person and select the “Sign In” button. Below the “Sign In” button is the “Sign Out” menu. This is to be used when a barber leaves the shop. Once the barber selects himself from the menu, he would select the “Sign Out” button. After signing in or out, the barber is directed to a screen confirming that they have successfully updated their status. The confirmation screen has options to return to the home page or update customers in the waiting list.

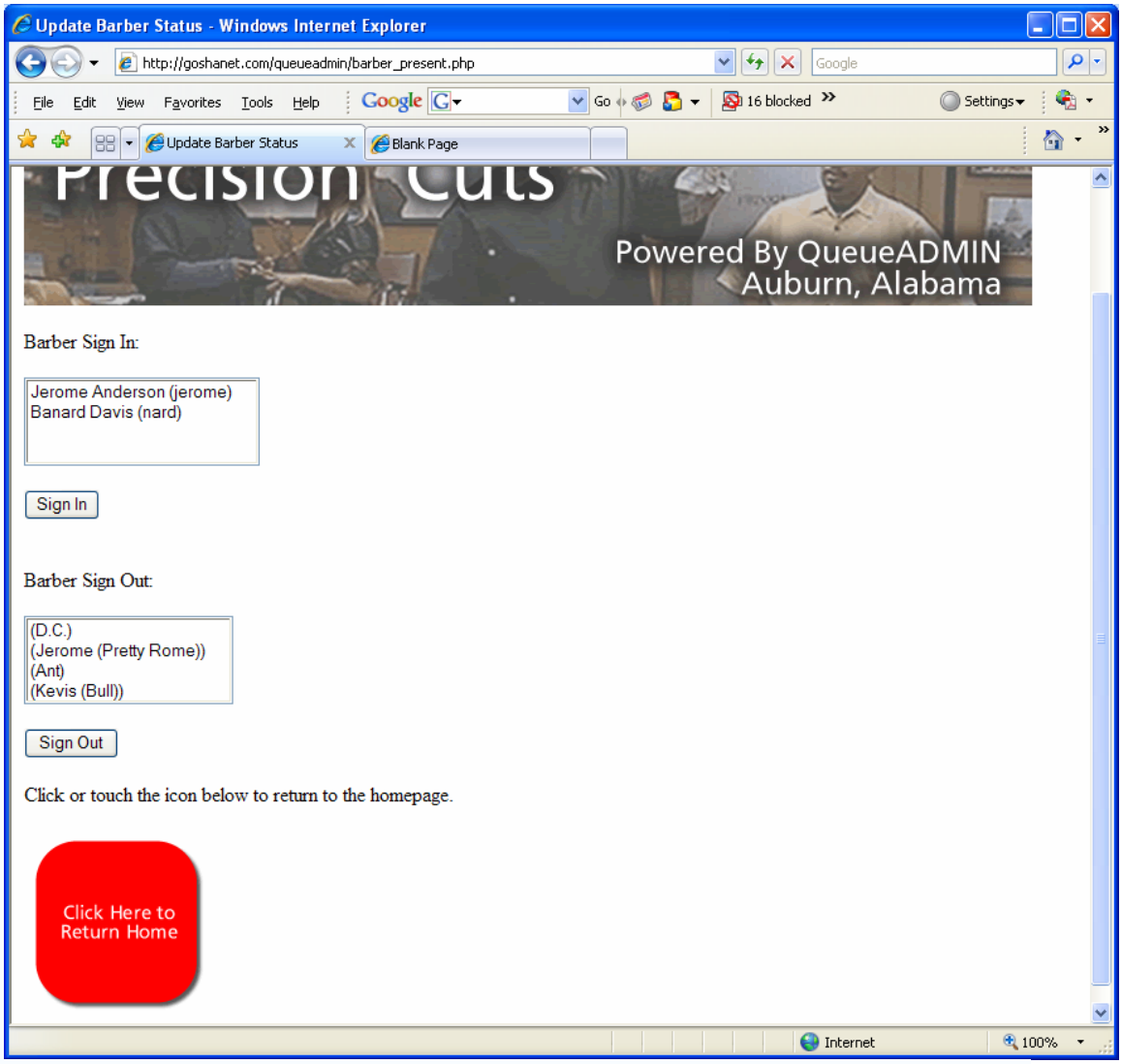

Figure 4.5 – Screenshot of page used to sign barbers in and out

In addition to being able to update the waiting list after signing in or out, barbers are also able to update the list from the home page. Once they select the forth icon, they are directed to a page asking the barber to enter their password (figure 4.6). After the correct password is entered, the screen appears which gives the barber two main choices (figure 4.7). The first choice is to dismiss a customer after they have finished their cut.

This is done by selecting the customer from the drop down menu and touching or clicking the button named “Dismiss.” The other main option the barber has is to update the system with the next person who enters his chair. When updating the system with the next customer, the barber would choose the customer they wish to update from the drop down menu. Because the customers in the menu are in order from the time they added themselves to the list, the barber selects the first customer on the list that either prefers that particular barber or has no preference at all. Many times a new customer enters as soon as another customer leaves, but this is not the case all of the time. This is why the task of dismissing and updating customers are separate functions.

