THE GREAT GREEN INTERACTIVE QUALIFYING PROJECT

An Interactive Qualifying Project Report

submitted to the faculty of

WORCESTER POLYTECHNIC INSTITUTE

In the partial fulfillment of requirements for the

Degree of Bachelor of Science

By

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April 16, 2005

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ABSTRACT

This project was designed to create an informative, internet based, interactive education game for the Unions of Concerned Scientists. Using the latest Java technology we created a board game style feature that utilized the information presented in book *The Consumers Guide to Effective Environmental Choices*. The information was presented in the form of questions and life choices. The results of the life choices were displayed in an easy to understand graphic featured called the envirometer. The completed feature was presented on the UCS website and received 100,000 visitors in the first month and 80% of users surveyed expressed that they learned something new about the impacts of their consumer activities.

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INTRODUCTION

Educational software has been common since desktop computers began entering the home in the early 80's. An entire generation grew up learning multiplication tables playing Math Blaster or learning history on the Oregon Trail. This changed in the late 90's when the Internet exploded as a new median to access information world wide. In the past five years the Internet has evolved into an informational tool and multimedia experience. Macromedia Flash; a tool that allows software developers to integrate video, text, and audio graphics into robust interactive applications; created a new online environment of niche interactive games ranging from punting an animated penguin for distance to learning about the effects of recycling programs in your neighborhood.

This change spawned a generation full of mixed messages. The old adage "less is more" no longer applied and the new motto was "more is more." Recycling and conservation became part of our grade school curriculum and our families moved into bigger houses and bought Sport Utility Vehicles. It became "in" to be environmentally conscious. Not recycling became taboo and there were a thousand ways to save the environment. Each time a new environmental crisis was introduced there were more things to do. Use plastic instead of paper and don't use spray cans, or use cloth diapers instead of disposable, for example. The problem was these things obscured big things and caused a misunderstanding of the real environmental impact.

In October of 1998 we set out to develop a multi-media, online, interactive feature for the Union of Concerned Scientists. The goal of the project was to create an interactive feature that would reach a large number of people and inform them about environmental consequences of consumer choices. The feature would demonstrate the impacts of choices big and small and help focus consumers on choices that mattered most. In addition the project was to use a unique, high tech median to help enforce the "cutting edge" image of *The Union of Concerned Scientists* and promote their book *The Consumers Guide to Effective Environmental Choices*. The feature needed to be playful and fun yet also informative and engaging to attract a demographic that would reach beyond the current UCS member base. We determined an online game would be the best tool for meeting our goals.

To effectively communicate a clear message about the environmental impacts of consumer choices we needed to understand them. As part of this process we studied the *Consumers Guide to Effective Environmental Choices* and worked closely with the authors to understand the data behind the book. By reviewing the book *Environmental Overkill* we learned a contrasting view to the material presented in the *Consumers Guide to Effective Environmental Choices*. We also needed to understand available technologies that could help build an interactive, online, computer game. We determined the best platform to achieve our goal was Java.

To evaluate the effectiveness of our game in educating consumers we designed clear, easy to understand, and unbiased surveys. For this task we consulted our WPI IQP Handbook and developed two surveys for different phases of the project. The intent of the surveys was to guide design and assess the effectiveness of the game in achieving our goals. The last metrics to assess the effectiveness of our feature was publicity and number of users who played the game. The result of our project was very positive.

BACKGROUND

2.1 Union of Concerned Scientists

Founded in 1969, the Union of Concerned Scientists is an organization of approximately one hundred thousand scientists of science minded individuals concerned about the environmental health and safety of the planet earth. The organization began at the Massachusetts Institute of technology with a group of students and faculty that felt society was misusing technology. Their mission was to educate the masses and help shift the use of science and technology to improve the environment and cure the world's ills. Since 1969 the union has worked using science to transform transportation policy, promote agriculture, limit weapons proliferation and educate consumers about the environmental impacts of their behaviors.

2.2 Consumer Impacts on the Environment

In 1994 the College of Environmental Science and Forestry of the State University of New York estimated that the average baby born in 1999, in their lifetime, will generate "one million kilograms of atmospheric waste, ten millions kilograms of liquid waste and one million kilograms of solid waste." The group of scholars also projected that with the current rate the average American would consume 700 kilograms of minerals and 24 billions BTUs of energy (Bower and Leon).

At first glance these estimates may seem preposterous but consider that currently over 18 billions disposable diapers are consumed each year and over 70 million pounds of pesticides are used to treat our lawns and gardens each year (Bower and Leon). The rate of consumption in America is growing and the data presented in *The Consumers Guide to Effective Environmental Choices* demonstrate the increase but common sense dictates that it does not take reams of data, simply look at the homes and cars of your friends and neighbors. Since 1970 the average family household living space has increased from 1400 square feet to 2100 square feet at the same time the family size has decreased (Bower and Leon). Heating today's bigger houses and fueling the larger, more powerful vehicles requires tremendous resources, plus the materials consumed building them. Leonard Fine and Herbert Beal in their text book Chemistry for Engineers and Scientists, state "within the short span of perhaps less than 200 years from the first discovery of petroleum in the united state (in 1859), our estimated total recoverable resources may well be more or less exhausted."

As we consume these fossil fuels we are sending fine particulate matter and carbon dioxide into the atmosphere. In California it is estimated that as many as 3000 deaths each year are caused by particulate matter plus an additional 60,000 to 200,000 respiratory infections. These pollutants also contribute to global warming, in the past 100 years the average temperature worldwide has increased between 0.5 and 1.1 degrees Fahrenheit. This global warming is causing glacial melting and rises in sea level that has begun to alter habitats and communities. Man is destroying habitats even faster by building big houses further and further from the city encroaching on natural habitats and cutting an enormous number of trees to build bigger and bigger homes. Common sense dictates there is only so much "stuff" in the world the more we use and destroy the less there will be for future generations.

2.3 Project Goal

On April 12th, 1999 the Union of Concerned scientists released a new book titled *The Consumers Guide to Effective Environmental Choices*. The book, written by Dr. Michael Brower and Dr. Warren Leon, details the misconceptions and hard science behind consumer activities. As part of this project a detailed review of the book and materials contained in it follows this section. The goal of this project is to further the mission of the Union of Concerned Scientist by using new technology to develop a fun and exciting interactive feature, based on the science in the new book. This interactive feature will simplify the large amount of

environmental advice available and help users understand what the most important decisions are. The feature will offer useful knowledge on consumer's impacts while supporting the secondary goal of promoting the new book by piquing interest in the subject matter. Additionally the effectiveness of this tool will be gauged through the use of consumer surveys.

2.4 Java

This project was written using Java. Java is a programming language and runtime environment created by Sun Microsystems. It is a language that tries to take all the advantages of C/C++ (including syntax) and put them into a powerful programming language that shields the programmer from many of the common programming issues that must be addressed when using C/C++; the biggest issue being the misuse of pointers which can create some hard to trace bugs in the completed program. The Java source code is compiled by a Java compiler into byte code which is then interpreted by the Java Virtual Machine that is running on the host computer. The actual byte code produced by the Java compiler is not directly executable in most cases and must be interpreted by the Java Virtual Machine. Though this may have minor performance issues, it also adds to the portability of the code since recompiling for different platforms is not necessary. Each platform would run its own Java Virtual Machine and would interpret and execute the byte code. This allows the program to be written once and then run anywhere that has a Java Virtual Machine. So a Java applet written

on a Macintosh will, in theory, run in exactly the same way on a PC and the Java Virtual Machine will take care of all the cross-platform dirty work.

When the project was written, the Java language itself was constantly being improved and extended at Sun, so this had led to an inconsistent level of support in the real world at that time. For example, version 4 of Netscape's Communicator software available then came with several different versions of the Java Virtual Machine. Though the major version number of Communicator 4 was the same across all minor versions, the support of Java was inconsistent. Versions 4.0 – 4.05 of Netscape Communicator didn't fully support Java 1.1, however, versions 4.06 and up all did support it. A lot of people were still using version 4.05 and below and these people were not able to run an applet written for Java 1.1. These were the inconsistencies that had to be considered when developing the application in Java. Developing an applet in Java was a tradeoff. The programmer had to carefully weigh what features they want to support against the population they hoped to reach.

Though the inconsistent support of Java was a problem for some developers, there were many advantages to using Java to develop real-time interactive projects. This was because the alternatives available were not designed for real-time response that an interactive feature needs. For example, there is some level of interactivity that can be achieved by using server-side scripts to do interactive projects. Examples of this would be using CGI scripts, PHP scripts, Java servlets, JSPs, Cold Fusion, Perl, etc. These alternatives,

however, can't respond in real time since they are run server side and are only executed in response to a call from the user's web browser. The problem here is that the browser must specifically call the script at regular intervals. It is not possible to automatically and instantly update the browser if the user presses the arrow key, for instance. Also, providing animation that moves seamlessly across the screen for visual effects is limited to animated gifs and JavaScript. However, JavaScript and animated gifs had too many limitations to be effectively used in an interactive project of this scope.   Because of these limitations, the alternatives available didn't work well for a large, real-time, interactive project such as the Great Green Web Game.

Java, however, is a complete programming language. It can be used to update its display at any interval in any way offering unlimited potential for animation. Also, all this can be done in real-time which is a key requirement in a game style project such as The Great Green Web Game. The platform independence also allows the game to support the widest possible user base without having to build a different version for each platform. All the user needs is a Java Virtual Machine on their platform. Java, however, does have a few limitations. One of these limitations is that it wasn't consistently supported everywhere when the project was written. Because of this it wasn't possible to be 100% certain that it would run the same on all users' computers. Different people could be using different virtual machines that support different features, or even older versions of the same virtual machine that may not include all the

features that the applet was designed to use. The second major limitation of Java is the security limitations imposed upon it by the web browsers that run the virtual machine within it. These limitations are for security purposes so that someone with hostile intentions can not damage a user's computer just by having them click on a link.

