PRINCIPLES OF GREEN DESIGN: ANALYZING USER ACTIVITIES AND PRODUCT FEEDBACK

A Senior Scholars Thesis

by

NICOLE ESPOSITO

Submitted to the Office of Undergraduate Research
Texas A&M University
in partial fulfillment of the requirements for the designation as

UNDERGRADUATE RESEARCH SCHOLAR

April 2011

Major: Mechanical Engineering

PRINCIPLES OF GREEN DESIGN: ANALYZING USER ACTIVITIES AND PRODUCT FEEDBACK

A Senior Scholars Thesis

by

NICOLE ESPOSITO

Submitted to the Office of Undergraduate Research
Texas A&M University
in partial fulfillment of the requirements for the designation as

UNDERGRADUATE RESEARCH SCHOLAR

Approved by:

Research Advisor: Julie Linsey
Director for Undergraduate Research: Sumana Datta

April 2011

Major: Mechanical Engineering

ABSTRACT

Principles of Green Design: Analyzing User Activities and Product Feedback.
(April 2011)

Nicole Esposito
Department of Mechanical Engineering
Texas A&M University

Research Advisor: Dr. Julie Linsey
Department of Mechanical Engineering

This study investigated the design principles applicable to environmentally friendly product design. A practical approach was taken to examine principles that aid designers in producing an eco-friendly product that consumers will enjoy and use. Another important aspect to this study was to determine whether a positive environmental attitude or a willingness to change for the environment relates to environmentally responsible behavior. Two hypotheses were developed for successful eco-friendly products and then appropriate products were purchased to test these hypotheses. The activity hypothesis claims that if a product adds user activities, is less likely to be used. The feedback hypothesis states that a product that gives clear feedback is more likely to be used than a product that does not. Student participants took home products to use for one week, recorded each time they used the products, and then completed surveys afterword. One survey determined product success and the second measured environmental consciousness. The sample size for the experiment was 15 participants. The results indicate that there may be a positive relation between environmental attitude

and environmental behavior, both of which were measured through surveys. For the activity hypothesis, we supposed that the product not adding user activities would be used more than the product adding activities. However, the experimental results have shown that this may not always be the case. For the feedback hypothesis, we speculated that visual reminder feedback and energy savings feedback both increase product usage. Combining both types of feedback was assumed to increase product usage more than any single type of feedback. The results for this part of the experiment indicate errors in the experimental design, but also aid in the future work for this research experiment.

ACKNOWLEDGMENTS

I am thankful for my advisor, Dr. Julie Linsey, whose guidance, support, and encouragement enabled me to aim high and achieve my aspirations. Without her, this thesis would not have been possible.

TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION

We are living in a time when the reality of our heavily industrial past is quickly catching up to us. The push for an environmentally friendly future is evident around the world. Politicians are campaigning for stricter, more eco-friendly standards, and companies are producing greener products for a growing number of eco-savvy consumers. Mackenzie (1997) emphasizes this issue by saying, "Improving the environmental performance of products, through intelligent design, is now a major focus of interest." In addition to many other design criteria, a "green" aspect should be taken into consideration. This may not be such an easy task for a designer, but it is essential to respect future generations that will inhabit our planet. Many ecological problems already exist because of the pollution generated through the processing, production, use, and disposal of products. The good news is that a designer has authority over each step in creating a product and can influence the level of contamination to our environment. Today, a substantial opportunity exists for the designer to make a positive environmental impact. Fuad-Luke (2004) expresses the importance of designers by claiming, "Designers actually have more potential to slow environmental degradation than economists, politicians, businesses and even environmentalists."

Eco-friendly product design can be extremely challenging because the product that a

---

This thesis follows the style of *Journal of Engineering Design*.

designer creates will inevitably end up in a person's hands. Consumers demand excellent products and more than likely consumer's will not lower their standards for an eco-friendly product. Therefore, what do consumers value in an eco-friendly product? How does functionality compare to the eco-friendliness of the product? What do consumers like and dislike about eco-friendly products? These are vital questions in need of answers, and this experiment attempts to dive into the depths of this rather un-researched area.

Usually, an environmentally friendly product requires a change in the consumer's habits and this is where the problem lies. Humans can have a hard time un-doing what they have been doing all their lives. However, if a designer could design a product so that the consumer will want to change their behavior, then they might use it more. If consumers use eco-friendly products more, then the world would be a much better place. So how can a designer create a product that encourages behavior change? This is yet another unanswered question this research investigates.

Another aspect in need of consideration is consumer motivation. What makes a consumer more motivated to use an eco-friendly product? In this experiment, environmental attitude and willingness to change for the environment were believed to be motivation for a consumer to use a product. This experiment examines whether motivation actually leads to increased product use.

