Recycling @ UM
Final Project Report

12/11/08

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Abstract:

Recycling @ UM is a web application designed to make recycling easy and convenient for individuals living, working, or attending college in College Park, Maryland. It enables users to quickly locate nearby recycling locations for specific types of recyclable items. The application utilizes the Google Maps API to plot the recycling locations on a map. To find a location that accepts common items, users can click on any of the quick-search buttons at the top of the interface. For example, clicking on the button labeled “Paper” will display all recycling locations that accept paper on the map. Similarly, if looking for a location that accepts less common items (for example, batteries), a user can enter the item’s name in the search text box, and click search. Recycling locations accepting this type of item will be plotted on the map. Moreover, users can filter search results by locations that offer money in exchange for items (for example, printer ink/toner cartridges). Additionally, users can add new recycling locations to the database.

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Introduction

Problem

Most people in modern society would agree that recycling is critical to long-term sustainability. In fact, most people like to recycle, and try to do so when possible. However, individuals are more likely to recycle when recycling is convenient. Curbside pickup in residential areas of the United States has helped increase recycling there.

Unfortunately, college students, such as those attending the University of Maryland, College Park, are one group that may find recycling inconvenient. Dormitories usually offer convenient “trash rooms” for waste disposal, but similar recycling locations may be more difficult to find, if they are even offered at all.

Additionally, individuals that work in and around College Park, Maryland may not know where to recycle. For example, someone working in an office or lab may need to replace a printer’s toner cartridge. What should be done with the cartridge? If the individual knew where toner cartridges could be recycled, he or she would likely drop it off there. Otherwise, it would likely be disposed of as normal waste. This situation raises a significant question: If a person does not know of a recycling location nearby, how can he or she find one?

In our experience, information about recycling locations seems to be scattered among a variety of websites. If the information is available, it will likely take a significant amount of time and effort to locate. Even determined individuals may become frustrated and give up searching. As a result, people may not be able to find a local recycling location when they are in particular need of one. This leads to recyclable material being thrown out instead of being recycled.

The goal of Recycling @ UM is to help solve this problem, by providing a web application with a consolidated list of recycling locations, accessible using a map or text, which can be used quickly and easily by a wide variety of individuals.

Previous Work

Our idea is modeled after a very successful and frequently used website, Google Maps [11]. The Google Maps web application enables easy access to a multitude of location specific information. Google Maps offers street level maps, route planning / directions (for motor vehicles, pedestrians, and bicycles), and a business / facility locator (for a variety of purposes, such as dining, entertainment, banking, travel, lodging, etc.). All of this information is offered in one place, using a simple searchable, map-based user interface.

Google offers their Maps API to the public at no cost. There are many other useful websites that now leverage this API. For example, CrimeInDC[13] is a website that will show the locations of crimes committed in Washington D.C. Another example is CrashStat[12]. This website displays
the locations of various types of accidents involving pedestrians. These are just a few examples of useful websites utilizing Google Maps. There are a great deal of others, too numerous to list.

Some websites have some useful, campus specific information regarding recycling at the University of Maryland. The university’s recycling site, ResnetRecycling[16] has information specifically targeting students, and provides local resources. MarylandRecycling[17] is a state run website with information for Marylanders regarding all kinds of recycling resources.

Additionally, there have been many scientific studies in the area of recycling. Pike et al. showed that when given recycle bins, students living in campus apartments significantly reduced their waste stream [9. Pike, et al., 2003]. This study supports our belief that one of the best ways to get more students to recycle is to make recycling as convenient as possible.

Similarly, Ludwig et al. showed that placing recycling bins in convenient locations in academic buildings (primarily where beverages were often consumed) increased the amount of recyclable material deposited daily [8. Ludwig and Gray, 1998]. This study lends further credibility to the idea that students will recycle more when recycling is convenient.

DeBell examined the role of campus recycling and how universities can best contribute to their community. He sampled various programs and their diverse approaches. He also explains some of the lessons learned [3. DeBell, 1994].

Derksen and Gartrell conducted a very interesting study on the social context of recycling [4. Derksen and Gartrell, 1993]. They found that people with access to a structured recycling program have much higher levels of recycling than people without access to such a program. Additionally, they found that individual concern about the environment enhanced the effect of a recycling program, but did not overcome the barriers presented when there is no access to such a program. This type of study adds more support to our idea. Even when people were concerned about the environment, they only increased their recycling when they had access to a structured recycling program.