2.5 Interactive Qualifying Project

The IQP (Interactive Qualifying Project) is one of two projects required for the completion of a degree program at WPI (Worcester Polytechnic Institute). The purpose of the IQP is to relate science and technology to society. This project uses the latest internet technology to help improve the environment by educating consumers about the environmental impacts of their decisions.

LITERATURE REVIEW

3.1 *The Consumers Guide to Effective Environmental Choices*

The Consumers Guide to Effective Environmental Choices, written by Dr. Michael Brower and Dr. Warren Leon, details the misconceptions and hard science behind consumer activities. The authors caution against the danger of too much environmental advice and rather than focusing on thousands of activities to save the environment the authors encourage readers to focus on the choices that offer the most impact to help the environment. *The Consumers Guide to Effective Environmental Choices* is composed of two sections, Part I:

Consumers and the Environment and Part II: What You Can Do. The book also includes an appendix with a section detailing research methods and results, resources for concerned citizens and finally notes on references and assumptions in the text.

The consumers and the environment section deals with how various consumer activities impact the environment and to what extent this impact can reach. The section breaks down various activities and the relative damage for each. The authors define the most harmful consumer activities as:

1. Cars and light trucks

2. Meats and poultry

3. Fruits, vegetables and grains

4. Home heating, hot water, and air conditioning

5. Household appliances and lighting

6. Home constructions

7. Household water and sewerage

The authors do not necessarily discourage these activates but they detail how the activities impact 4 key components of the environment. The key components being global warming, air pollution, water pollution and habitat alteration.

In the second section of *The Consumers Guide to Effective Environmental Choices* transitions from how consumers impact the environment to what they can do to reduce their impact. With the continuing theme from the first section the authors detail the 7 Rules for Responsible Consumption.

1. Give special attention to major purposes – large purchases often have a greater impact on the environment than smaller purchases. For example when purchasing a refrigerator, choosing a more energy efficient model will save more energy than buying recycled paper towels.

2. Become a weight watcher – In all likelihood, the heavier the item purchases the more resources were consumed making it.

3. Analyze you consumption quantitatively – Consider how much the activity actually consumes. For example if consumers choose to turn off the water while brushing their teeth they may save two gallons of water but watering their lawn uses 100 gallons per day.

4. Don't worry or feel guilty about unimportant decisions – Past environmental reasoning seemed to put equal weight on all activates for example choosing paper grocery bags instead of plastic at the grocery store. The authors argue that not only is plastic perhaps slightly better than paper, but the actual damage caused is insignificant compared to the SUV in the driveway.

5. Looks for opportunities to be a leader – The authors encourage that consumers get involved in public policy to help the environment by being environmental role models. For example the authors suggest a consumer can set an example for their neighborhood by riding their bike to work.

6. Buy more of those things that help the environment – While slightly more expensive the authors encourage purchasing organic and environmentally

friend products. Purchasing more conscientious products serves two purposes, one to help the environment and second to encourage more environmentally friendly consumer products in the market place.

7. Think about non-environmental reasons for reducing consumption – The authors encourage readers to seek secondary reasons to reduce consumption for example reducing debt or simplifying your life.

Data in *The Consumers Guide to Effective Environmental Choices* was compiled using tool called Comparative Risk Assessment which is commonly used by environmental scientists. Comparative Risk Assessment works by first pulling together a list of all hazards within a category for risk, such as water pollution. Then all of the available data is pulled together for each risk within the category. After assessing all the risks for a variety of predefined topics the final results are compiled into a weighted list from lowest to highest impact in the category. The authors caution that the final results should be viewed with caution since the method is not a precision tool that can distinguish between problems of comparable magnitude.

In conclusion we felt that the information provided in *The Consumers Guide to Effective Environmental Choices* was extremely valuable and the approach of focusing on core actives was very effective.

3.2 *Environmental Overkill*

Environmental Overkill by Dixy Lee Ray is a book about scientific honesty and a common sense approach to environmental issues. The author, a former Washington state governor and winner of the United Nations peace prize, details the current policies and beliefs about the environment. He delves into policies on air pollution, land usage, population and consumerism. The author's approach is to the right of many typical green books and at points takes issues with the tactics and politics behind the green movement.

Addressing the many components of air pollution, including global warming, ozone depletion, ultraviolet rays, and smog, the author's conclusion encourages readers to judge for themselves based presented facts. The facts the author presents are startling and in contrast to the mainstream view. When addressing global warming the author points out that the slight warming of the 1980's actually offsets the slight cooling of the 1970's and ultimately climates in the 1990's are indeed cooling. As an example the author details the shrinking climate zone for orange crops moving south. According to the author this indicates a trend toward cooler temperatures.

On the topic of Ozone (an unstable molecule or three Oxygen atoms that absorbs UV radiation from the Sun) depletion, the author asks readers "Who should we believe?" and gives advice to look for evidence and not arguments. She cautions that science should not be a popularity pole. As an example of a scientific argument against the Ozone the author sites a 1992 NASA press detailing a dramatic hole in the Ozone layer over Antarctica. She states that the

report did not tell the whole truth. It was used to create a media frenzy that resulted in the United States Senate passing a 97-0 amendment accelerating the phase-out of CFCs (Chlorofluorocarbons), the suspected cause of Ozone depletion, by 1995. The fact the report left out, the author writes, was that this Ozone hole (defined a decrease in the amount of Ozone by 50 percent) is a documented phenomenon which occurs at the end of the dark, cold Antarctic winter and lasts less than five weeks. The phenomenon was first documented in 1956-1957 far before the mainstream use of CFCs, she writes.

The author defines Smog as fine particulate matter including sulfur oxides, hydrocarbon, nitrogen oxides, carbon monoxide and ground level Ozone. The science about smog is vague and poorly understood, the author indicates, and the issue seems to more of a regional problem than a nationwide problem. When large numbers of people settle in a small area, natural vegetation is removed and replaced with asphalt and building materials, these surfaces reflect light differently that green leafy surfaces and effectively create a "heat island." This "heat island" interferes with the dispersion of pollutants by altering air circulation. Geography plays a role, the author explains, which why areas of the most dense smog are not always locations with the most contributors. While local problems with smog are real, the author argues, the current approach set by the Clean Air Act if 1970 treats all locations as being equal and puts an unfair burden on companies and citizens in areas not severely impacted. The author details the standards imposed for fine particulate matter and explains that the

limits are unreasonably low considering there is no scientific proof that levels even several times higher result in respiratory problems as claimed.

On the subject of land usage the author focuses particularly on the issue of deforestation and wetland use. In depth analysis of the logging industry is provided and a review of the wetland protection regulations present at the time of publication (1993). As an example of how environmental issues are exaggerated she details NASA images of the pacific-northwest taken in the 1990s that indicate enormous areas of deforestation. Again, the author explains how the media ran with the story with out checking the facts, months later it was determined that what the satellite photos do not show is the thick coverage of 4-10 trees or even the 8-10 foot tall trees in the young forest. The author explains that for every 83 trees that are cut, 400 young trees are replanted. The author debunks the misconception that "old trees" are better than "new trees" by explaining the natural cycle of forests and how some populations of wildlife prefer new growth and prosper in the replanted forests.

The issue of consumerism is addressed by the author from the point of view of supply and usage, not actual environmental impacts. The impacts of consumerism are instead reflected in sections dealing specifically with environmental damage. Specifically targeted are the issues of the genetic modification of crops, the use of pesticides and fertilizers and the notion of suburban sprawl. The author extols the benefits of genetically modified crops explaining how the impact of "toxic" pesticides is often based on slanted science

and misconceptions. As an example of how science is slanted the author points out that we consume nearly 10,000 times more natural pesticides (naturally occurring chemicals plants evolved to protect themselves) by weight than of man made residues. When examined for toxicity and carcinogenicity many of these natural pesticides test positive.

In conclusion we felt the information provided by *Environmental Overkill* was insightful and thought provoking and offered some balance to prevailing environmental notions.

3.3 *Recycle City*

Recycle City is an interactive online feature designed by the EPA (Environmental Protection Agency) in Macromedia Flash. The program allows users to run a virtual City Hall and observe how various programs impact the fictional town. The game begins on a map of a fictional city which is visually run down and clearly in need of waste reduction programs. The need for waste reduction programs is indicated by trash in the streets, the burning of leaves on a front lawn, a dilapidated junk yard and a large landfill behind city hall.

The programs offered by the virtual City Hall include the Reuse Center to recycle household items such as couches and lamps, Grass Recycling, Home Composting, Pay as you Throw trash removal program, Business Recycling, Business Composting, Drop-off Recycling Center, Home Yard Trimming Pick-up, Home Recycling Pick-up. For each program implemented by City Hall there is a bar graph indicating the current waste per day for a variety of materials including

paper, glass, steel, aluminum, plastics, wood, yard trimmings and textiles. There are also bar graphs for overall waste and total cost in a city hall waste recovered section.

The game was both easy to use and engaging. We found the information provided on program costs and benefits insightful. Implementing the programs and seeing the visual changes to the city as well as the changes to the various waste categories made the material fun and interactive. For each program there was detailed information provided on what communities can do and examples of similar programs in action.

The only down side of the game we was the cost details were not clearly defined. It was uncertain if the $73,000 cost of the Reuse Center was for the implementation or the ongoing costs. Also for the Reuse Center there were some interesting facts on revenue generated by similar centers and it would have been interesting to see how that was reflected in our City Hall budget.