Design for environment

The concept of Design for Environment (DfE) emerged in the 1990s and has been adopted by many companies around the world. DfE describes the "systematic consideration of design performance with respect to environmental, health, safety, and sustainability objectives over the full product and process life cycle." (Fiksel 2009) The life-cycle principle involves analyzing a product and its processes from "cradle-to-grave". A product life-cycle consists of four main stages: material processing, production, use, and end of life (Abele, Anderl, and Birkhofer 2005). Each of these stages consumes resources and generates waste that may affect our environment. The "use" phase is a focus of this study. In the use life-cycle stage, the consumer-product interaction is of utmost importance. In this study, we would like to shine light on the question—what principles can aid designers in developing an eco-friendly product that consumers will like and use? This question will be explored through development and testing of hypotheses for successful environmentally friendly products.

Environmental consciousness

The question whether environmental attitudes predict actual behavior has been a topic of debate for decades. Many research studies speculate that environmental consciousness may lead to environmentally responsible behavior, while others state there is a weak correlation between attitudes and behavior (Mainieri *et.al* 1997). Environmental awareness has a variety of definitions; some see it as an attitude toward the environment and others believe it represents an action. One theory that encompasses multiple psychological aspects describes environmental consciousness as cognitive, attitudinal,

and behavioral (H'Mida 2009). It has been suggested "an important research task is to establish that a relationship exists between a positive environmental attitude and environmentally responsible behavior." (Fransson and Garling 1999) A vital component to this study is to provide insight into environmental consciousness and to determine if environmental consciousness relates to environmentally responsible behavior.

Demographics and environmental concern

Multiple studies attempt to understand demographic variables and their affect on environmental consciousness. This research subject has also been disputed for quite some time. Some suggest younger, more educated individuals are environmentally aware, while others say gender and political standing are indications of human attitude toward the environment. Others conclude that demographic variables do not relate to a consumer's willingness to live an eco-friendly lifestyle (H'Mida 2009). Some believe that demographics predicted environmental concern in the past but no longer play a role in present-day society. Van Liere and Dunlap (1980) proposed five hypotheses concerning socio-demographic factors and environmental attitude. The age hypothesis said that younger people are more concerned about environmental quality than older people are. The social-class hypothesis states that environmental concern is positively associated with education and income. The residence hypothesis says that urban residents are more likely to be concerned about the environment that rural residents. The political hypothesis states that Democrats and liberals are more concerned about environmental quality than their Republican and conservative counterparts. The gender hypothesis notes that gender differences have seldom been investigated and of the

studies that have researched the idea, ambiguous results have been reported. The hypotheses tested in this experiment include age, gender, education, and political ideology. Even with the development of widely used scales for measuring environmental concern, controversy continues to exist over this issue.

Measuring environmental concern

The two most frequently used scales for measuring environmental concern are the Ecological Attitude Scale or EAS (Maloney, Ward, and Braucht 1975) and the New Environmental Paradigm Scale or NEP (Dunlap *et al.* 2000). The EAS is used to measure environmental behavior and consists of three scales, the Verbal Commitment (VC), the Actual Commitment (AC), and the Affect (A). The VC measures what the person states they are willing to do to protect the environment, the AC measures what the person actually does to protect the environment, and the A measures the degree of emotion related to such issues (Maloney, Ward, and Braucht 1975). The NEP scale was originally developed in 1978 by Riley E. Dunlap and Kent D. Van Liere and consisted of 12 Likert items to measure environmental attitude. The scale was later revised in 2000 to consist of 15 items. The NEP addresses five different ecological worldview facets: the reality of limits to growth, antianthropocentrism, the fragility of nature's balance, rejection of exemptionalism, and the possibility of an ecocrisis (Dunlap *et al.* 2000). Both the EAS and the NEP will be used in this study to measure attitude and behavior.

Behavior change

Conventionally, many Americans have fallen back on technological innovations instead of changing their behaviors and lifestyle choices to improve the environment (Mainieri *et al.* 1997). Mainieri *et al.* (1997) declares that through consumers' adoption of environmentally sound behaviors we will be able to protect the earth's natural resources and prevent further damage. The problem for humans is that behavior change can be an incredibly challenging task. Fiksel (2009) suggests a possible reason is that it is difficult for people to change their behavior when the consequences lie in the distant future. Even if we are environmentally conscious, we may not be able to take the steps to change our environment-damaging behaviors. Clearly, many things are working against us here. However, thinking as an optimist, one might say that we can make things work for us in this situation. Psychologists have yielded information about how the human brain works and even more specifically, how it works when we are presented with change. With this information, we were able to apply a few psychological principles to product design. Maybe people can live a more green lifestyle if they use eco-friendly products that encourage them to change their behavior.