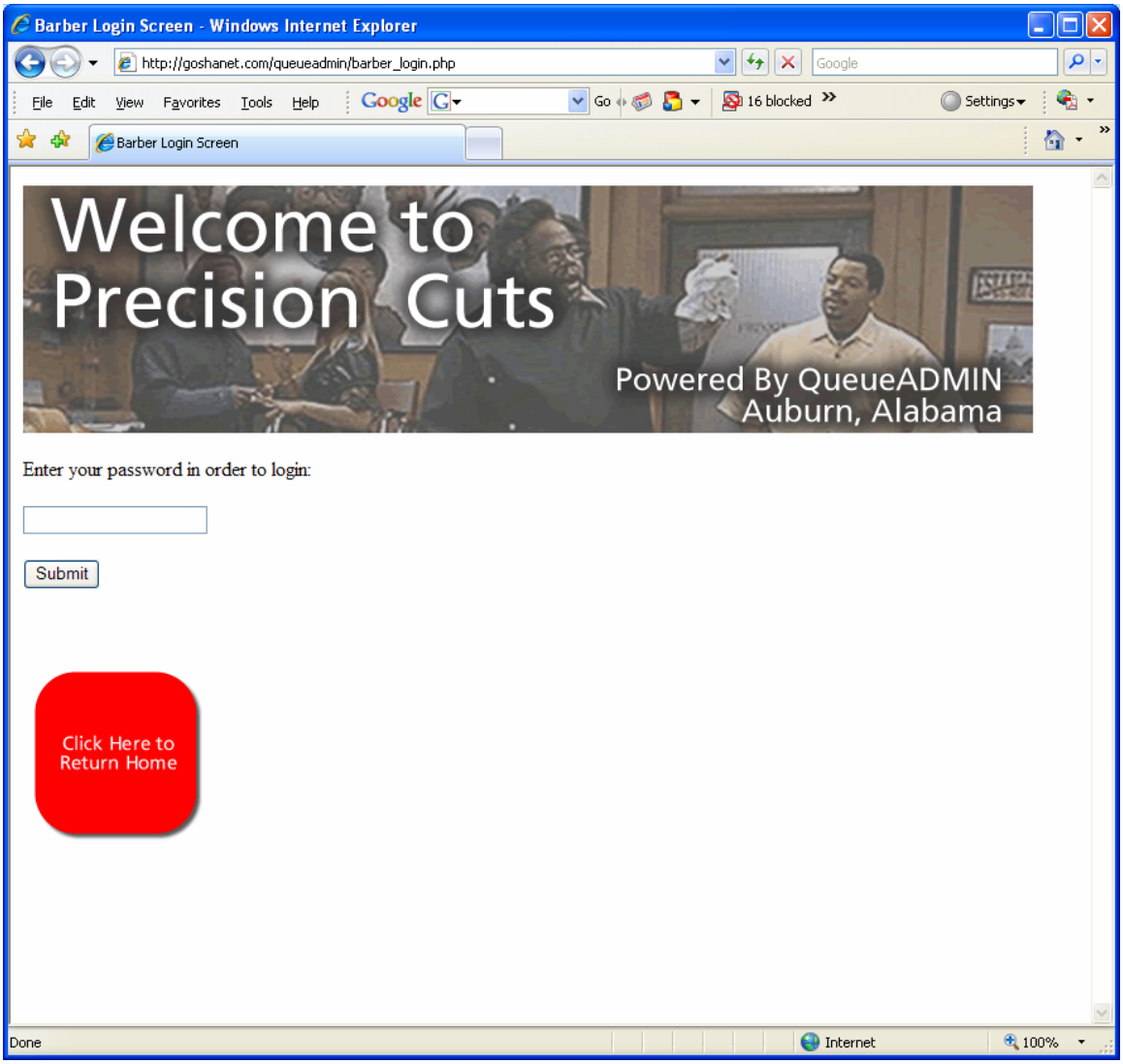

Figure 4.6 – Screenshot of page where a barber enters their password

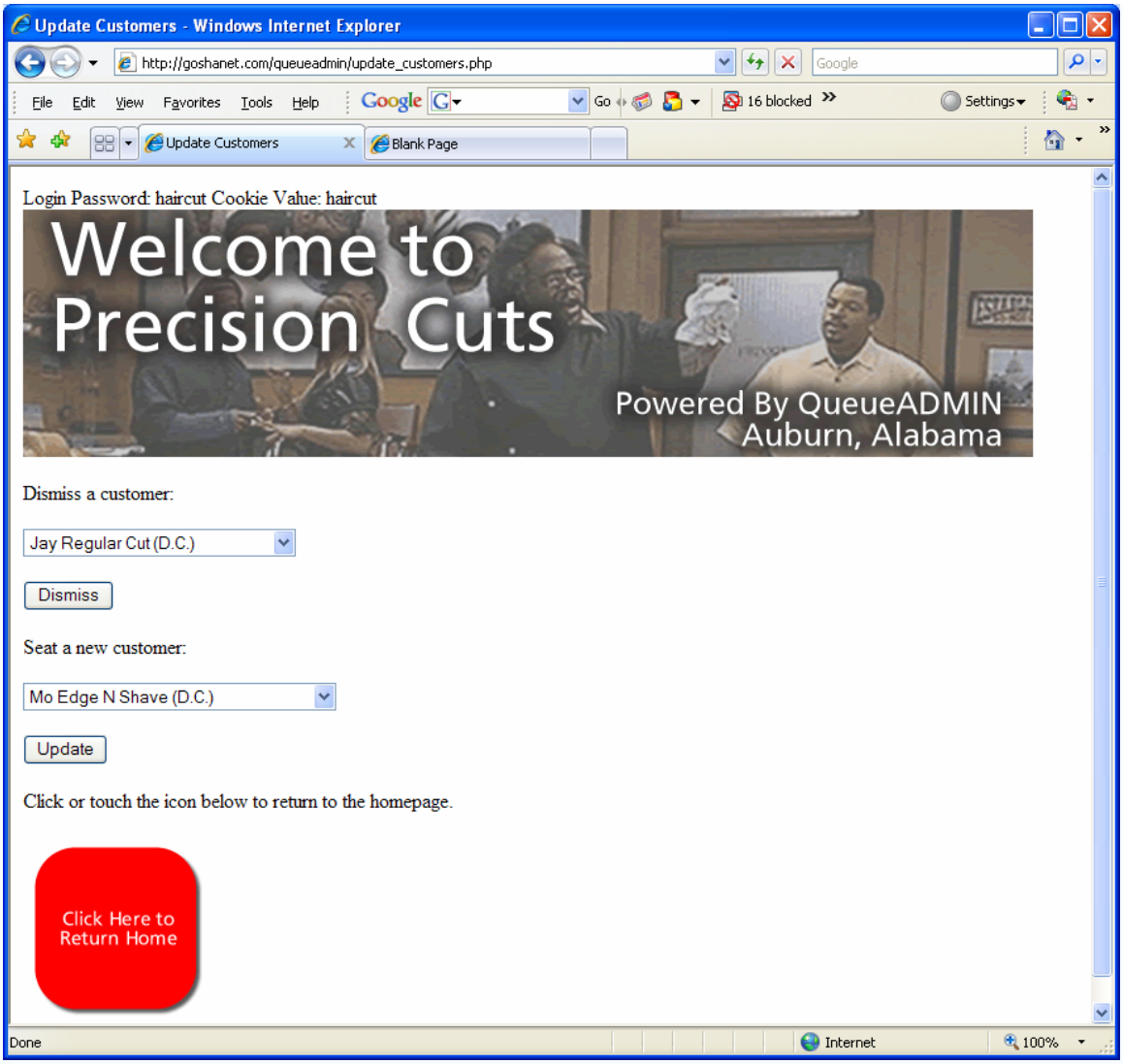

Figure 4.7 – Screenshot of page where customers are seated or dismissed by the barbers

Once a customer is updated or dismissed, the barber is directed to a confirmation screen (figure 4.8). This screen shows the barber which customers they just updated. It also gives the options to either return to the home screen or the previous screen. When a barber returns to the home screen they are automatically logged out of the system.