METHODOLOGY

The technical aspect of the project would consist of three parts, the game logic and art, the text resources that would make up the various questions and event spaces, and a testing a feedback phase. The first two phases were kept separate to allow the java code and feel of the game to be developed independently of the written material. This was necessary because we

anticipated that the text from the book that was used in the game would go through many more revisions than the game code itself due to both our own revisions and those resulting from changes to the book, which wasn't yet completed at the time the game was being built. Keeping the text separate would also make it easier to maintain the game in the future since game text could be changed and revised in the future without having to recompile the source code. Additionally, if UCS wished to translate the game to different languages, they would only have to translate the text resource files and no code changes would be necessary because Java's built in international support will handle any of the special font glyphs necessary to support any foreign language text.

Development of the game Java code followed the normal development cycle of any software application. We first had the planning phase where all the details of the game itself, including the game flow and how it would play, were planned. UCS was allowed some input during this phase to verify that their expectations and ours were consistent. We anticipated this phase lasting between 2 – 3 weeks.

The second phase of the game development was actually building the game. A schedule for game development in which each part of the game would be listed and allocated time was written and followed. Each part was also made available online for UCS and WPI staff to view so that the project progress could be monitored and any potential problems could be spotted and fixed early.

Stability was also a large focus during development as, at the time of release, Java applets didn't have a reputation for stability, and we wanted to provide a stable applet. The tools used for developing the Java game would be MS-DOS edit, to edit source files; the Java JDK 1.2 beta development kit, to compile the Java source files; Photoshop, to edit the graphics used in the game; and Netscape Communicator and Internet Explorer, for testing the game.

Special care was taken while testing the code since it was written to provide compatibility with the widest range of web browsers installed on users' computers. This involved doing some research to find out what versions of which browsers were being used by what percentage of the internet community.

During the software development, the text for the game was written in parallel. The text was based largely off the book with some feedback from UCS regarding what they wanted in the game, and what they wanted to leave only in the book. A set format for this text was developed so that it could be transparently "plugged" into the game for testing purposes.

The third and final stage of development was testing and feedback. During this stage the completed game was made available to UCS and WPI staff, and anyone else invited into the process, to be played, tested, and most importantly, to give us feedback on how the information in the game and book would effect peoples' perspective on their actions on the environment around them. The feedback was provided to us through a questionnaire we designed to measure the effectiveness of the game on those who played it.

The normal fourth stage of software development, maintenance, was not necessary for this project as the final step involved turning the project over to UCS for their web site, with no further obligations on the part of WPI. The design of the game, however, made it easy for UCS to maintain the text used for the game so that questions and content could be changed at UCS's discretion.

The methodology behind the design of questionnaires followed suggestions provided in Chapter 10 of the *Handbook for Interactive Qualifying Project Advisors and Students*. We implemented three rounds of surveying. The first round was administrated to assess the effectiveness of a variety of proposals for interactive features. The second phase was implemented as we neared a final beta phase of the selected feature and surveyed for problems with the feature and potential improvements. A final survey was designed for the final release of the feature and surveyed the effectiveness of communicating the message of environmental impacts to a broad base of users.

Questions were designed to be straight forward and to not lead testers to a desired result. Questions consisted of both pull down selections on an HTML (Hypertext Markup Language) form and open text entry fields. The selection fields allowed us to compare results across users with a common metric and the free test answers allowed users to submit comments to improve the feature or report bugs.

DESIGN AND IMPLEMENTATION

The design and implementation phase of the project was composed of an initial proposal to UCS followed by detailed expansion of the chosen interactive game idea. The content of the game was designed in parallel with the code. It went through an extensive review process with both UCS staff and the authors of the source of our data, *The Consumers Guide to Effective Environmental Choices*. Feedback was continuous throughout the implementation and design phase. Final acceptance criteria were agreed upon in a final proposal submitted after the beginning of programming work.

5.1 Initial Proposal

As part of the preliminary project topic decision we presented the Union of Concerned Scientists with four different ideas for the interactive feature. These ideas were a board game, a virtual mall shopping trip, a quiz game show, and a simple questionnaire where we would analyze the users' choices. These four ideas were as follows.

The Board Game:

The initial proposal for the board game was to have a course that the player would advance through that would be set in a small town setting. The player would advance their game piece along by the roll of a die. We also determined that there should only be approximately 30 spaces on the game board so that it would play out quick enough to prevent the player from getting bored, but long enough such that they could learn something from it. At various

points along the game board there would also be milestone spaces where the player would be forced to stop for a moment to answer a major life-choices milestone question. The player's answer to these questions would be what determines their actual score at the end of the game. We also thought that by adding some brief justifications to justify why certain choices have certain effects on the environment would further aid the player in their learning experience. In addition to the life choices spaces there would also be information spaces that might give a helpful hint as to the best way to answer a future life choices, provided the player happens to land on the space. A third space type that was planned was the random event space. This space would just be a random event that you would land on that would cause some kind of impact on your total score; it could be good or bad, it just throws an element of randomness and chance into the game. The fourth space type would be the common space. The common spaces consist entirely of move ahead/back spaces that the player has a chance of landing on to either throw them back a bit, or send them ahead. At the end of the game we could then present the player with a summary of their performance as well as some pointers as to how they could score a little better if possible. We could also provide links to relevant locations on the UCS web site if the player wishes to research more information.

The Virtual Mall:

For this idea, the user would be presented with a virtual mall full of various shops that they could shop from. The idea here is that the person playing can go to each shop and buy things as they would in real life to get an idea as to how they are impacting the environment. The player's cumulative score would be represented by a bar on the screen that would increase as their environmental impact increases. The mall would contain shops such as real estate, grocery, electronics, auto and marine dealerships. By making purchases at these various shops the player can see just what their environmental impact is, and have a little fun along the way. To add an element of entertainment to the feature, we would also add events such as finding an empty soda can on the ground. If the player would choose to click on it and recycle it their environmental impact would be decreased a little. The player would be able to leave the mall at any time by clicking on the mall exit. At this point he or she will be given a summary of what they bought, what they could have bought instead if a better choice exists, and what justification there is for the suggestion. Links to relevant areas of the UCS web site would also be provided to allow the people running through the program a chance to look up more information on the topic. The end goal of this project would be to educate people on the environmental impacts of their choices, such as those made in a simple shopping mall.

The Quiz Game Show:

This game would mimic the style of popular game shows such as Jeopardy, only the questions would be based on material from The *Consumers Guide to Effective Environmental Choices*. There would be two other computer controlled contestants that would attempt to answer the questions with a randomly determined delay before they would buzz in, so as to not exclude any chances of the player buzzing in. There would also be a time limit, if nobody answers within this time limit, the question is thrown out and another is asked. There is also a time limit to answer once a contestant has buzzed in. If the question is not answered within this time limit, then the amount the question is worth is deducted from that contestant's score. With that said, scoring would work as follows. The questions would be of varying difficulty, the more difficult the question the more it is worth. Answering the question correctly causes points to be added to the contestant's score. Answering it incorrectly or taking too long to answer will result in the question's value being subtracted from the contestant's current score. It would be possible for contestants to drop into negative scores, and the contestant with the highest score at the end of the game wins. Each question would also include a small piece of info that justifies the answer. This information would only be displayed after the question has been answered. It is intended that through all this the player will not only learn something, but also have fun doing it in a friendly game show environment.

The Great Green Questionnaire:

This is the simplest idea of the four. This project would consist of a CGI form where the user would fill out a form detailing their spending habits. This information would then be submitted and a summary would be displayed on the screen. This summary would consist of a rating, possibly done using a visual graphic, and a summary of how they could have chosen better in those areas that they didn't choose optimally. A series of links to related parts of the UCS web site will also be provided to allow the users to research areas that are of interest to them. The end goal of this idea is to provide the users with some feedback as to how their choices impact the environment by allowing them check what the impact is for each of their actions. It is also noted by those of us doing the project that this is also the most boring idea of the four.

5.2 Feature Design

After meeting with the Union of Concerned Scientists it was agreed upon to pursue the board game idea. We then agreed write a proposal of the questions needed as well as the contents of the game board spaces.

The contents of the game board spaces came entirely from the book, as well as the content for the life choices. By taking simple facts presented in the book and using them where appropriate we came up with a proposal for the event spaces, info spaces, and the landmark spaces. Using this new material we fashioned a more detailed proposal for the board game idea. Ideas for the name

of the board game were also suggested. The revised proposal was presented to the Union of Concerned.

For the final proposal we needed to have the flow of the game laid out in detail. This would include where the title screens would go, when the player would select their character, how the instructions for the game would be given, how the player would progress through the game, and how information would be presented to summarize the player's performance. Another important part of this final proposal was what the plot of the game would be. We needed to come up with some kind of story line and feel for the game. We decided to pursue a more cartoon-like type of appearance to give the game a lighter, more amusing feel. This would keep the players interested as they played the game so it wouldn't appear to be a fact book thrown into a board game. It was at this time that we also began sketching what we felt the characters of the game should look like.

The flow of the game was finalized and consisted of starting with a basic introduction/title screen. At this screen the player would click on the start button to move to the next part of the game. The next part would show the instructions for the game which the player would read as the rest of the game loaded. When the game finished loading, a continue button would appear for the user to click on. Upon doing this the game board would be displayed and the character selection window would pop up allowing the user to select which character they wanted to play as. Once the character is selected the game

would commence and the player would advance through the game by clicking on the "roll dice" button. Upon reaching the end of the course of spaces the player would be taken to the summary screen. At this summary screen the player's choices that were made would be analyzed and suggestions would be given as to how to improve these choices. The player would also be given the option to play again by clicking on a "play again" button.