The dual mind

It is known in psychology that the human brain functions as two systems. Heath and Heath (2010) describes them as the emotional side and the rational side and Thaler and Sunstein (2008) calls them the Automatic System and the Reflective System. The first part of the brain is instinctive and reacts quickly while the second is more reflective and conscious. An analogy created by Jonathan Haidt in *The Happiness Hypothesis* describes

the first system as an instinctive elephant and the second system as its conscious rider. The rider has the reins and seems to be in control of the situation but the elephant is very large and can easily overpower the rider (Heath and Heath 2010). Heath and Heath (2010) explains that "changes often fail because the Rider simply can't keep the Elephant on the road long enough to reach the destination." Both systems of the brain need to be influenced so that they can work together to easily achieve change.

Creating change

Heath and Heath (2010) says that in order to achieve behavior change, the rational side needs clear directions, the emotional side needs motivation, and the situation must be tweaked. Thaler and Sunstein (2008) specifies certain situations in which people are more likely to make a behavior change. Frequency is one of these situations. The more something is practiced, the more likely a person is going to change through developing a habit. Another of these situations is feedback. If clear feedback is given to a person, they can be aware of the change happening and can learn to change themselves as a result. One other situation is the default. More often than not, a person will choose a default option. If the default option is the best possible choice, then the change is easier. Sometimes, the person would not even have to change their behavior at all.

CHAPTER II

METHOD

Hypotheses

As stated before, we would like to explore eco-friendly products that consumers will like and are more likely to use. Two hypotheses were developed by applying psychological theories to product design, and then appropriate products were chosen to test these hypotheses. One theory tested in this study was the *activity hypothesis*. This hypothesis was built upon the idea that if a product adds user activities, it is less likely to be used. People have busy lives and demand products that do not require much time or effort to use. Imagine choosing between a cell phone charger that you could plug in and forget about and one that requires you to crank continuously to charge your phone. Most people would use the one they could plug in and forget about because they are available to do other things while charging their phone. The crank charger ties them down so that they cannot do other things. In addition, the Theory of Inventive Problem Solving has shown that as products evolve they become more automated, thus requiring fewer user activities (Otto and Wood 2001).

Another theory tested in this study was the *feedback hypothesis.* This hypothesis was constructed from the notion that user awareness is important for an eco-friendly product. Thaler and Sunstein (2008) says, “Learning is most likely if people get immediate, clear feedback after each try.” This theory is being applied to the realm of product design. It is

assumed in this research that people will learn from product feedback and as a result change their behavior so that they behave in a more environmentally friendly way. Therefore, an eco-friendly product that gives feedback will be used more than an eco-friendly product that does not give feedback. Clear feedback from a product enables the user to visualize the change and learn from it. An example of feedback seen in many eco-friendly products is the visualization of energy. Energy conserving devices are common, but energy is an intangible thing that many people have a hard time conceptualizing. Therefore, a simple solution is to provide feedback to the user so they can see the energy savings that is happening.

Activity Hypothesis: A product that adds user activities will be used less than a product that does not add user activities.

Feedback Hypothesis: A product providing feedback to its user will be used more than a product that does not provide feedback.

The hypotheses stated above will be evaluated using a hands-on approach involving participants and actual products. Appropriate products will be purchased for each hypothesis and then given to participants to use for one week. The participants will record every time they use the products. After this testing period, they will take a survey relating to the performance of the products as well as a demographics survey. The accuracy of the hypotheses will be analyzed by comparing the average number of product uses for each experimental condition.

Experimental design

The feedback hypothesis has four different conditions with a 2x2 factorial design. There are two types of feedback found in the product used to test the feedback theory. The first type is feedback that shows the user the amount of energy they are saving by using the product, thus termed "Save Energy Feedback." The second type is called "Visual Reminder Feedback" and is the visual presence of the product acting as a reminder for the user to use the product.

There are two conditions tested for the activity hypothesis. The first being a product that adds user activities and the second being a product that does not add user activities.

Products

The product chosen to test the activity hypothesis was a portable speaker for an MP3 player that uses a solar panel, crank arm, or wall outlet to charge. The audio player also has an AM/FM/weather radio. For the first condition, the product was modified so that the solar panel was covered and only the crank arm could be used. The reason for covering the solar panel was so the participant was constrained to using only the crank arm to charge the speaker. This crank arm adds an extra user activity compared to the conventional way of charging through a wall outlet. A wall charger was not given to the participants with this condition so they were forced to only use the crank to charge. An image of the crank speaker can be seen in the center of Figure 1. The second condition was the control product, which did not add a user activity. The control was the same portable speaker, except the crank arm was removed so that only the solar panel or wall

charger could be used. The use of a solar panel or wall charger does not add user activities to the speaker. Images of the control product and the original product can be seen in Figure 1 on the right and left respectively.