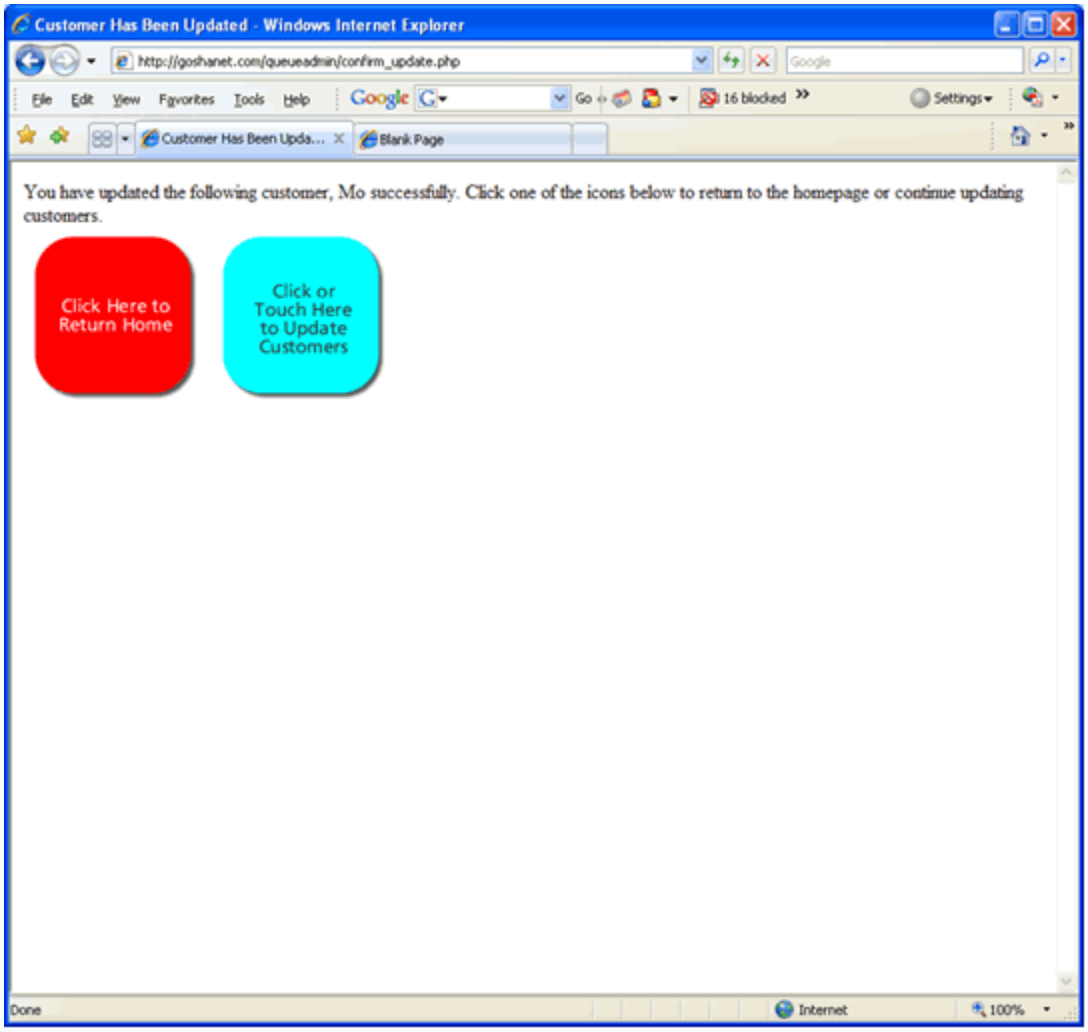

Figure 4.8 – Screenshot of page confirming a customer has be updated in the queue.

4.3 METHOD

4.3.1 PARTICIPANTS

Neighborhood Barbershop is a locally owned barbershop located on Opelika Road in Auburn, Alabama. It also serves as the site for this study. The shop is owned by Mobile, Alabama native, John. John is not only the owner of the shop, but he serves double duty as the head barber. Assisting him with barbering duties are three other

barbers. Because Saturday brings in more customers than any other day of the week, all four barbers are usually on duty during this time. This heavy flow of customers was the reason the study was held on Saturday.

The customers of Neighborhood Barbershop are of all ages and consist mainly of African-American and Hispanic males. These customers are one of two types: those with a barber preference and those with no preference. Customers who have a preference are willing to wait longer to receive the services of their preferred barber. Those customers with no preference feel that any of the barbers will give them a satisfactory cut and would like the services of the first available barber.

4.3.2. PROCEDURES

The procedure for the study was a simple one for the barbers and customers. All of the customers over the age of 19 who entered the shop during the time of the study were asked if they were interested in becoming a participant in a study of Queue Management Systems. Those interested were given an information sheet (See Appendix E.) giving them details of the study. Those that were still interested were asked to add themselves to the waiting list. Before starting, customers were informed that the system had touch screen functionality and could be used instead of the mouse if preferred. As the customer added themselves to the list, the Project Lead recorded notes on how the customers reacted to the system. Once the customers added themselves to the waiting list, they were seated until they received their haircut. Once finished with their haircut, they were asked to fill out a survey (See Appendix B). This concluded their involvement in the study.

Barbers in the study had a separate set of instructions. First they had to log into the system once entering the shop. Before starting, they were told the password by the project lead. As soon as they were logged in they waited until a customer logged in and chose them as their barber or chose no preference as to whom their barber was. Once seated the barber went to the kiosk, signed in and updated the customer. Once finished servicing the customer, the barber then proceeded to the kiosk to dismiss the customer. After dismissing the customer, the barbers checked the waiting list to see who was next in the waiting list that needed his services. If there was a customer who needed his services, the barber would update the new customer in the waiting list while seating them in the chair. The barbers continued this pattern for the remainder of the study. At the conclusion of the study, the barbers were asked to complete a survey (See Appendix A) to get their thoughts on the system.