The user interface for the game would be a simple mouse interface. Anything that the user can click on will also highlight as the mouse passes over these objects. This would make the interface as intuitive as possible so that we could attract the largest player base possible.

As mentioned previously, we began drawing up sketches as to how the artwork for the game should appear and what the layout of the game itself would be. For game characters we decided that we would have four in all; a walking recycle bin, an electric car, a walking windmill, and a floating earth. We named them Binny, Zippy, Windy, and Earthy respectively. We also drew up a sketch of the game board as well as the intro screen.

After discussing these items with UCS we agreed on a timeline for a final draft of the game board space contents, a final draft of the life choices questions, and a proposal as to how we would handle scoring in the game for the life choices and event spaces.

For the scoring aspect of the game, we proposed adding an "envirometer" which would visually show the player's score in form of environmental impact.

The envirometer would consist of four separate bars that would rate the player's environmental impact in the areas of air pollution, water pollution, habitat alteration, and global warming. Both the player's choices in the life choices space and the impacts of the random event spaces would impact on the envirometer. Upon submitting this idea along with the scores for each space as well as the draft for the questions and event spaces we got some interesting feedback from UCS.

Essentially, UCS wanted to change how the game was played entirely. They wanted to eliminate the die roll from the game. Instead they wanted the player's progress to be determined by answering questions. If the player answered a question correctly they would move ahead more spaces than if they incorrectly answered the question. If answered correctly on the first try the player would move ahead 4 spaces, if it took two tries they moved ahead 2 spaces, otherwise the player would only move ahead 1 space. Also, UCS wanted the life choices and information spaces to be removed entirely. This way the board would only consist of event spaces and common spaces. On the positive side, UCS liked the character sketches that we drew. One brief change UCS also wanted was to move the point where the player chose their character to right after the intro screen but just before the player reads the instructions. They also wanted the start game button removed so that the game would just continue right on to the character selection screen after the initial loading was finished.

After taking all this feedback and thinking it through, we drew up yet another proposal for the Union of Concerned Scientists. For this new proposal we included all the changes that UCS wanted to see. We also gave a draft for the event spaces and the order in which these spaces would appear on the board. Since some events would obviously occur at specific points in a person's life, a logical ordering was necessary. It would not make sense to users be scolded by their young child for not recycling after all their children had graduated from college and were holding down good jobs. Also added to this proposal was a draft on how the scoring would work for these event spaces. This draft was not final, since it had been agreed that both UCS and the book authors had to approve the scoring. The last part of this final proposal was a time schedule that detailed our goals for the progress of this project. This document outlined just what we expected to have done by which date. It was essentially broken down by the day and was as detailed as possible as well as aggressive. After this meeting where this final proposal was presented, we began development of the game.

5.3 Design of Life Choices

Life choices were one of the more challenging aspects of content development. After the decision to pursue the envirometer option we had to author a series of events and choices a typical user might make in life and display them visually. The book *The Consumers Guide to Effective Environmental Choices* uses a process called comparative risk assessment to weight the damage

of various environmental activities in a given category. In order to create questions that would work well with the envirometer, we needed to identify actions that that had impact in three or more of the environmental categories. Once we identified the actions we needed to figure out how to display the data.

The nature of the envirometer is that there is a center point that is neutral and some choices have positive impact from the neutral point and some have a negative impact. Determining the neutral points was based on the choices offered. We created three choices for each life event one choice was an approximate neutral point and in most cases the two other choices were a better and worse choice. The actual weights granted to each choice were derived from the tables provided in the book and while the nature of comparative risk assessment weighing does not lend well to cross category comparisons, several consultations with the authors of the book as well as ongoing feedback from users resulted in what we feel are effective results with very positive user impact. The complete set of life choice events is available in Appendix A.

5.4 Implementation of Feature

During development of the game, we kept in close contact with UCS. Each night we would email them an update outlining what we had accomplished and they would later respond with their thoughts and suggestions. During this process, many things were redesigned and some of the new graphics furnished by NMP, a small graphic design in Washington D.C hired to assist us by UCS, were added. One of the changes made initially was that the method of asking

questions was changed at first to make previously selected incorrect answers no longer selectable. This was later changed to only give the players one shot at answering the question, instead of allowing them to try again. Other changes consisted of font alterations, the removal of the "next question" and "quit" buttons, the alteration of the envirometer's order and labels and other changes to the graphical appearance and layout of the introductory screens.

Very close to the end of the development of the game we got a call from the Union of Concerned Scientists. With only about 1 day left before the game was finished, they decided they wanted to rework how the game would be played. To begin with, they wanted to remove all of the event spaces and common spaces. The reason for this was that they felt it was unfair to arbitrarily punish someone for landing on a space after answering a question correctly. They wanted to instead put the life-choices spaces back in the game and have them be the only special spaces in the game. Every other space would just be blank with no affect on the game whatsoever. Naturally, scoring would then be entirely based on these life-choices that were presented to the user. Also, UCS wanted to add the reasons for an answer being correct back into the game. These would essentially justify why a player's answer to a question was correct or incorrect and would be displayed after the player selected an answer. Initially, this explanation screen was closed by clicking on the window; UCS wanted it to just automatically go away after a few seconds. After realizing this was a bad idea, the post-answer screens were again restored to being dismissed

by a click. These changes that UCS wanted required a large amount of rewriting so we decided to finish the current version of the game and then take the additional step of and creating the new version. We would then post both versions and let the testers decide which version was better. It should be noted that this new version of the game much more closely matches the idea that we originally proposed to UCS.

Upon completing both versions of the game, they were posted on UCS's web site along with some HTML forms for submitting feedback and bug reports to us. The feedback we got back from the beta testers was fairly evenly divided. Half of the people preferred the original version with arbitrary event spaces driving score, and the other half preferred the new version were users controlled their own destiny. We decided that the split in version preference was partially due to the testing group selected. Nearly one quarter of the group selected was UCS staff that had been involved in the proposal process. We also got feedback on what parts of the game people enjoyed, and what parts they felt the game could do without. We then submitted a compiled summary of the responses to UCS with some suggestions as to what we would do next. UCS sent back a reply outlining additional changes they would like to see, one of them being to add sound.

Given these changes, we developed the final version. The graphics for this final version were changed to give the game a nicer look. Also, the scales on the envirometer bars were adjusted so that they better matched the scores

available in the game. This way it would be possible to score very well or very poorly. Also, the ending was changed to create a two-screen summary. The first screen summarized the player's score based on the number of correct answers they made and the second gave feedback as to how well their decisions were made. The sounds were also added and the final game was posted on the World Wide Web for all to see.

5.5 Final Version

The feature begins with an introduction screen. The loading bar displays the process of graphics and files being loaded from the UCS website (see figure 3). Users are prompted to select a character to use in game play (see figure 4). The characters were designed to represent environmental themes covered in the book *Consumers Guide to Effective Environmental Choice*.

The game begins with a question derived from the *Consumers Guide* (see figure 5). The game notifies the user if their answer was correct. Then it gives a detailed explanation of the correct answer (see figure 6). On yellow event spaces users are prompted to make a life decision (see figure 7). A horizontal environmental bar graph shows the users' impact on the environment. The area to the left is a positive impact and the area to the right of center negatively impacts the environment. Once made the selection is represented in the "envirometer" on the right of the screen.

When the game is completed the user is given a score based on the percentage of questions they got correct (see figure 8). If they score over

60% their score will be displayed on the high score board. The values on the board were chosen based on experience of testers. Several phrases are hard coded to summarize the responsibility level of consumers (see figure 9). An option to play again is offered.

RESULTS

Two surveys were designed and implemented for this project. The first was sent via email to a group of UCS testers as well as some family and friends for a total of 20 people. The survey consisted of 7 open ended question with the intent of evaluating the direction of development for the game (see Appendix A for list of questions).

The results of the survey were consistently positive and heavily directed the path of game development as detailed in the implementation section and software change log in Appendix A. One example of something users liked about the game was that the questions and life choices were thought provoking. Users surveyed also liked the cartoon style feel of the game and liveliness of the character animations. In our initial survey one item users did not like was that the lack of instructions and users also indicated some problems loading the feature.

The final survey was deployed via the web using an HTML form that automatically emailed completed the surveys to us. The goal of the final survey was to assess the effectiveness of the feature and to also to make a final

decision between two versions that had been built (see Appendix A for list of questions). Two types of questions were asked, opened ended and multiple choice questions. The purpose of the multiple choice answers were too allow us effectively compare results for the entire group of testers. The final group of testers consisted of 48 testers including, UCS staff, family and friends as well as arbitrarily selected WPI peers.

6.1 Survey Result and Analysis

The results of the survey were surprising. Even among users who had already read the book the game was based on, 80% of those surveyed felt they learned something new about the impact of their consumer activities (see Table 1). More than sixty five percent of individuals surveyed felt the game moved at just the right speed. Only two users answered that the game was too slow (see Table 1). An overwhelming majority of users surveyed felt the instructions provided with the game were easy to follow (see Table 1); we translate this response to indicate that the feature was easy and intuitive to use.

6.2 Final Evaluation of Objectives

The response from the public was tremendously positive. The feature was spotlighted by several media outlets including an April 1999 article on MSNBC.com and the April 27th, 1999 edition of the NH newspaper, Second *Front Page*. Stonyfield Farms Yogurt was so impressed by the feature they offered to promote it on their yogurt lids during the month of April (see figure 10). In the

first month of release approximately 100,000 users played the feature. It was

such a hit that UCS later contacted us about turning it into CD based feature as

part of a fund raising drive.