All of this existing research helped us to design our application. These studies add support to our belief that one of the best ways to increase recycling is to make it as convenient as possible. This was one of our primary goals in designing and implementing our application. We wanted to help make recycling information easy and accessible to students, faculty, and other individuals of all skill levels. Consolidating the important information in one place, as well as enabling easy access to the information is one way to make recycling more convenient. We utilized the approaches that many other successful websites have used, such as featuring an interactive, easy to use map. We learned a great deal from examining these useful web applications, and applied what we learned when designing our application.

Our hope is that our application will help enable easy access to recycling information (particularly the locations and materials accepted for local recycling centers), and as suggested by this previous research, increase recycling by making it more convenient.
Presentation of Design

Overview of Approach and Solution

As a group, we thought about what makes interfaces easy to use and how we could apply the eight golden rules to the project. A simple navigation scheme and quick learning curve were essential; without it, the user could get confused and lose interest in the program. That’s why we chose a tabbed interface. With four big tabs, the user is unlikely to get lost and the main functionality of the program is visible by looking at the tab names.

One goal of this project was to make the interface as flexible as possible. The picture buttons help with this goal because they allow the user to quickly click a button without having to read a written description of its function. For example, the user needs only to click the picture of ink cartridges to display all locations that accept them. This simple feature saves time and provides an enjoyable experience. The results listing is another time saver. While all locations are listed in the left hand panel, the user is not required to read all results before making a selection; the user can click a balloon on the map to display a picture and address of a location.

One of the eight golden rules is consistency and our group decided this should be an important design factor. Elements of consistency can be seen in the Why Recycle tab and the Help tab. Clicking either of these tabs displays a screen with three clickable buttons on the left and a picture of the earth on the right. These tabs have completely separate functionality but their appearance is similar and this helps reduce confusion for the user.

To satisfy two more golden rules, we designed the interface such that every action by the user causes some change in the interface. This predictable behavior helps the user feel in control. To minimize user error, this interface does not allow the user to input text except when necessary, such as for adding a new recycling location. In addition, when adding a new location, the input address must be validated before it is accepted and the user is informed of any missing or incorrect fields.

In summary, our goal with this interface was to use an intuitive design that is easily navigable and can be learned with minimal effort. We achieved the goal by considering the golden rules, comparing two prototypes, and working as a team to make a piece of software that is enjoyable for the user.
Transition Diagram

Sequence Diagram

User          Website          Database
Selects an icon or enters a search (Home tab) → Queries database → Returns results

Displays results on map / in list

Clicks add location icon

Displays add location page (figure 2)

Enters location information → Stores location to be verified

Displays verification that location submitted

Returns OK

Figure 1 (Transition Diagram)
Program Screenshots

Each of the following screenshots is from a different part of the program. Every screen of the project is included with a description of its purpose.

![Program Screenshots](image)

**Figure 2 (Main Screen)**

The main screen is the first thing a user sees after loading the program. It loads with no results listed until the user does a search. From the main screen, the user can navigate to any part of the program, search, and move the map around.
To search, the user may enter a term in the text box or click on one of the icons. Clicking “Find” with no search terms will display all recycling locations in the area. Checking the “for cash” box limits results to locations that offer cash for recyclable items. Results are listed on the left and displayed as balloons on the map. Hovering over a balloon displays the address and clicking on a balloon displays a picture of the location as well as the address. The user may drag the map and adjust the zoom settings. If desired, the user may perform multiple searches and the map and results will be updated accordingly.
Since this program depends on user input to keep the database of recycling locations current, we provided a way for users to enter new locations. The user must enter an address and a description and may submit an optional photo. The address is validated before acceptance to prevent false entries. If any required fields are left blank, a warning message is displayed indicating what the user must complete. If all fields are valid, the new location is added to the database and will appear in search results.
“Why Recycle” provides informational material to the user to promote recycling and explain why recycling is so important. The user may click any of the three tabs to display information about a certain aspect of recycling. This part of the program is important because it increases the chance users will continue using the program. A user with prior knowledge about recycling may find this information useful and continue using the program after realizing the benefits of recycling.
Figure 6 (Help Screen #1)

Clicking the help tab brings the user to this screen and presents the option of viewing help for three specific parts of the program. The Main Page Help has help about using the main page and search for recycling locations.
The Add Location Help describes the form the user must fill out to submit a new recycling location. It describes fields on the form that may be confusing.
Why Recycle Help describes the Why Recycle tab and explains that each button displays information about a specific aspect of recycling.