Figure 1. Three configurations of the portable audio player.

The product chosen to test the feedback hypothesis is called the eco-button. This small illuminated button attaches to a computer via USB cable and is pressed before leaving the computer. Since the button is illuminated, it acts as a strong visual reminder to save energy. The eco-button software puts the computer into the lowest energy settings while keeping track of the pounds of CO_2 and money saved from each use. This product uses two different types of feedback to attempt to facilitate behavior change from the consumer. The first is the energy savings feedback and the second is the visual reminder feedback. A picture of the eco-button is shown in Figure 2.

Figure 2. Eco-button used in this experiment.

The first condition consists of only the eco-button software without the actual button to use. The second condition is the eco-button and the software that comes with the button. The third condition is to use the eco-button, but to use a modified program that does not show the user the energy savings. The fourth and final condition is instructions to shutdown the computer. Table 1 below illustrates the different conditions for the Eco-button and Table 2 shows the 2x2 factorial design.

Table 1. Eco-button conditions.

	Software Only	Eco-button and Software	Eco-button Only	Instructions to Shut Down Computer
Energy Savings Feedback	✓	✓		
Visual Reminder Feedback		✓	✓	

Table 2. Factorial design for Eco-button conditions.

		Visual Reminder Feedback	
		Yes	No
Energy Savings Feedback	Yes	Eco-button and Software	Software Only
	No	Eco-button Only	Instructions to shut down computer

Experimental procedure

Each participant received products to use for a one-week testing period. The participants were given one condition to test for the eco-button and one condition for the speaker. They were given a usage sheet for each product to document every time they used it. Examples of the usage sheets used are shown in Figure 3 and Figure 4. For the speaker, the usage sheet asked the participant to specify whether they used the product indoors or outdoors. This was done because using the product outside with nature could affect the participant and make them want to use it more. After a week, they would return the products and usage sheets and then complete two questionnaires. As compensation, the participants could chose between thirty dollars or in some cases, extra credit in their design class. A product evaluation survey was given for each product to measure success and a demographics survey was given to measure environmental consciousness and a few demographic variables. The Ecological Attitude Scale was used to measure environmental behavior and the New Environmental Paradigm Scale was used to measure attitude toward the environment.

Indoor with Solar Panel	
Indoor with wall charger	
Outdoors with Solar Panel	
Outdoors with wall charger	
Total	

Indoor with Crank	
Outdoors with Crank	
Total	

Figure 3. Usage sheets for both speaker conditions.

Remember to bring this sheet back when you return the product!

This sheet is for you to keep track of the number of times you use your ecobutton. Place this sheet right next to your computer so you remember to use it. Please use a tally mark to indicate each time you use the ecobutton.

Total	

Figure 4. Usage sheet for the Eco-button.

Questionnaires

There were two different surveys that participants were asked to complete after testing the eco-friendly products. The demographics survey asked basic questions such as age, gender, education, and political views. Environmental consciousness was also assessed on the survey through several questions about environmental attitude and behavior. Environmental attitude was part one of the survey, and was determined using the 15 Likert item NEP scale developed by Dunlap *et al.* (2000). The participants were given a series of statements about the environment and were asked if they strongly agree, mildly agree, are unsure, mildly disagree, or strongly disagree. Environmental behavior was part two on the survey, and was calculated using the 30 true/false items in the EAS scale devised by Maloney, Ward, and Braucht (1975). Part three of the survey was a single question used to evaluate self-designated environmental consciousness. The question was stated, "All things considered, would you classify yourself as an environmentalist?" In part four, questions were asked to measure the participants' willingness to make life-style changes because of environmental problems. There were nine life-style changes given and the participant was asked if they did this, were willing to do this, reluctant to do this, or even opposed to do this. The questions from part three and four were based on the research of Krause (1993).

The product evaluation survey asked the participants about their weeklong experience with the product. For every product the participant tested, they were given a separate evaluation survey for each product. The first part of the questionnaire asked the participant to rate the environmental friendliness of several products, including the

product they tested, on a 1-7 scale where one was LEAST environmentally friendly and seven was MOST environmentally friendly. The purpose of this question is to observe how green the participant believes the product is compared to other well-known environmentally benevolent products. The second part of the survey presented five questions regarding the success of the product. The participants were asked to circle their best answer. For instance, "Would you recommend this product to a friend or family member?" was asked and the responses to choose from were strongly recommend, recommend, neutral, NOT recommend, and strongly NOT recommend. The third and final part of the questionnaire included short answer questions. They were asked to describe what they liked most and least about the product and to explain why. Another important question asked was whether the product influenced them to become more eco-friendly in other aspects of their life. The actual questionnaires used in the experiment are provided in the appendix. The first survey shown is the demographics survey and the second is the product evaluation survey for the speaker.