  After the release of the game we received email accolades from

individuals ranging from common web surfers to college professors who said that

they would use the game as a classroom tool. Unfortunately many of these

emails were lost over time as this final report is being submitted several years

after the completion of the project. Ultimately the fact the feature is still

available on the UCS website and is consistently rated one of their 5 most

popular features (see figure 11) speaks volumes about the games effectiveness.

DISCUSSION

The Great Green Web Game accomplished the majority of goals we set out to achieve. The game was a tremendous success and the publicity from the Stonyfield Farm Yogurt lids and various media outlets helped us achieve our goal of reaching beyond the UCS user base. In fact the game was so successful in reaching out to potential UCS members that in 2000 we were contacted by UCS to release the game on CD-ROM as a promotional give away to new members.

The results of our final survey indicated that an overwhelming majority of users learned something new from the game which was a key goal of the project. In hindsight the surveys left room for improvement and it would have added value to assess the user's level of interest in the subject matter as well as if the information learned from the game would impact their consumer behaviors. While it could be inferred by the success of the game and the results of the survey, without additional surveying there is no way to determine if the feature altered behaviors or clarified what the most important consumer choices were.

The game is still available on the UCS website and is a consistently popular feature. It still runs without issue on the latest version of Microsoft's Internet explorer on both Windows and Macintosh without any updates for six years, a fact that speaks to the cutting edge nature of the project.

Moving forward using the new technologies available the game could be made more interactive by adding a multi-user component or at a minimum creating a real top score functionality to allow players ability to compare scores with everyone else. When compared to other online games built using more basic technologies, we feel our feature is a noteworthy accomplishment.

7.1 Summary of Contributors

This project would not have had such tremendous success without the help of Anita Speiss and Eileen Quinn at UCS. Their guidance and support not only shaped the final game design, their editing shaped out material into world class content. In addition to the UCS staff the authors of the *Consumers Guide to Effective Environmental Choices* were valued contributors to the project. As students it is very rare to have the authors of your primary reference available to answer questions and explain their methodologies. Finally the completion of this project would not have been possible without Steve Pierson who worked with UCS to create the opportunity and both Mark Claypool and Dave DiBiasio who kept us on track throughout the three terms of project work and now have us back on track six years later.

1. Have you read The Consumers Guide to Effective Environmental Choices?				
Yes	No			
8	40			

2. Have you played a previous version of the great green web game?				
Yes	No			
11	37			

3. Are you a UCS employee?				
Yes	No			
11	37			

4. I learned something new about the impacts of my choices as a consumer.				
Very True	Somewhat True	Somewhat Untrue	Very Untrue	
17	25	6	0	

5. Which version of the Great Green Web Game did you like better?				
Version 1	Version 2			
22	26			

6. I found the speed of game play.				
Too Fast	A Little Fast	About Right	A Little Slow	Too Slow
0	6	31	9	2

7. I found the instructions for the game. (* To Follow)				
Easy*	Somewhat Easy*	Somewhat Difficult*	Very Difficult*	
41	7	0	0	

Table 1. Chart showing of survey responses of 48 testers, with the exception of an open text bug report field, all questions on the form utilized were mandatory.
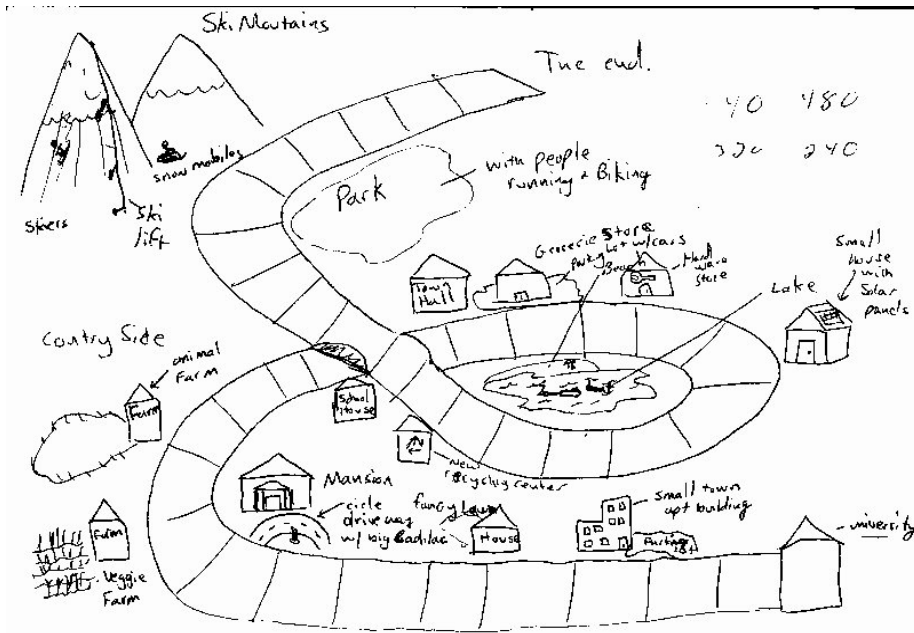
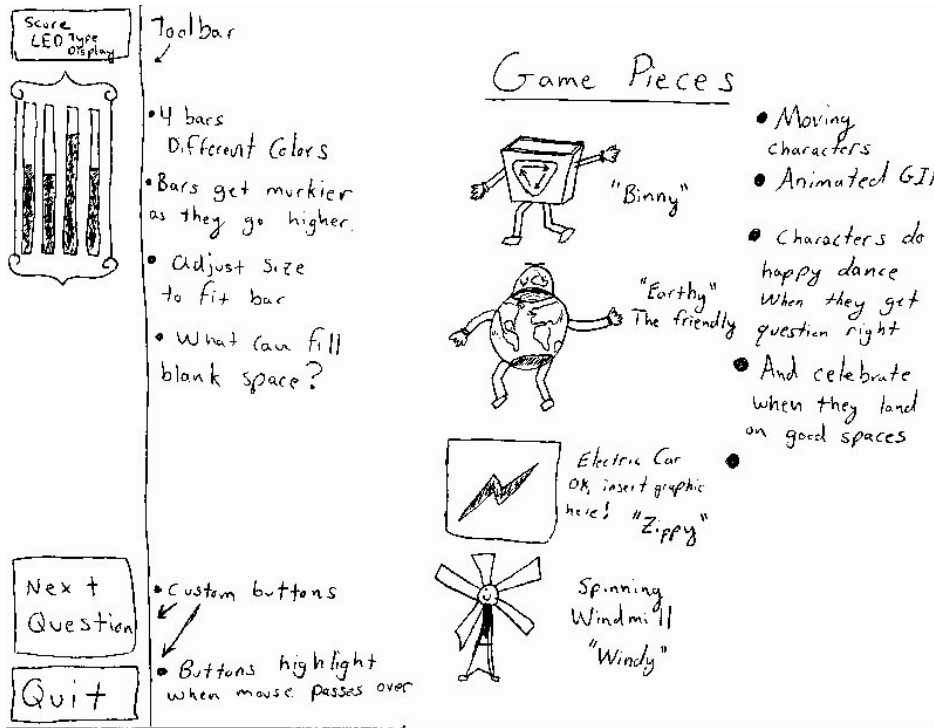**Figure 1:** Sketch of game board proposed to UCS.

Figure 2: Sketches of the characters and envirometer proposed to UCS.

Figure 3. Introduction screen from The Great Green Web Game.

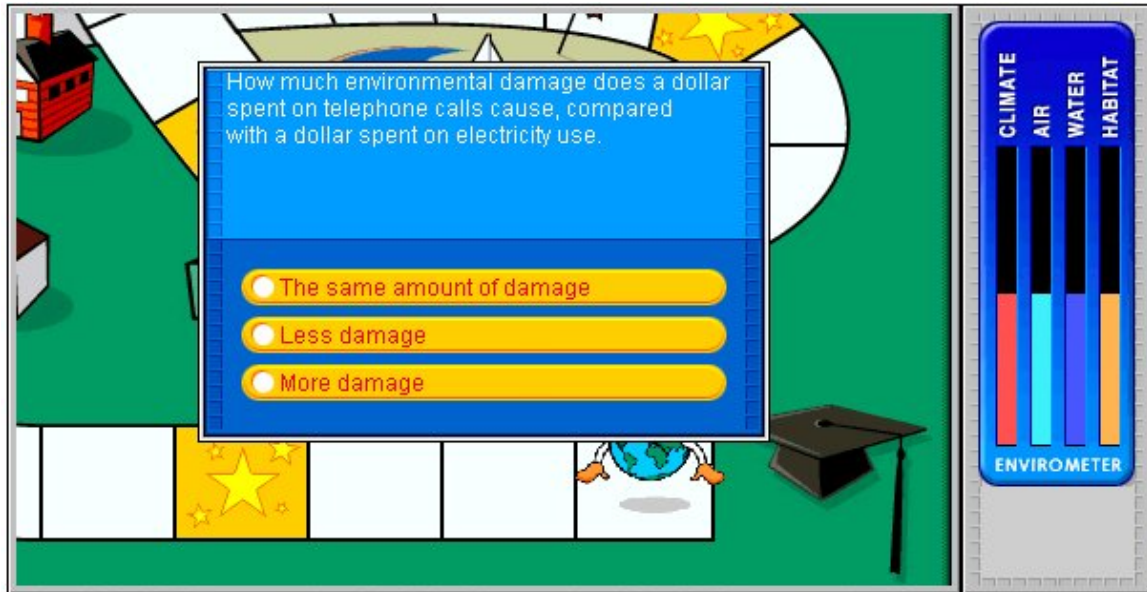**Figure 4.** Character selection screen from The Great Green Web Game.