Before the start of the study there were a few steps that had to be taken in preparation. First the system had to be set up in the barbershop. John, the shop owner, cleared off some space at the end of the main counter for the kiosk. Items belonging to the kiosk are explained in section 4.3.3. Once the kiosk was assembled, the system had to be configured with information specific to Precision Cuts. First were the names of the barbers to be added to the system. Next was the name of all the services that were available. After all the equipment was set up, the barbers were briefed on the purpose and details of the study by the Project Lead.

4.3.3 MATERIALS

There was a variety of equipment, software, and technology used in this study. In order to execute the study, the kiosk had to be set up. The kiosk consisted of one 19 inch touch screen monitor, one notebook computer, a wireless mouse, and a wireless keyboard. The 19 inch touch screen not only provided the study participants the option to touch the screen in addition to using the mouse, but allowed for easier viewing of the system with the large screen size. The computer used was an HP Pavilion Entertainment Notebook PC. The small size of the Pavilion Notebook saved valuable space in the area reserved for the kiosk. A wireless mouse and keyboard were used in order to reduce the clutter of wires in the kiosk area and allow customers a more comfortable way of entering data. Because QueueAdmin is accessed online, a network card was used to provide internet access. Additional details about the equipment used are located in Appendix F.

Other equipment used in the study was the information sheets that where offered to the participants of the study (See Appendix E) and the surveys given to the study participants (See Appendix A and C).

The technology used to create the QueueAdmin system consisted of three popular, powerful technologies. The first of these technologies is Hypertext Markup Language or HTML. HTML is a computer language used to make web pages. Advantages of using HTML includes its portability and contents. A HTML document can be displayed on any type of computer, i.e. a Macintosh or Window based PC. Because the content of a HTML document is text, it is able to transfer quick over the internet [11].

In order to make the webpages dynamic, the server scripting language called PHP was used. PHP stands for Hypertext Preprocessor. “PHP is the widely-used, free, and

efficient alternative to competitors such as Microsoft's ASP. PHP is perfectly suited for Web development and can be embedded directly into the HTML code" [12]. One advantage to PHP is that it can talk to a variety of database systems. The database system used in QueueAdmin to store information is MySQL.

"MySQL (pronounced "my ess cue ell") is the most widely used open source database, with millions of users ranging from single users powering their own personal Web sites to large corporations powering high-traffic Web sites" [13]. Advantages of using MySQL include speed, portability, ability to be used with any programming language and it price [13].