CHAPTER III

RESULTS AND DISCUSSION

Pilot results

The pilot experiment was executed with four participants. This small sample was used to test the experimental procedure and questionnaires for errors. Since the sample size was small, pilot results are presented here. A sample size of 16 was used in the actual experiment and those results are presented later.

An analysis of product use for each condition was done to determine whether the results corresponded to the experimental hypotheses. The number of uses for each condition is shown in Figure 5. Two participants tested the crank condition for the speaker and two tested the control or solar condition. It is anticipated that with a larger sample size the average number of uses for the solar condition will be higher than the average number of uses for the crank condition. Only three out of four eco-button conditions could be tested due to the limited sample size. Participant 001 was not able to participate in the eco-button experiment because their computer had broken. The average number of uses for the Software Only, Software plus Eco-button, and Eco-button Only conditions were estimated to be higher than the average number of uses for the control or shutdown condition. The Software plus Eco-button condition includes both types of feedback and was predicted to have the highest average number of uses.

The pilot experiment went well and the participants were able to understand and follow all directions. The pilot participants responded well to all product instructions and reported that there were no issues using the products. All participants remembered to record their product uses and had no problems with the surveys they took at the end of the week. The pilot results were not expected to resemble the experimental results because the pilot sample size was so small that they could not be considered accurate.

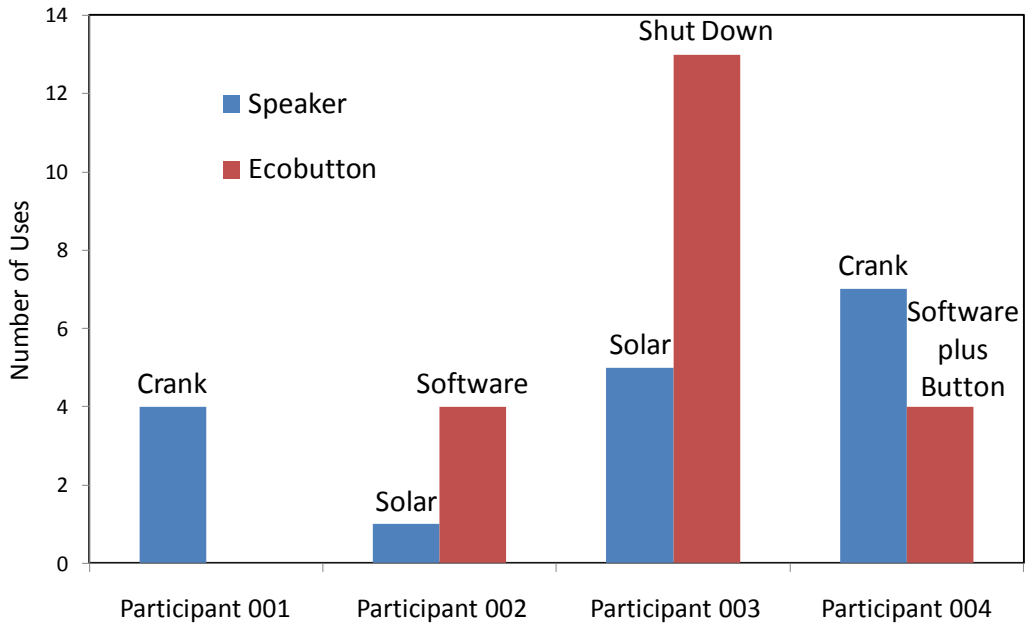

Figure 5. Number of uses for each condition in the pilot experiment.

A students' environmental consciousness was measured through both environmental attitude and behavior. Studies have yielded contradictory results as to whether a positive environmental attitude relates to environmentally responsible behavior (Fransson and Gärling 1999). A somewhat positive trend between environmental attitude and behavior

can be seen in Figure 6. This participant behavior illustrated in the graph is a self-reported behavior that is measured with survey questions. Another representation of environmental behavior may be seen in the use of environmentally friendly products. This is a very small part of environmental behavior, but it is also a relevant one. There may be a relation between environmental attitude and the number of uses for a product. A valid prediction can be made that if a person has a positive view of the environment, then they may use eco-friendly products more often. To determine whether this statement is true, a graph of environmental attitude versus number of product uses must be made for each product. This is not possible with such a small sample size used in the pilot experiment, but this analysis will be performed later when a larger sample size is used. The pilot results did not reveal any problems with the experiment design; therefore, no changes were made to any part of the experiment.