Figure 5. A screen shot of a question dialog box from The Great Green Web
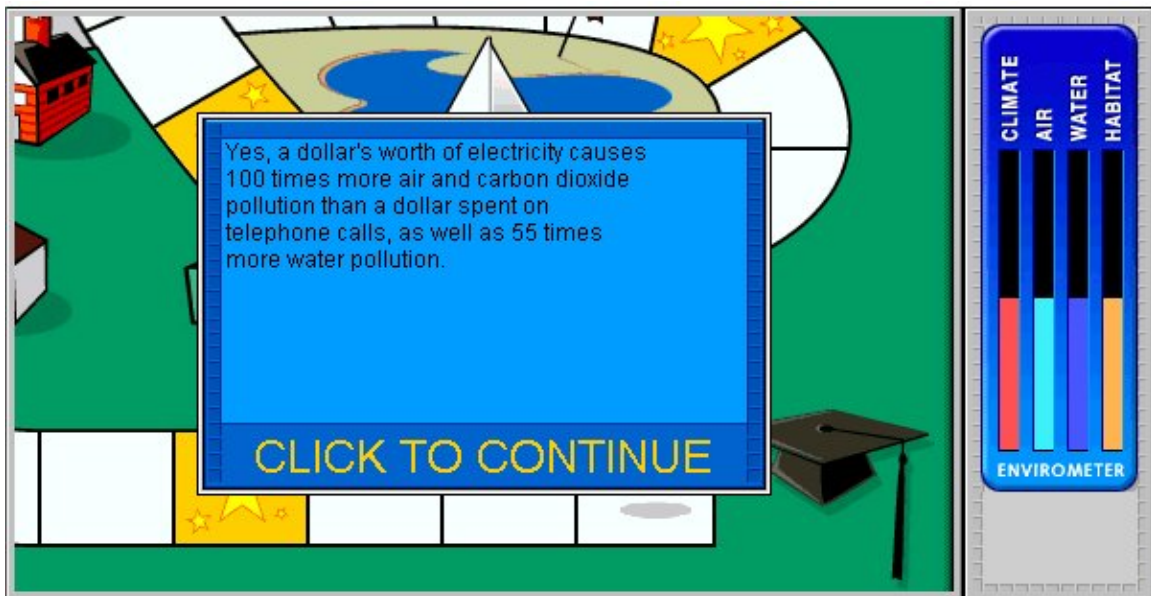
Game.

Figure 6. A screen shot of the explanation dialog box from The Great Green
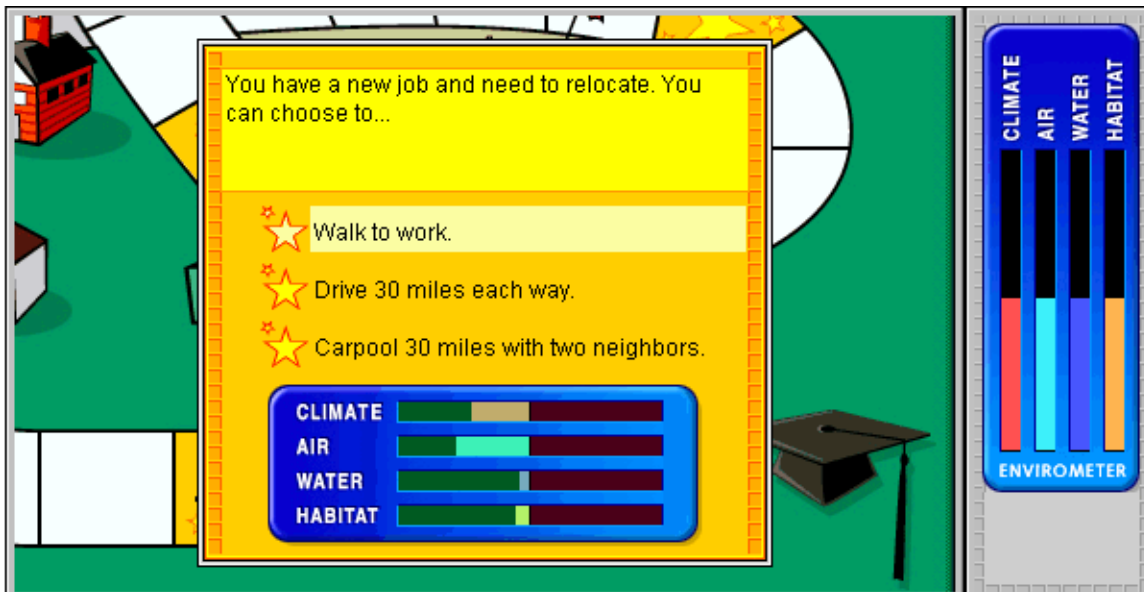
Web Game.

Figure 7. A screen shot of a life choice from The Great Green Web Game.

Figure 8. A screenshot of the score page from The Great Green Web Game.

Figure 9. A screenshot of the final summary screen from The Great Green Web Game.

Figure 10: Picture of Stonyfield Farm yogurt lid from April 1999 featuring the Great Green Web Game.

Figure 11: A recent screenshot of the UCS website showing The Great Green Web Game as the 5th most popular page for the week of March 20th, 2005.

APPENDIX A

8.1 Game Questions

Question #1
An hour of water skiing can create as much smog as driving from Washington, D.C., to...
Answer 1: Baltimore, Maryland
Answer 2: Atlanta, Georgia
Correct Answer: Orlando, Florida
Reason: one hour of water skiing creates as much smog as driving from Washington, D.C., to Orlando, Florida. The air pollution controls on most gasoline engines are much weaker that those on car engines.

Question #2
What share of paper and paperboard is recycled?
Answer 1: 25%
Correct Answer: 35%
Answer 3: 45%
Reason: Americans recycle 35% of the paper and cardboard they use. Although recycling has increased in recent years, more could still be done.

Question #3
The large quantities of energy needed to produce aluminum make it especially worthwhile to recycle aluminum cans and other aluminum products. What share of the aluminum used by Americans is recycled?
Correct Answer: 38%
Answer 2: 48%
Answer 3: 58%
Reason: Americans recycle 38% of the aluminum they use. Making aluminum cans from recycled cans takes less than a quarter of the energy needed to make them from virgin aluminum.

Question #4
The largest share of America's electricity is generated from...
Answer 1: Nuclear power
Answer 2: Hydroelectric power
Correct Answer: Burning coal
Reason: coal-burning plants produce 54% of America's electricity. By contrast, nuclear power plants produce 21%, hydroelectric plants 11%, and other sources contribute 14%.

Question #5
What currently happens to the used radioactive fuel at America's nuclear power pants?
Answer 1: It's used to make new nuclear fuel
Answer 2: It's stored in a deep underground facility
Correct Answer: It's stored at the plant that made it
Reason: despite long-standing proposals to build a permanent waste facility, almost all used nuclear fuel is currently stored in water pools at the power plant that produced it.

Question #6
Which of the following uses the most electricity in the average home?
Answer 1: Televisions and computers
Correct Answer: Refrigerator
Answer 3: Lights
Reason: refrigerators account for 1,400 kilowatt hours of electricity in the average household each year, followed by 900 kilowatt hours for lighting, and 800 kilowatt hours for televisions and computers.

Question #7
Which of the following fish is so endangered that environmental groups urge consumers not to eat it?
Answer 1: Mackerel
Correct Answer: Swordfish
Answer 3: Striped bass
Reason: swordfish, sharks, and orange roughy are among the endangered fish that consumers should avoid eating.

Question #8
What is most of the timber harvested in the United States used for?
Correct Answer: Lumber for construction
Answer 2: Furniture
Answer 3: Paper and paper products
Reason: about two-thirds of the timber harvested in the United States goes for lumber used in construction.

Question #9
What share of the population walks to work?

Answer 1: 1%
Correct Answer: 4%
Answer 3: 8%
Reason: the 1990 US Census found that 4% of the population walked to work, down from 5.6% in 1980.

Question #10
The United States is responsible for what percentage of world oil use?
Answer 1: 15%
Answer 2: 20%
Correct Answer: 25%
Reason: the United States, with only 5% of the world's population, consumes 25% of the oil used worldwide.

Question #11
The average American eats how much meat a week?
Answer 1: 1.25 pounds
Correct Answer: 3.25 pounds
Answer 3: 7.25 pounds
Reason: the average American eats 3.25 pounds of meat each week. This is 1.5 times as much as the average Briton or Italian and more than 2.5 times as much as the average Japanese.

Question #12
Which of the following causes the most environmental damage?
Correct Answer: Cars
Answer 2: Disposable diapers
Answer 3: Lawn mowers
Reason: the use of cars is by far the single most harmful consumer activity, according to UCS's new book, The Consumer's Guide to Effective Environmental Choices.

Question #13
On average, how many advertising messages are Americans exposed to each day?
Answer 1: 500
Correct Answer: 3,000
Answer 3: 5,000

Reason: with exposure to 3,000 advertising messages a day, almost all encouraging greater and greater consumption, Americans may find it hard to focus on the environmental costs of their way of life.

Question #14
On which of the following do Americans spend the most money?
Answer 1: Toys
Answer 2: Entertainment
Correct Answer: Clothes
Reason: the average household spends about $2,400 on clothes each year, followed by $1,100 on entertainment, and much less than $1,000 on toys.

Question #15
Which of the following causes the most environmental damage?
Answer 1: Washing clothes by hand
Answer 2: Washing clothes in a washing machine
Correct Answer: Dry cleaning
Reason: commercial dry cleaning produces high levels of toxic air pollution, even though government regulations are beginning to require some improvement.