**Why Recycle?** - learn about the benefits of recycling and why it is so important for everyone to do their part.

Buttons: **Reduce Waste, Sustainability, Protect the Environment**. Clicking a button displays a specific aspect of recycling.
Report on Development Process

Two separate prototypes were developed during the design phase of the project. The team attempted to come up with an interface that would allow any type of user, no matter how sophisticated, to effectively use what the application has to offer. The team repeatedly met to try to refine the screens and their functionality. The main goal of the whole process was to create something that would make the application easy and intuitive to use.

Low-fidelity Prototype #1

This prototype’s focus was to facilitate application context switching via tabbing, present users with Google Maps on the main page, and allow for really simple and self-explanatory search controls. Main application’s functionality would reside on the main screen, allowing users to conveniently find recycling sites of specific items. From the very beginning, the team had a lot of interest in leveraging Google Maps for enhanced user experience, thus creating an appealing application for new users. Explaining the application’s purpose (“Why Recycle”) and access to the help screen had to be salient in order to minimize user’s frustration with the application. The team decided that images of mostly commonly recycled items should act as buttons, thus giving users an opportunity to match recyclable items to one-click controls.

The team unanimously agreed that it would also be nice to have a GUI feature that allowed users to enter new locations that are not yet in the application’s database. Those sites that are conveniently located or offer cash for recyclables would be of most interest. This way, the application’s database could evolve and be updated with new information from multiple sources (users). Therefore, the team decided to dedicate a separate screen for a new location’s profile information entering.
Figure 9 (Main Screen)

Figure 10 (Add Location Screen)
Low-fidelity Prototype #2

The second prototype the team designed puts much emphasis on the left hand-side menu that would be part of every page rendered by the application. The main goal of the menu was to promote layout consistency during user navigation and to enable quick jumps to other sections of the application. The four sections of the menu provided named links to various points of interest within the application. In contrast to the first prototype, the second prototype does not have the same level of concentration of information.

Figure 11 (Main Screen)
Figure 12 (Add Location)

Figure 13 (Search Results)
High Fidelity Prototype:

During the end phase of the GUI design process, the first (original) prototype was deemed to be most flexible and straightforward to use. The team’s goal was to maximize a user’s experience with the application via the use of compact interface, pleasant coloring, and visual cues (images). Prototype #1 was revised to include “Add Location” as a tab rather than a stand alone button. This way there is a consistent transition from one screen to another in all cases via the tabs.

Everyone on the team agreed that the interface should minimize the level of user confusion at all costs. The team decided to group relevant field and controls together to facilitate user convenience and promote a sense of consistency.

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Figure 14 (Main Screen)
We arrived at the high fidelity prototype through a constant refinement of the screens, their controls, and coloring schemes. Consistency and visual appeal were always at the top of our consideration to help us align ourselves with the design techniques discuss in the class.
Usability Testing

Usability testing study was conducted to test the graphical user interface of the Recycling@UM application. The subjects were selected from the likely target demographic for the application (individuals living, working, or attending college in or around College Park, MD). One of the subjects participated in a trial run of the study as well as the actual usability test. In the trial run, the subject completed a few of the tasks and gave some useful input on changes to make. These changes were implemented, and the new version of the application was used for the usability study.

The usability study consisted of a pre-test (see appendix A), a set of tasks (see appendix B) that the subjects were asked to complete, and a post-test (see appendix C). The subjects were observed while completing the tasks.

Usability Test Descriptions

A 20-year old woman, college junior moderate computer skills, was pleased with the overall atheistic choices of the application, but did not find it very practical. Subject was able to complete all the tasks but got stuck inserting a photo into a new location posting. Otherwise subject had no trouble navigating the application and seemed very at ease when using it. The subject had failed to use the quick navigation buttons and instead used the search bar to look for the “Batteries” locations. During the post test the subject revealed that the quick navigation buttons did not actually look like buttons, suggested giving them a 3D look for clarity. The subject was also displeased with the state selection dropdown menu, finding the inability to type in the state name a hindrance.

A 28-year old woman, college graduate with moderate computer skills, liked the design of the application and completed the given tasks without any problems. She found that application is very easy to use without any need of additional help. The person liked that the most important part of the application (the search) is displayed on the main page, without the need to perform additional tasks. According to the subject, help is nicely organized and brings attention to the key fields that enables user to scan through and read only desired parts. The subject was a bit confused by the location numbering when there were more than eight items and after pressing next, location numbers instead of continuing (9, 10, ..) started from (1, 2, ..). She wished to click on a location in the locations and be directed to the specified location on the map. Did not like the fact that she was required to write a location name in the “Add Location” form and that name was not even displayed in the location’s field when searched.