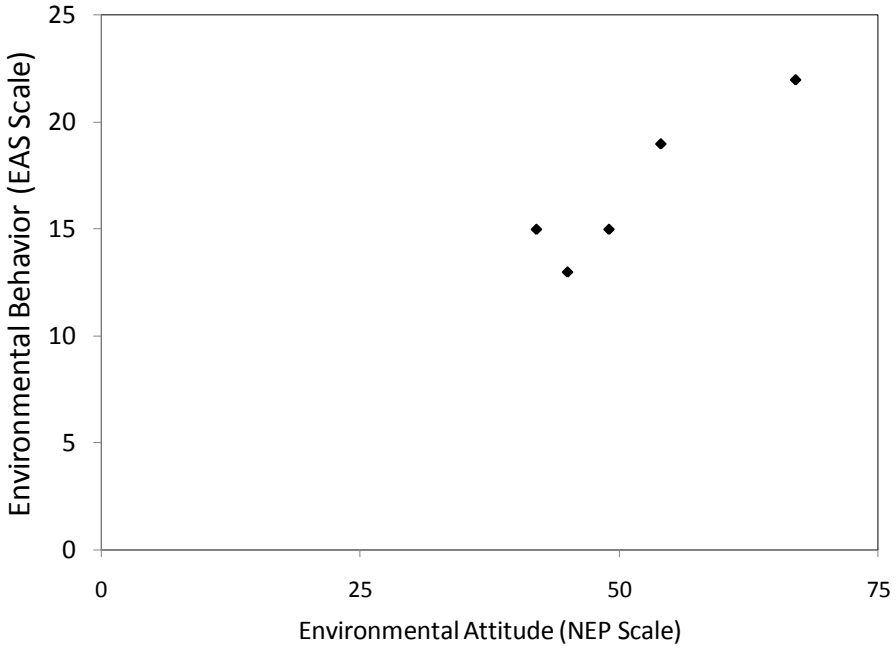

Figure 6. Relationship between environmental attitude and environmental behavior.

Experimental results

Sample description

There were 16 participants used for the pilot experiment. Three of which were females, 13 males, and all were between 18-26 years of age. All participants were engineering students attending the college of Texas A&M University in College Station. Five of the participants were graduate students, eight participants were seniors, one participant was a junior, one participant was a sophomore, and one participant was a freshman. Eight of the students tested the crank condition for the activity hypothesis while eight tested the solar (control) condition and four participants tested each of the four eco-button conditions.

Product usage

The average number of uses for the crank condition was believed to be lower than the solar condition because cranking the speaker adds a user activity. However, the results of the experiment showed that the average number of uses for the crank condition were actually higher than the solar condition. Based on the feedback hypothesis, the average number of uses for the Software Only, Eco-button plus Software, and the Eco-button Only conditions were all expected to have more uses than the shutdown condition. The Eco-button plus Software condition was also assumed to have the most uses of all the Eco-button conditions. Again, the results of the experiment did not agree with our hypotheses. Table 3 shows the results for the average number of uses for each product.

Table 3. Average number of uses and standard deviations for each product.

	Crank Speaker	Solar Speaker	Eco-button Software	Eco-button Software plus button	Eco-button Only	Shutdown
Average # of Uses	9.13	5.38	3.25	1.5	10.25	14.75
Standard Deviation	4.58	2.00	4.03	1.73	8.62	9.98

The results from the eco-button experiment indicate that problems may exist in the experimental design. One problem encountered during the experiment was that many participants did not use their Eco-button software because they could not get it to work correctly. A total of four participants reported that they had this problem (two participants with the Eco-button plus Software condition, one participant with the Software Only condition, and one participant with the Eco-button Only condition). This

made the average uses for each of these conditions lower since the participants had zero product uses during the week. The participants with zero product uses were removed to determine whether this made a significant difference in the data. Figure 7 shown below illustrates the data with the zeros removed as well as the original data.