Question #16
The average American discards how much trash in a year?
Answer 1: 1,000 pounds
Answer 2: 1,500 pounds
Correct Answer: 2,000 pounds
Reason: the average American discards 2,000 pounds of trash each year, two to three times as much as the typical European.

Question #17
When you buy a can of frozen orange juice, what has caused the most environmental damage?
Correct Answer: Growing the oranges
Answer 2: Processing and packing the juice
Answer 3: Transporting the juice to the store
Reason: growing food usually causes more environmental harm than processing or shipping it.

Question #18
Which of the following accounts for the most environmental damage?

Correct Answer: Beef production
Answer 2: Dairy production
Answer 3: Chicken production
Reason: the biggest share of the water pollution caused by animal waste comes from beef production. Large amounts of land and water are also devoted to beef production.

Question #19
How many chickens are raised and sold in the United States each year?
Answer 1: 700 million
Answer 2: 1.7 billion
Correct Answer: 7 billion
Reason: US agriculture raises and sells 7 billion chickens each year, an average of 25 chickens per person.

Question #20
How many tons of waste are produced by US livestock each year?
Answer 1: 1 million
Answer 2: 1 billion
Correct Answer: 2 billion
Reason: US livestock produces 2 billion tons of manure each year. This is ten times the weight of all the garbage discarded by US households.

Question #21
What type of lighting is the best environmental choice?
Correct Answer: Fluorescent lamps
Answer 2: Incandescent lamps
Answer 3: Halogen lamps
Reason: fluorescent lights use much less electricity than incandescent or halogen lights, and last longer.

Question #22
Which of the following is the best environmental choice?
Answer 1: Gas stove
Answer 2: Electric stove
Correct Answer: Microwave
Reason: a microwave allows you to reduce your consumption of electricity or natural gas, using only one-third of the energy of a conventional oven.

Question #23
Which of the following cleaning methods is the best environmental choice?
Answer 1: Washing clothes by hand in hot water
Correct Answer: Washing clothes by machine in cold water
Answer 3: Dry cleaning
Reason: since dry cleaning causes considerable air pollution and 90 percent of the energy used for washing clothes goes to heating the water, cold water washes are the most environmentally friendly choice.

Question #24
How many miles do members of the average US household drive their cars in a year?
Answer 1: 11,000 miles
Answer 2: 16,000 miles
Correct Answer: 21,000 miles
Reason: the average US household accounts for 21,000 miles of driving each year. This is about 400 miles each week.

Question #25
Which of the following definitely helps the environment?
Correct Answer: Recycling aluminum cans
Answer 2: Choosing paper over plastic at the store
Answer 3: Buying cotton clothes over polyester
Reason: recycling aluminum saves more than three- quarters of the energy needed to make aluminum cans while there is no clear environmental winner when choosing between paper and plastic or between cotton and polyester.

Question #26
In states that require consumers to pay deposits for cans of soda and beer, how many cans are recycled compared to those in states without deposit laws?
Answer 1: The same number of cans
Answer 2: 20% more cans
Correct Answer: 70% more cans
Reason: in the 10 states that require deposits on beer and soda containers, 70% more cans are recycled than in states without such requirements. Instituting deposit systems in other states would be a good step for the environment.

Question #27
What is the maximum amount of water new toilets can use per flush?
Answer 1: One-half gallon

Correct Answer: 1.6 gallons
Answer 3: 4.6 gallons
Reason: new toilets use 1.6 gallons of water or less. Since old toilets use up to 6 gallons, new ones are significantly better for the environment.

Question #28
The US Environmental Protection Agency's program for certifying certain computers, TVs, VCRs, and other household items as good environmental choices is called...
Correct Answer: Energy Star Program
Answer 2: EPA Good Guy Program
Answer 3: Green Smart Program
Reason: when purchasing appliances, home electronics, and office equipment, look for models that have received an Energy Star.

Question #29
How much steel does the average car contain?
Answer 1: More than 500 pounds
Correct Answer: More than 2,000 pounds
Answer 3: More than 5,000 pounds
Reason: the average car contains more than 2,000 pounds of steel, accounting for most of its weight.

Question #30
How much environmental damage does a dollar spent on telephone calls cause, compared with a dollar spent on electricity use.
Answer 1: The same amount of damage
Correct Answer: Less damage
Answer 3: More damage
Reason: a dollar's worth of electricity causes 100 times more air and carbon dioxide pollution than a dollar spent on telephone calls, as well as 55 times more water pollution.

Question #31
Which of the following is the best choice for the environment?
Answer 1: Disposable diapers
Answer 2: Cloth diapers
Correct Answer: The two are about equal

Reason: neither disposable diapers nor cloth diapers is significantly better than the other, unless you live in a location with severe water shortages or a severe garbage disposal problem.

Question #32
What's the best advice when shopping for household cleaning products?
Correct Answer: Avoid serious safety warnings
Answer 2: Buy products labeled natural
Answer 3: Buy products labeled biodegradable
Reason: the more serious the safety warnings and precautions--such as wearing gloves or keeping windows open for ventilation--the more likely it is that the product poses significant hazards to the environment.

Question #33
Burning one gallon of gasoline in your car produces how many pounds of carbon dioxide, the major greenhouse gas?
Answer 1: 4 pounds
Answer 2: 10 pounds
Correct Answer: 20 pounds
Reason: the carbon in the gasoline combines with oxygen in the air to produce an amount of carbon dioxide greater than the initial weight of the gasoline.

Question #34
Which of the following still contributes to depleting the ozone layer?
Answer 1: Spray cans
Correct Answer: The pesticide methyl bromide
Answer 3: Polystyrene (styrofoam) cups
Reason: methyl bromide is still used in agriculture while most ozone-depleting chemicals have been banned from consumer products.

Question #35
Which lifestyle change would have the greatest environmental benefit?
Correct Answer: Eating chicken instead of beef
Answer 2: Wearing cotton instead of polyester
Answer 3: Choosing paper instead of plastic bags
Reason: beef production causes much more water pollution and requires much more land than chicken production, while cotton does not have significantly less environmental impact than polyester, nor are paper bags significantly less harmful than plastic ones.

Question #36
From an environmental standpoint, what's the best recreational choice?
Correct Answer: Join a health club
Answer 2: Build a swimming pool
Answer 3: Buy a snowmobile
Reason: snowmobiles cause a lot of air pollution, while a swimming pool requires large quantities of water and considerable electricity to run the filter.

Question #37
What percentage of homeowners who use pesticides in their yards do not read the warning labels?
Answer 1: 20%
Correct Answer: 50%
Answer 3: 70%
Reason: 50% do not read warning labels. Use of pesticides in yards poses significant threats to health and the environment, and many homeowners apply much more pesticide than manufacturers recommend.

Question #38
Which of the following is the greatest health and environmental hazard?
Correct Answer: PVC (a type of plastic)
Answer 2: Polystyrene (styrofoam)
Answer 3: PET (a type of plastic)
Reason: PVC plastic is the greatest hazard, because it emits vinyl chloride, a human carcinogen, during manufacturing.

Question #39
Compared with a new refrigerator, a 1973 refrigerator of the same size used how much electricity?
Answer 1: Half as much
Answer 2: Twice as much
Correct Answer: Three times as much
Reason: new refrigerators are three times as efficient as old ones, in part because the federal government has raised efficiency standards for appliances.

Question #40
With just 5% of the world's population, the United States consumes what share of the world's aluminum cans?
Answer 1: About a quarter

Correct Answer: More than half
Answer 3: About three-quarters
Reason: more than half of the world's aluminum cans are used in the US.
Recycling can significantly reduce the pollution caused by a highly energy
intensive manufacturing process.

Question #41
New, front-loading washing machines offer many advantages. Which of the
following is NOT one of them?
Answer 1: They use less electricity
Answer 2: They use less water
Correct Answer: They cost less
Reason: front-loading machines currently cost significantly more than traditional
top-loading models, but they use much less water and electricity and are gentler
on clothes.

Question #42
Which type of refrigerator is usually the least energy efficient?
Correct Answer: Side-by-side models
Answer 2: Top-freezer models
Answer 3: Bottom-freezer models
Reason: side-by-side models use more electricity than the others, and they cost
more. A typical 24-cubic-foot side-by-side model costs about $400 more than a
comparable top-freezer model, and uses an extra $20 of electricity each year.

Question #43
How much coal is burned each year to provide an average US household with
electricity?
Answer 1: 1,000 pounds
Answer 2: 2,000 pounds
Correct Answer: more than 3,000 pounds
Reason: more than 3,000 pounds, since coal is used to generate most of
America's electricity.

Question #44
In 1982, the average horsepower of a new car was 99. What is it today?
Answer 1: 99
Answer 2: 120
Correct Answer: more than 155

Reason: average horsepower has increased to more than 155 as automakers have continued to make cars more powerful, requiring the use of more gasoline.

Question #45

Which does the most environmental harm?

Answer 1: Catching bluefish

Correct Answer: Catching sharks

Answer 3: Catching squid

Reason: the methods used to catch most sharks also result in the capture of unwanted fish, as well as turtles and dolphins.

Question #46

Using a typical lawnmower for an hour produces how much air pollution compared with driving a car for an hour?

Answer 1: Half as much

Answer 2: Twice as much

Correct Answer: Ten times as much

Reason: lawnmowers produce ten times as much air pollution as a typical car because they have few pollution controls. Luckily, lawnmowers are used much less than cars are.

Question #47

What percentage of Americans believe that most of us buy and consume far more than we need?

Answer 1: 50%

Correct Answer: 82%

Answer 3: 95%

Reason: in a 1995 poll by the Merck Family Fund, 82% agreed that most Americans buy and consume far more than we need.

Question #48

In 1970, the average size of a new house was 1,400 square feet. Today it is roughly...