4.4 ANALYSIS

4.4.1 MEASUREMENT

The measurements used for this study were comprised from the studies given to the customers and barbers. The survey asked customers and barbers different questions about the features of the system they used, their opinions on their QueueAdmin system, their thoughts on queue management in barbershops, and personal background information pertaining to this study.

4.4.2 RESULTS AND DISCUSSION

The results of the study come primary from the data acquired from the surveys given to the customers and barbers. In all, there were 25 participants in the study. The participants consisted of the four barbers who are employed at Neighborhood Barbershop

and 21 customers who entered the shop during the time of the study to get a haircut. All 21 of the customers who agreed to participate in the study completed the customer specific survey.

Barbers who participated in the study had the option of using the touch screen monitor or just the mouse and keyboard interface. All four barbers who participated used both the touch screen and the keyboard with the mouse interfaces. Overall all four barbers either agreed or strongly agreed that they were satisfied with using the QueueAdmin system and would use the system again. All four barbers strongly agreed that it was easy to add customers to the waiting list. When asked about the look of the QueueAdmin system, all four barbers strongly agreed that they like the appearance.

The barbers were also asked questions about how they felt about waiting list management. When asked how QueueAdmin affected their performance at work, 50 percent of the barbers strongly agreed and 50 percent agreed that their productivity as well as the quality of the cuts they give would increase due to a lack of having to concentrate on managing the waiting list. All of the barbers strongly agreed that the QueueAdmin would reduce their doubts about who is next in line.

Customers who participated in the study had a different study to fill out than the barbers. However, some the questions were the same or similar. Customers had an option of checking the current status of the waiting list using their cell phones. Of all the customers who participated in the study, only 10 percent of the customer tried the feature. Ninety-five percent of all the customers used the touch screen interface and all of the customers used the mouse and keyboard. Around 91 percent of all of the customer participants strongly agreed that they were satisfied with using QueueAdmin and would

use the system again. All of the customers were able to successfully add themselves to the waiting list and thought that QueueAdmin would be able to accurately preserve their spot. When asked about the look of the system, all of the customers either agreed or strongly agreed that they liked the appearance of the QueueAdmin system. Customers were also asked about waiting list management. Ninety-five percent of the customers strongly agreed that they would feel more comfortable waiting in line knowing an estimate of how long the wait would be. Customers also commented on saving their space in line. Ninety-one percent of customers strongly agreed that they would feel more comfortable waiting in line knowing if they left their seat, their space in line would not be subjected to question. Eighty-one percent of customers strongly agreed that they would consider changing barbershops if the length of time spent waiting was repeatedly too long.

5. CONCLUSION AND FUTURE WORK

5.1 CONCLUSION

The experiment of this study ended successfully on 24 March, 2007. Results from this study recommended several facts for both the barber side as well as the customer side of problems presented earlier in this thesis. The barber results suggested many things. First, that barbers felt that the queue management system could accurately manage the waiting list of a barbershop. Second, that there are times when they are confused about who is next in line. Third, that a queue management system could reduce this confusion. Finally, the results showed that a queue management system would increase barber productivity and quality as well.

Results from the customer survey suggested several theories as well. First, that customers felt like a queue management system would accurately manage the waiting list. Second, customers felt more comfortable waiting in line knowing an estimate of how long the wait would be. Third, a queue management system made them more feel more comfortable when having to leave their seats in the waiting area. Last, customers would consider changing their barbershop if the time spent waiting was considerably too long.

These results show only a portion of the overall finding from this study. Additional findings can be viewed in Appendix B and D.

What QueueAdmin represents is the first step in the right direction. This study did not address every issue involving queue management at a barbershop. QueueAdmin itself cannot solve every problem. It wasn't designed to. It was designed to show how key queue management can be utilized in a barbershop setting. Also, it set the stage for another tool that would be able to analyze the information collected by QueueAdmin. This information included the dates and times that every customer added themselves to the waiting list, removed themselves from this list to start their cut and the time their cut concluded. After reading this paper, one should be able to see how the problem solving approach used in the creation of QueueAdmin could be replicated in the design of a system in other areas other than barbershops. In the next section, the possibilities created due to this study's findings are explored future.

5.2 FUTURE WORK

QueueAdmin opened the door to more research opportunities in queue management for barbershops as well as other audiences in the government, education, and industrial sectors. Earlier in this paper, queueing models were introduced. For the first installment of QueueAdmin, exploration into different queueing models was inconsequential and outside the scope of this study. However, the possibility exists that changing the queueing model could have a positive effect on the wait time of the shop's customers. In addition to queueing models, this study opens another door with reporting. QueueAdmin handles the task of recording data related to the waiting list and stores it in a MySQL database. Because it is stored in a database, it is possible to create an application to show the results that QueueAdmin records in a way that is useful to the

manager of a barbershop. QueueAdmin could have included some reported capabilities for John, but what about any other manager who wants to use this system? Different managers will want the data stored by QueueAdmin displayed in different strategic ways. Which way this data should be displayed is another study in itself.

John and his shop had a successful experience with the testing of QueueAdmin. Does this mean that other shops will have similar experiences? Barbershops differ from locations, sizes, technical expertise of their staff and customers, and the layouts of their shops. In the future, it would be imperative to test the QueueAdmin system in a new shop, with different customers and barbers. The third page of both the customer and barber surveys collected background information of all the participants. This will help in future studies with the selection of additional test barbershops with the intent of sampling diverse users of the system.