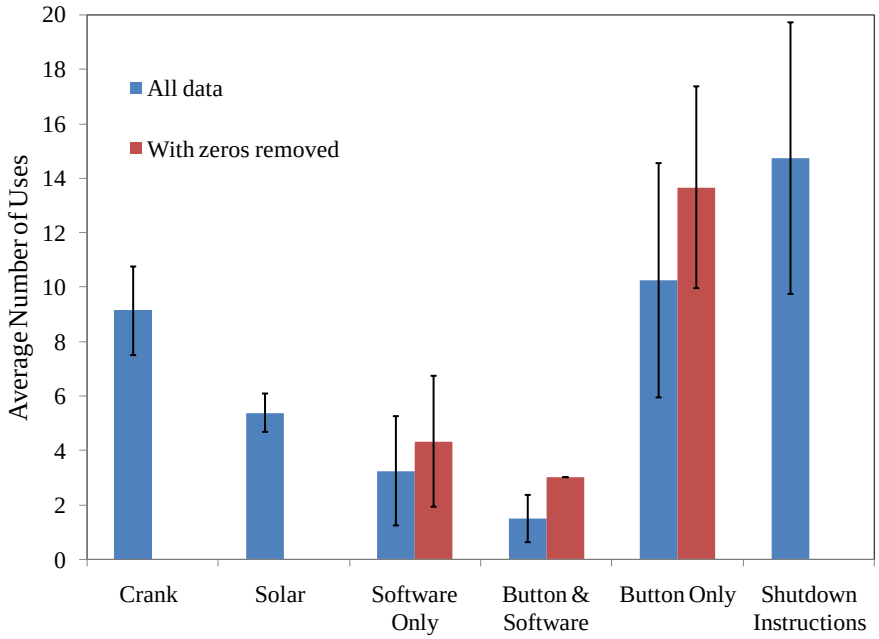

Figure 7. Average product use for full data set as well as with the zero data removed.

The participants should have been able to download the software onto their computers because they were asked about their type of operating system to insure that the program would work. Therefore, there may have been another reason behind the participants not downloading the software. Since the Eco-button Only condition had more uses than the Software Only and the Eco-button plus Software conditions, there may have been an issue with the instructions to download the software. The instructions to download the

modified program for the Eco-button Only condition were short and simple compared to the Eco-button software instructions. The length of instructions may have led the participants to believe the installation would be difficult; therefore, they would not even attempt to download the software.

In addition, a flaw in the experimental design for the Eco-button may have caused an error in the data. The participants were asked to record each time they used the product when they should have been asked to record every time they shutoff or slept their computer. This is because the participants may have been shutting off or sleeping their computers without the use of the Eco-button or Eco-button software. The participants should have been asked to record each time they used the product and each time they shut down their computer without it. Table 4 shows the average listening time for each speaker type. These results reveal that not only was the crank speaker used more times than the solar speaker, but it was also used for a longer period. This may have been because the participants enjoyed cranking the speaker to listen to their music.

Table 4. Listening time for each speaker.

	Crank Speaker	**Solar Speaker**
Average listening time per use (hr.)	1.2	0.4
Average listening time per week (hr.)	11.5	2.7

Environmental consciousness

For most products, it was found that no correlation exists between the participant's environmental attitude and the number of times they used the product. The results for this correlation are shown below in Table 5. The exceptions are the Eco-button plus Software condition with a high positive correlation of 0.88 and the Shutdown Instructions condition with a 0.75 correlation value. Similarly, it was established that the participant's willingness to change for the environment was not related to the number of product uses for most of the conditions. Again, the two exceptions were the Eco-button plus Software condition and the Shutdown Instructions condition. The Eco-button plus Software condition had a very high positive correlation with a value of 0.93 and the Shutdown Instructions condition had a low positive correlation value of 0.49.

Table 5. Pearson's correlation for number of product uses versus attitude and willingness to change.

	Product Uses vs. Attitude	**Product Uses vs. Willingness to Change**
Crank Speaker	0.21	0.10
Solar Speaker	-0.32	0.22
Software Only	-0.04	-0.05
Eco-button & Software	0.88	0.93
Eco-button Only	-0.05	-0.13
Shutdown Instructions	0.75	0.49

There was a moderately significant correlation between the participant's willingness to change and their environmental attitude, with a value of 0.63 for Pearson's correlation.

Figure 8 illustrates this positive relationship. Fransson and Gärling (1999) state that a person's "values are related to willingness to take pro-environmental action" and these results seem to support this claim.