Answer 1: 1,600 square feet

Answer 2: 1,900 square feet

Correct Answer: 2,100 square feet

Reason: although the average number of people per household has decreased in recent decades, the average size of the house they live in has grown to more than 2,100 square feet.

Question #49
Each year, the world's population grows by how many people.
Answer 1: 30 million people
Answer 2: 60 million people
Correct Answer: 90 million people
Reason: the world is adding about 90 million people each year to a current population of 6 billion. This is equivalent to adding the entire population of Mexico each year.

Question #50
Which state could produce all its electricity from wind and still have a surplus to offer to other states?
Answer 1: Arizona
Correct Answer: North Dakota
Answer 3: Oregon
Reason: the wind resources in North Dakota and several nearby states are so great that they could produce all the electricity they need using wind turbines.

Question #51
How much money does the United States spend each minute on foreign oil?
Answer 1: $10,000
Answer 2: $50,000
Correct Answer: $100,000
Reason: we spend $100,000 per minute since most of the oil used in the US comes from foreign sources. More efficient cars and advanced-technology vehicles could significantly reduce this number.

8.2 Life Choices

Question: You've decided that you need a new car, but what kind of vehicle do you want to drive?
Answer 1: A fuel-efficient, low-emission vehicle? (Impact: -71, -100, -12, 0)
Answer 2: A station wagon? (Impact: 0, 0, 0, 0)
Answer 3: A large sport-utility vehicle? (Impact: +71, +90, +24, 0)

Question: You have a new job and need to relocate. You can choose to...
Answer 1: Walk to work. (Impact: -36, -45, -6, -9)
Answer 2: Drive 30 miles each way. (Impact: +36, +45, +6, +9)
Answer 3: Carpool 30 miles with two neighbors. (Impact: -12, -15, -2, -3)

Question: You're looking for a new home -- what kind of heating system would be best?
Answer 1: Oil fueled. (Impact: +27, +8, +5, +0)
Answer 2: Electricity. (Impact: -11, -2, 0, +2)
Answer 3: Natural Gas. (Impact: -17, -6, -5, -2)

Question: That cabin in the country looks great, but how would you spend your winter weekends?
Answer 1: Riding a snowmobile. (Impact: +2, +20, +2, 0)
Answer 2: Taking up cross-country skiing. (Impact: -4, -2, -2, 0)
Answer 3: Building a big fire and watching it. (Impact: 0, +9, 0, 0)

Question: Congratulations. Upon receiving $3,000 from a stock dividend, you've decided to spend it on home improvements. You can...
Answer 1: Build a fireplace. (Impact: 0, +23, 0, 0)
Answer 2: Replace your old appliances. (Impact: -11, -5, -2, 0)
Answer 3: Install solar panels to heat your water. (Impact: -28, -8, -5, 0)

Question: The food on your table comes with a cost to the environment. You can lower that cost by...
Answer 1: Choosing pultry over beef and pork. (Impact: -3, -3, -14, -47)
Answer 2: Eating half as much meat and poultry. (Impact: -4, -3, -24, -40)
Answer 3: Buying organic produce. (Impact: -6, -9, -9, 0)

Question: You want to initiate an environmental project at your local community center, and you've thought of three things you can do...
Answer 1: Switch to fluorescent lighting. (Impact: -26, -12, -5, -2)
Answer 2: Insulate the building. (Impact: -26, -12, -5, -2)
Answer 3: Use cloth diapers at the day-care center. (Impact: 0, 0, 0, 0)

Question: You've decided to start conserving energy at home -- what's a good way to begin?
Answer 1: Lower the thermostat by three degrees. (Impact: -6, -2, -2, 0)
Answer 2: Wash your clothes with cold water. (Impact: -2, -2, 0, 0)
Answer 3: Weatherstrip around the windows. (Impact: -3, -2, 0, 0)

Question: It's your lucky day. Through an unexpected inheritance, you can afford the home of your dreams. You can...
Answer 1: Build a new 20-room mansion. (Impact: +100, +44, +33, +42)
Answer 2: Build a 7-room energy-efficient house. (Impact: -44, -18, -14, +4)
Answer 3: Rehab a deteriorating old house. (Impact: -44, -18, -14, -18)

Question: It's summer, the ideal time for that project in the backyard. You can..
Answer 1: Work on the perfect lawn. (Impact: 0, +5, +27, +5)

Answer 2: Put in a swimming pool. (Impact: +23, +11, +5, +2)
Answer 3: Plant an organic garden. (Impact: -1, -3, -16, -2)

8.3 Change Control & Timeline
3/8/1999

1. Updated the instruction screen.

2. Removed the start button from the title screen.

3. Added functionality for the summary screen.

3/3/1999 - 3/7/1999

1. Added new space system using "life choices" spaces.

2. Added the justification descriptions for the questions.

3. Removed the intro music.

4. Created the questionnaire CGI and html forms.

5. Updated www.wpi.edu/~mattrc/UCS to function as the site home page.

3/2/1999

1. Fixed the bug that causes either system instability or slowdown as a
   result of closing the applet while a game piece is in motion.

2. Changed the number of spaces the piece can move. The game piece now
   moves 3 spaces for a correct answer and 1 space for an incorrect answer.

3. Changed some colors around to better match the color theme of the game.

4. Modified the loading bar to appear vertically in the side toolbar.

5. Changed character selection to happen before the instructions.

6. Added the Windy animations.

7. Changed the "play again" button to send you to the character selection

screen instead of all the way back at the beginning.

8. Experimented with sound, the results are... unique.

3/1/1999

1. Changed the space dialog bar appearance to more closely resemble the envirOmeter appearance.

2. Changed the colors for the questions dialog.

2/28/1999

1. Added the Earthy and Zippy animations.

2. Revamped the questions system. Changes include...
   a) Only allowing an answer to be selected once.
   b) If the answer is incorrect, the correct answer is displayed with an explanation for that answer.
   c) If the answer is correct, an explanation is given for that answer.
   d) Dialog box for question confirmation is now dismissed by clicking on it.
   e) Added functionality to track the number of questions asked.

3. Fixed the issue of the game pieces walking on top of the trees near the end of the board.

4. Revamped the space dialog to show impacts in a horizontal envirOmeter relative to the largest impact a single space has in the game instead of simply displaying the number for the impact.

5. Added a field to display the number of questions asked in the ending summary screen.

Known Issues

1. The problem of system instability or great slowdown as a result of closing the applet while a piece is in motion has been located and will be corrected as soon as possible.

2. The game space impacts are still set at values of 1 all across.

3. The Windy animations are not yet in the game since they are proving quite difficult to use.

4. Character happy/dance animations are not yet in, they will be added soon.
2/24/1999

1. Changed the introductory and instruction screens.

2. Changed space dialog to display scores centered in their respective display area.

3. Added draft version of the summary screen.

2/23/1999

1. Added functionality for the game piece to move back spaces.

2. Added the latest list of spaces to the game giving a grand total of a 34 space game.

Known Issues:

1. The scoring is not set up until further review of the score values for each space. For now, each space is worth 1 point of each envirOmeter scale.

2/22/1999

1. Added the final version of the game board provided by the graphic designer.

2. Added layering so that the game piece appears to move under the overpass and umbrella.

3. Completed animation functionality and added the Binny animation as provided by the graphic designer.

2/21/1999

1. Added the automatic scrolling features for the game board.

2. Resized the game board to better match that of the final board size.

3. Resized the game pieces to match the new game board size.

4. Added all the questions to the game.

5. Added all the spaces to the game making it a 25 space game. (though the initial board has 37 spaces)

6. Added the ability to play again after reaching the end of the game.

7. Increased the speed at which the game pieces moved.

8. Revamped the intro screen.

9. Revamped the directions screen to actually include directions.

2/20/1999

1. Changed the method of asking questions so that the player can't repeatedly choose the same incorrect answer.

2. Fixed the text size difference issue between Netscape and Internet Explorer.

3. Fixed the game crash bug in the alogorithm for selecting the next question.

4. Removed the user confirmation dialog after answering a question correctly allowing the game piece to move immediately after correctly answering the question.

5. Modified the event space screen so that it can be dismissed by clicking on the event space box.

6. Added a shadow effect to better show that the contents of the event space dialog represents what's on the space.

2/18/1999

1. Resized the applet to better fit in a 640x480 display size.

2. Added character selection screen.

3. Modified the event space screen to automatically go away after a few seconds and then immediately ask the next question.

4. Removed the "Next Question" button.

5. Revamped the event space screen to display the values of the enviro meter impacts.

8.4 SURVERY QUESTIONS

First Survey:
How long did it take you to play the game (was it too long or two short)?
What did you like most about the great green web game?
What did you like least about the great green web game?
Where there any typos in the material presented in the game and if so what were they?
How would you rate the visual appeal of the game?
How might you suggest we improve the game?
Did you encounter any difficulties playing the game and if so what were they?

Final Survey:
Have you read The Consumers Guide to Effective Environmental Choices?
(Choices: Yes, No)
Have you played a previous version of the great green web game?
(Choices: Yes, No)
Are you a UCS employee?
(Choices: Yes, No)
I learned something new about the impacts of my choices as a consumer.
(Choices: Very True, Somewhat True, Somewhat Untrue, Very Untrue)
Did you encounter any difficulties playing the game and if so what were they?
Which version of the Great Green Web Game did you like better?
(Choices: Version 1, Version 2)
I found the speed of game play.
(Choices: Too Fast, A Little Fast, About Right, A Little Slow, Too Slow
I found the instructions for the game.
(Choices: Easy to Follow, Somewhat Easy to Follow, Somewhat Difficult to Follow, Very Difficult to Follow.)

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