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APPENDICES

APPENDIX A

Barber Survey

Post-Experiment Survey for Barber Participants

1. Features used (check all that apply):
□ Touch screen interface □ Keyboard & Mouse Interface

Please mark the choice that best reflects your reaction using the QueueAdmin system:

2. Overall, I was satisfied using QueueAdmin.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

3. I would use QueueAdmin again.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

4. It was easy to update customers in the waiting list.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

5. If I made a mistake, it was easy to correct.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

6. I was successful in updating the customer waiting list.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

7. I liked the appearance of QueueAdmin.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

Please mark the choice that best reflects your reaction after using the QueueAdmin system:

8. I trust QueueAdmin to **accurately** manage the waiting list?
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

9. QueueAdmin would be easy to use by people who don't know a lot about computers.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

10. There are times when I do not know who is next in line.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

11. I feel that QueueAdmin will reduce my doubts about who is next in line.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

12. I feel that my productivity at work would increase due to the lack of having to concentrate on managing the waiting list.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

13. I feel that the quality of my haircuts would increase due to the lack of having to concentrate on managing the waiting list.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

14. QueueAdmin could help manage the waiting list of my barbershop.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

If you used the **touch screen** feature:

15. It was more convenient for me to update the waiting list using the touch screen.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

16. I would continue to use the touch screen functionality.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

17. I would improve QueueAdmin by:

_____

_____

---

18. Additional comments/suggestions:

_____

_____

Background Information

Age:
□ 19-24 years □ 25-34 years
□ 35-44 years □ 45-54 years
□ 55-59 years □ 60-64 years
□ 65-74 years □ 75-84 years
□ 85 years and over

Gender:
□ Female □ Male

Race/Ethnicity:
□ White/Caucasian □ Black/African American
□ Hispanic/Latino □ American Indian/Alaska Native
□ Asian □ Native Hawaiian/Other Pacific Islander

Highest degree obtained:
□ High School Diploma (or equivalent)
□ Bachelors Degree □ Masters Degree
□ Doctorate Degree □ None of the above

Do you have any disabilities (Yes or No):_____ If Yes, please explain

Is English your native or second language?
□ Native language □ Second language

For approximately how many years have you been a barber?
□ 1-3 □ 4-6 □ 7-9 □ 10 or more □ Never

For approximately how many years have you been using a computer?
□ 1-3 □ 4-6 □ 7-9 □ 10 or more □ Never

On average, how many times do you use a computer during the course of a week?
□ 0 - 1 □ 2 – 3 □ 4 - 5 □ 6 or more

In the section below, choose the response that most accurately describes you.

1. I am computer literate.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

2. I am good with computers.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

3. I trust computers to do online shopping.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

4. I am comfortable using computers to pay household bills.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

5. I trust computers to securely send my personal information over the internet.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

APPENDIX B

Barber Survey Results

Question Number	Answer Choice	Percentage
1.	Touch screen interface	100
	Keyboard & Mouse Interface	100
2.	Strongly Agree	75
	Agree	25
	Neutral	0
	Disagree	0
	Strongly Disagree	0
3.	Strongly Agree	100
	Agree	0
	Neutral	0
	Disagree	0
	Strongly Disagree	0
4.	Strongly Agree	100
	Agree	0
	Neutral	0
	Disagree	0
	Strongly Disagree	0
5.	Strongly Agree	75
	Agree	0
	Neutral	0
	Disagree	0
	Strongly Disagree	0
6.	Strongly Agree	100
	Agree	0
	Neutral	0
	Disagree	0
	Strongly Disagree	0

7.	Strongly Agree	100
	Agree	0
	Neutral	0
	Disagree	0
	Strongly Disagree	0
8.	Strongly Agree	75
	Agree	25
	Neutral	0
	Disagree	0
	Strongly Disagree	0
9.	Strongly Agree	75
	Agree	25
	Neutral	0
	Disagree	0
	Strongly Disagree	0
10.	Strongly Agree	100
	Agree	0
	Neutral	0
	Disagree	0
	Strongly Disagree	0
11.	Strongly Agree	100
	Agree	0
	Neutral	0
	Disagree	0
	Strongly Disagree	0
12.	Strongly Agree	50
	Agree	50
	Neutral	0
	Disagree	0
	Strongly Disagree	0

13.	Strongly Agree	50
	Agree	50
	Neutral	0
	Disagree	0
	Strongly Disagree	0
14.	Strongly Agree	100
	Agree	0
	Neutral	0
	Disagree	0
	Strongly Disagree	0
15.	Strongly Agree	50
	Agree	25
	Neutral	25
	Disagree	0
	Strongly Disagree	0
16.	Strongly Agree	50
	Agree	25
	Neutral	25
	Disagree	0
	Strongly Disagree	0
Age:	19-24 years	25
	25-34 years	75
	35-44 years	0
	45-54 years	0
	55-59 years	0
	60-64 years	0
	65-74 years	0
	75-84 years	0
	85 years and over	0