A 33-year old man, college graduate, with excellent computer skills, was very excited about the map; liked the idea of displaying pictures. According to subject the application is self-explanatory and easy to use. Colors are well chosen. The idea of having buttons for the most used items is excellent as well as having the map on the first page of the application. According to the subject, it would be a shame not to use this useful website. Also, he loved recycling for cash idea. Frustration occurred when the user was trying to click on one of the overlapping bubbles on the map. He had hard time clicking on the bubble Nr.1; therefore, the subject
suggested making links in the location field, clickable. Also, he suggested adding phone numbers of each location.

A 21-year-old student, with average computer skills, was able to complete the assigned tasks without needing help. He seemed neutral toward the practical applications of the project, ranking it a 6 on the satisfaction scale. Liked the use of color and thought the tabs were well designed. Despite liking the design, the subject didn’t think he would use it again. The subject was confused why the map didn’t center on search results; frustrated that search results disappeared when switching tabs, although this was corrected in an updated version. He didn’t like that recycling locations don’t have names even though a name was given when adding a new location.

A 19-year-old male, college sophomore, with excellent computer skills, was excited about the idea of the application, and said that he found it very easy and straightforward to use. He appreciated the option to search for recycling centers that offer cash for items. Additionally, he liked the fact that the map was immediately available on the main screen. According to the subject, the application was well organized, and he would be likely to use it again. The subject suggested that the application should clarify which items could be recycled for cash at a given location (currently the location is either marked as giving cash or not). He wanted to see the for cash details at the item level (for example: a center could offer cash for ink cartridges, but not for paper). He suggested adding names of the recycling centers to the info bubbles that appear when clicking on a pin marker on the map.

A 19-year-old female, college sophomore, with good computer skills, completed the assigned tasks without difficulty. She found the application to be easy to use and clear, and that everything was easy to find. She liked the fact that the search and quick search buttons were on the first screen, and required only a click or two to use. The subject reported that she would be likely to use the application again. She suggested re-centering the map and zooming out so that all results were visible on the map after searching. It was also not immediately obvious to her that the pin markers on the map were clickable, but this was discovered toward the end of the list of tasks.

Testing Results

Majority of the users who participated in testing were pleased with the application. However, we wish the number of users who are likely to use it again were different. Users found the interface generally intuitive and easy to use. In general, they were able to complete exercise the interface’s functionality without significant difficulties. All users were pleased with the color schemes and ease of navigation of the application.
Statistics

Overall satisfied:  83%
Map satisfied:   88%
Able to complete tasks: 100%
Likely to use again:  66%

After performing the above usability tests, the following problems were discovered:

1) Location result numbering had to be fixed
2) Name field
3) Overlapping bubble problem
4) Centering the map
5) Make list of locations clickable
6) Quick Navigation buttons should be identified as clickable
7) State Selection
8) Show cash details at the item level
9) Show that markers can be clicked
Conclusion

As of today December 12th 2008, the Recycling@UM application is mostly complete but is still not ready for a beta release. So far our designers have created a working, fairly polished interface that has performed extremely well in usability testing. Most users had no problem navigating to specific parts of the application and reported that it was “very easy and straight-forward to use.” Our developers, using the Google API as well as their own code, implemented the search, submit and help functions of the application. In its current state, Recycling@UM allows users to find a recycling point based on item type as well as cash back availability. When adding a new recycling point, users can enter address information, upload a photo of the location and enter the items the location accepts in a free form text box. There is an extensive help section in the application as well as a section that deals with the reasons for recycling.

Despite the positive results from the usability testing, there quite a few things that need to be added or modified before the application is released. User testing has also revealed that there is a disconnect between the text listing of the results and the markers on the map. One of the best solutions to this problem is to place the number of the location, as seen in the text listing, inside the actual marker and to allow the user to click on the text result in order to pop out the information for that location on the map. The map also needs better handling of overlapping markers. During the usability testing some of us observed that users were not using the “quick search” buttons at the top of the map. When asked about these buttons in the post-test, users said that they were not aware that those were clickable. One way to improve this is by making each of those buttons look 3D and have a more visible effect on a mouse rollover. When entering data for a new location almost all of the users were hampered by the dropdown box for state selection. According to post-test responses it would be much quicker to allow the user to type in the state while showing them all the possible options via a dropdown.