Gender:	Female	0
	Male	100
Race/Ethnicity:	White/Caucasian	0
	Black/African American	100
	Hispanic/Latino	0
	American Indian/Alaska Native	0
	Asian	0
	Native Hawaiian/Other Pacific Islander	0
Highest degree obtained:	High School Diploma (or equivalent)	50
	Bachelors Degree	50
	Masters Degree	0
	Doctorate Degree	0
	None of the above	0
Do you have any disabilities (Yes or No):	Yes	0
	No	100
Is English your native or second language?	Native language	100
	Second language	0
For approximately how many years have you been a barber?	1-3	50
	4-6	50
	7-9	0
	10 or more	0
	Never	0
On average, how many times do you use a computer during the course of a week:	0 - 1	0
	2 – 3	25
	4 - 5	0
	6 or more	75
I am computer literate:	Strongly Agree	75
	Agree	25
	Neutral	0
	Disagree	0
	Strongly Disagree	0

I am good with computers:	Strongly Agree	75
	Agree	25
	Neutral	0
	Disagree	0
	Strongly Disagree	0
I trust computers to do online shopping:	Strongly Agree	25
	Agree	50
	Neutral	25
	Disagree	0
	Strongly Disagree	0
I am comfortable using computers to pay household bills:	Strongly Agree	25
	Agree	50
	Neutral	25
	Disagree	0
	Strongly Disagree	0
I trust computers to securely send my personal information over the internet:	Strongly Agree	0
	Agree	50
	Neutral	50
	Disagree	0
	Strongly Disagree	0

APPENDIX C

Customer Survey

Post-Experiment Survey for Customer Participants

1. Features used (check all that apply):

□ Cell phone interface □ Touch screen interface
□ Keyboard & Mouse Interface

Please mark the choice that best reflects your reaction using the QueueAdmin system:

2. Overall, I was satisfied using QueueAdmin.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

3. I would use QueueAdmin again.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

4. It was easy to add themselves to the waiting list.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

5. If I made a mistake, it was easy to correct.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

6. I was successful in updating the customer waiting list.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

7. I liked the appearance of QueueAdmin.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

Please mark the choice that best reflects your reaction after using the QueueAdmin system:

8. QueueAdmin would be easy to use by people who don't know a lot about computers.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

9. I trust QueueAdmin to **accurately** handle additions to the waiting list?
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

10. I would feel more comfortable waiting in line knowing an estimate of how long my wait will be.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

11. I would feel more comfortable waiting in line knowing if I left my seat, my space in line would not be a question.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

12. I would consider changing barbershops if the length of time spent waiting was repeatedly too long.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

If you used the **touch screen** feature:

13. It was more convenient for me to add myself to the waiting list using the touch screen.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

14. I would continue to use the touch screen functionality.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

15. I would improve QueueAdmin by:

_____

_____

_____

16. Additional comments/suggestions:

_____

_____

_____

Background Information

Age:
□ 19-24 years □ 25-34 years
□ 35-44 years □ 45-54 years
□ 55-59 years □ 60-64 years
□ 65-74 years □ 75-84 years
□ 85 years and over

Gender:
□ Female □ Male

Race/Ethnicity:
□ White/Caucasian □ Black/African American
□ Hispanic/Latino □ American Indian/Alaska Native
□ Asian □ Native Hawaiian/Other Pacific Islander

Highest degree obtained:
□ High School Diploma (or equivalent)
□ Bachelors Degree □ Masters Degree
□ Doctorate Degree □ None of the above

Do you have any disabilities (Yes or No):_____ If Yes, please explain

Is English your native or second language?
□ Native language □ Second language

For approximately how many years have you been using a computer?
□ 1-3 □ 4-6 □ 7-9 □ 10 or more □ Never

On average, how many times do you use a computer during the course of a week?
□ 0 - 1 □ 2 – 3 □ 4 - 5 □ 6 or more

In the section below, choose the response that most accurately describes you.

1. I am computer literate.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

2. I am good with computers.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

3. I trust computers to do online shopping.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

4. I am comfortable using computers to pay household bills.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

5. I trust computers to securely send my personal information over the internet.
□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

APPENDIX D

Customer Survey Results

Question Number	Answer Choice	Percentage
1.	Touch screen interface	95
	Keyboard & Mouse Interface	100
	Cell Phone Interface	10
2.	Strongly Agree	91
	Agree	5
	Neutral	5
	Disagree	0
	Strongly Disagree	0
3.	Strongly Agree	91
	Agree	10
	Neutral	0
	Disagree	0
	Strongly Disagree	0
4.	Strongly Agree	86
	Agree	14
	Neutral	0
	Disagree	0
	Strongly Disagree	0
5.	Strongly Agree	71
	Agree	14
	Neutral	14
	Disagree	0
	Strongly Disagree	0
6.	Strongly Agree	100
	Agree	0
	Neutral	0
	Disagree	0
	Strongly Disagree	0

7.	Strongly Agree	95
	Agree	5
	Neutral	0
	Disagree	0
	Strongly Disagree	0
8.	Strongly Agree	91
	Agree	10
	Neutral	0
	Disagree	0
	Strongly Disagree	0
9.	Strongly Agree	91
	Agree	10
	Neutral	0
	Disagree	0
	Strongly Disagree	0
10.	Strongly Agree	95
	Agree	5
	Neutral	0
	Disagree	0
	Strongly Disagree	0
11.	Strongly Agree	91
	Agree	10
	Neutral	0
	Disagree	0
	Strongly Disagree	0
12.	Strongly Agree	81
	Agree	10
	Neutral	5
	Disagree	5
	Strongly Disagree	0

13.	Strongly Agree	66
	Agree	33
	Neutral	0
	Disagree	0
	Strongly Disagree	0
14.	Strongly Agree	66
	Agree	33
	Neutral	0
	Disagree	0
	Strongly Disagree	0
Age:	19-24 years	33
	25-34 years	23
	35-44 years	28
	45-54 years	14
	55-59 years	0
	60-64 years	0
	65-74 years	0
	75-84 years	0
	85 years and over	0

Gender:	Female	0
	Male	100
Race/Ethnicity:	White/Caucasian	0
	Black/African American	86
	Hispanic/Latino	14
	American Indian/Alaska Native	0
	Asian	0
	Native Hawaiian/Other Pacific Islander	0
Highest degree obtained:	High School Diploma (or equivalent)	67
	Bachelors Degree	19
	Masters Degree	14
	Doctorate Degree	0
	None of the above	0
Do you have any disabilities (Yes or No):	Yes	100
	No	0
Is English your native or second language?	Native language	86
	Second language	14

On average, how many times do you use a computer during the course of a week:	0 - 1	19
	2 – 3	19
	4 - 5	23
	6 or more	38
I am computer literate:	Strongly Agree	76
	Agree	10
	Neutral	14
	Disagree	10
	Strongly Disagree	0
I am good with computers:	Strongly Agree	76
	Agree	10
	Neutral	14
	Disagree	10
	Strongly Disagree	0
I trust computers to do online shopping:	Strongly Agree	28
	Agree	23
	Neutral	23
	Disagree	23
	Strongly Disagree	0
I am comfortable using computers to pay household bills:	Strongly Agree	28
	Agree	19
	Neutral	19
	Disagree	19
	Strongly Disagree	33
I trust computers to securely send my personal information over the internet:	Strongly Agree	19
	Agree	28
	Neutral	23
	Disagree	28
	Strongly Disagree	0

APPENDIX E

Information Sheet

AUBURN UNIVERSITY
SAMUEL GINN COLLEGE OF ENGINEERING
DEPARTMENT OF COMPUTER SCIENCE AND SOFTWARE ENGINEERING

INFORMATION SHEET
FOR
Research Study Entitled
QueueAdmin Advanced Queue Management System

You are invited to participate in a research study which aims to evaluate a new queue management system for barbershops. This study is being conducted by Dr. Juan E. Gilbert, Associate Professor in the Computer Science and Software Engineering Department at Auburn University. The study will measure the effectiveness and usability of a queue management system that uses normal keyboard input, touch screen input and wireless web input. You were selected as a possible participant because you are 19 years or older, and a customer of Precision Cuts Barbershop.

Participation is voluntary. If you decide to participate, you will spend about 20 minutes completing the study. First you will be asked to use the kiosk to register and add yourself to the waiting list. This step should not be more than 10 minutes. While waiting (if possible) check your spot in the waiting list using your mobile phone. Barbers will update customers as they are seated. A post-survey will be done after your haircut to understand your opinions about the system as well as to accumulate some background data. This should only take 10 minutes.

Any information obtained in connection with this study will remain anonymous. Information collected through your participation may be published in a professional journal and/or presented at a professional meeting.

While there are no guaranteed direct benefits to you from this research, you may find the research and interaction with the new interactive, mobile and touch enabled queue management system interesting. Your participation should make it possible to better improve this system. In addition, your participation in the study may result in a system that will make it easier and convenient for people to take care of their grooming needs.

Your decision of whether or not to participate in this study will not jeopardize your future relations with Auburn University or the Department of Computer Science and Software Engineering. You are free to withdraw from this study at any time without any questions. You will also be able to withdraw the data collected from you. If you have any questions, ask them now. If you have questions later, you may contact Dr. Juan E. Gilbert (gilbert@auburn.edu) who will be happy to answer them.

For more information regarding your rights as a research participant you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone (334)-844-5966 or e-mail at hsubjec@auburn.edu or IRBChair@auburn.edu .

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE WHETHER TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE, THE DATA YOU PROVIDE WILL SERVE AS YOUR AGREEMENT TO DO SO. THIS LETTER IS YOURS TO KEEP.

_____

Investigator's signature Date

107 Dunstan Hall • Auburn University, AL 36849-5347 • 334.844.4330 • Fax 334.844.6329 • www.eng.auburn.edu/csse/

APPENDIX F

Equipment Specification

CPU:
System: Microsoft Windows XP, Home Edition, Version 2002, Service Pack 2
Manufacturer: HP
Processor: Intel ® Celeron ® M 1.30 GHz
RAM: 480 MB

Monitor:
Brand: elo TouchSystems
Model: 1915L 19" LCD Desktop Touchmonitor (1000 Series)
Website: http://elotouch.com/Products/LCDs/1915L/default.asp

Keyboard:
Model Name:Microsoft Wireless Keyboard 3000
Model No. 1066
Website:
http://www.microsoft.com/hardware/mouseandkeyboard/productdetails.aspx?pid=058

Mouse:
Model Name:Wireless Optical Mouse 2.0
Model No. 1008
Website:
http://www.microsoft.com/hardware/mouseandkeyboard/ProductList.aspx?Type=Mouse&AdditionalType=Trackball&feature1=wireless_All

Network Card:
Provider: Verizon Wireless
Type: Broadband Access/National Access PC Card
Model: PC5740
Website:
http://www.verizonwireless.com/b2c/store/controller?item=phoneFirst&action=viewPhoneDetail&selectedPhoneId=1821

APPENDIX G

Photos from the Experiment