To facilitate better searching abilities and ensure data integrity users should choose what items a location point accepts from a list box instead of typing them in free text. This would improve searching speed especially when the data set grows large. Another must-have feature is a system of ensuring data integrity for new, user entered locations. This would be a 2-step process where a new posting is first checked by a dedicated administrator to make sure that it is legitimate (no profanity or fake/inappropriate photos). The second step would involve user interaction, where users would confirm or deny the newly added location and any location denied a certain number of times would get discarded from the database. Since users are much more likely to recycle items if they get money for them, our application should highlight which specific items can be turned in for cash at which locations. In addition, information should be provided for each location that offers cash back that will tell the user exactly how to get money for those specific items.

The features listed above should be implemented before this application goes live, while the following items can be addressed in future releases. Recycling@UM is currently developed on the Flash platform, which is very difficult to modify especially as the application grows larger. I propose that the entire app be ported to an AJAX framework with a Java back-end and a Hibernate persistence layer. The Java back-end would retrieve data from the Hibernate database and send it via XML to the client side, where it would be processed by JavaScript into
meaningful output. As more and more data goes into the application a database such as Hibernate will be necessary to provide quick searching and saving of location points. This whole framework will need to be run on a load balancing server such as JBoss in order to keep up with user demand.

The user demand will come from expanding this application to a national scale or at least a state scale. In order to achieve this goal the search feature will have to be improved drastically to allow users to search by location and to sort the results by distance. To expand our data set we would need to set up a team whose job it would be to find and confirm new recycling locations. This of course goes well beyond the foreseeable future and focus should be given to completing and improving the current feature set.

Acknowledgements

Thanks to the team members for working diligently on this project throughout the semester. Thanks to Dr. Shneiderman and Nir for the support and creative ideas. Thanks to the people who helped us with the usability tests.

References


8. Ludwig, TD; Gray, TW; Rowell, A., “Increasing Recycling in Academic


17. MarylandRecycling http://www.mde.state.md.us/Programs/LandPrograms/Recycling/md_recycling/index.asp
Appendix A: Pre-Test Questionnaire

Recycling@UM Pre-test Questionnaire

What is your age?

☐ < 20  ☐ 20-30  ☐ 30-40  ☐ 40-50  ☐ 50-60  ☐ > 60

What is your gender?

☐ Male  ☐ Female

What is your education?

☐ High School  ☐ College/University  ☐ Graduate and beyond

How many hours per day do you use computer?

☐ < 1  ☐ 1-3  ☐ 3-5  ☐ 5-7  ☐ 7-9  ☐ > 9

Are you wearing glasses/contact lenses?

☐ No  ☐ Yes

Do you have any motor problems that can slow down your typing?

☐ No  ☐ Yes  Please specify: _____________________________

We appreciate your help!
Appendix B: User Task List

Recycling@UM

User Task List

Task 1:
For this task please navigate to our website and find all the recycling points that accept used batteries. Pick two recycling points that are the closest to your location and write down the Name and Address of each below:

Recycling Point 1
Name:
Address:

Recycling Point 2
Name:
Address:

Task 2:
For this task we will ask you to add a new recycling point to our database. This recycling point should have the following parameters:
Staples Store
8125 Greenbelt Rd
College Park, MD 20740

Accepts: Batteries, Cartridges and Old Computers
This location also provides cash for cartridges.
A picture of this location is provided on the Desktop under the name Staples.jpg

Task 3:
For this task please find and click on the recycling point that you had just created and confirm that the information presented is the same as listed above.

Task 4:
For this task please follow the instructions in the help section to find a recycling point that accepts old printer cartridges for money. Once again please write down the information below:
Recycling Point 1
Name:
Address:
Appendix C: Post-Test Questionnaire

Recycling@UM Post-test Questionnaire

On a scale of 1-10, rate your overall satisfaction with the interface.

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<th>7</th>
<th>8</th>
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<tr>
<td>Not satisfied</td>
<td>Neutral</td>
<td>Very satisfied</td>
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On a scale of 1-10, rate your overall satisfaction with the map feature.

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<th>7</th>
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<th>9</th>
<th>10</th>
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<tbody>
<tr>
<td>Not satisfied</td>
<td>Neutral</td>
<td>Very satisfied</td>
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</table>

Were any parts of the interface confusing? Please describe.

__________________________________________________________

Were you able to complete all assigned tasks?

☐ Yes  ☐ No  Please specify: ________________________________

Based on your experience with the interface, are you likely to use it again?

☐ Yes  ☐ No

Please write any general comments you have.

We appreciate your help!