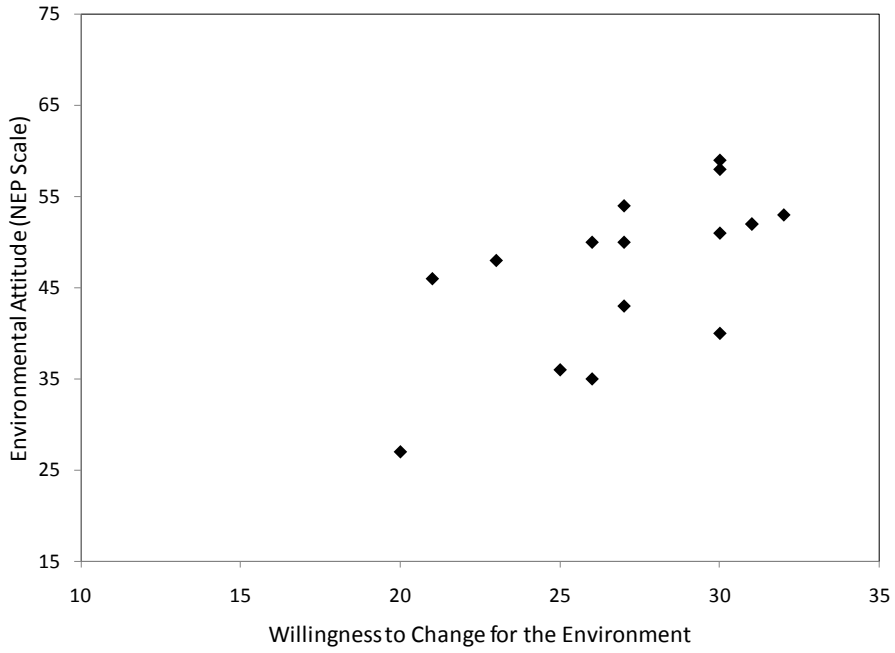

Figure 8. Positive correlation between participant's attitude toward the environment and their willingness to change for it.

Another positive relationship was found between willingness to change and environmental behavior, with a value of 0.66 for Pearson's correlation. The behavior was measured with the EAS Scale (Maloney, Ward, and Braucht 1975) and ranges from 0-30 with the lowest meaning poor environmental behavior and the highest meaning good environmental behavior. Figure 9 shows this positive trend between willingness to change and behavior. This result reveals that people who are not motivated to change

their lifestyle probably do not behave in environmentally benign acts, such as buying or using eco-friendly products. Previous results for this relation are not known to have been measured before.

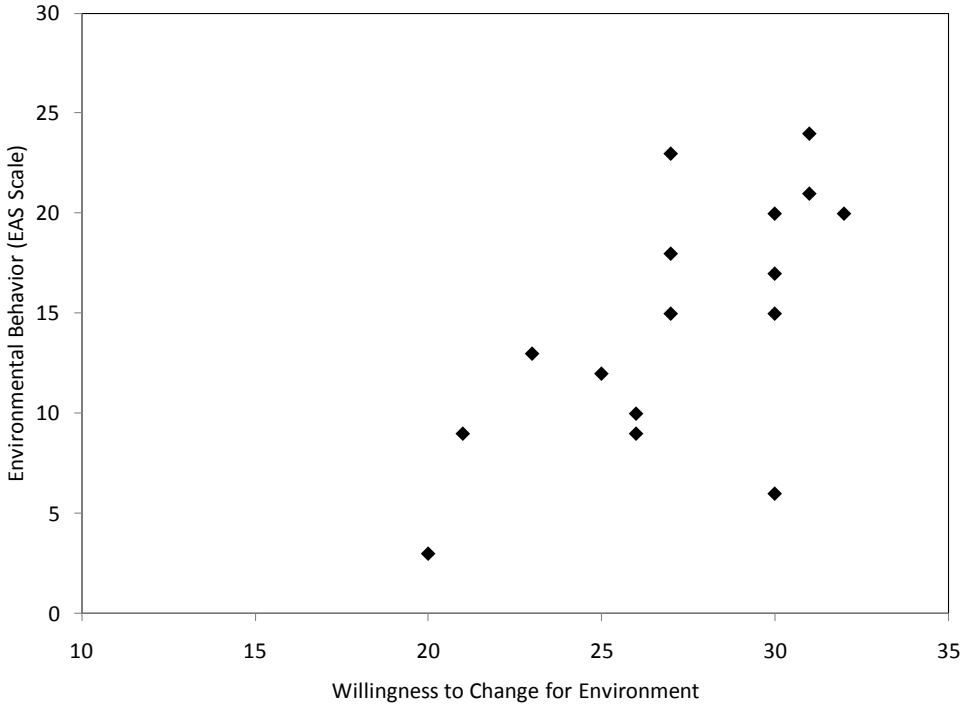

Figure 9. Positive relationship between participant's willingness to change and their environmental behaviors.

A strong correlation was discovered between the attitude and behavior measured with the EAS and NEP scales. Pearson's correlation for these two measurements was 0.73 and Figure 10 illustrates this relationship. Scott and Willits (1994) also compared the results of the NEP to the EAS and reported, "While the holding of environmental

attitudes were somewhat predictive of engaging in environmentally protective action, the linkages were not strong."

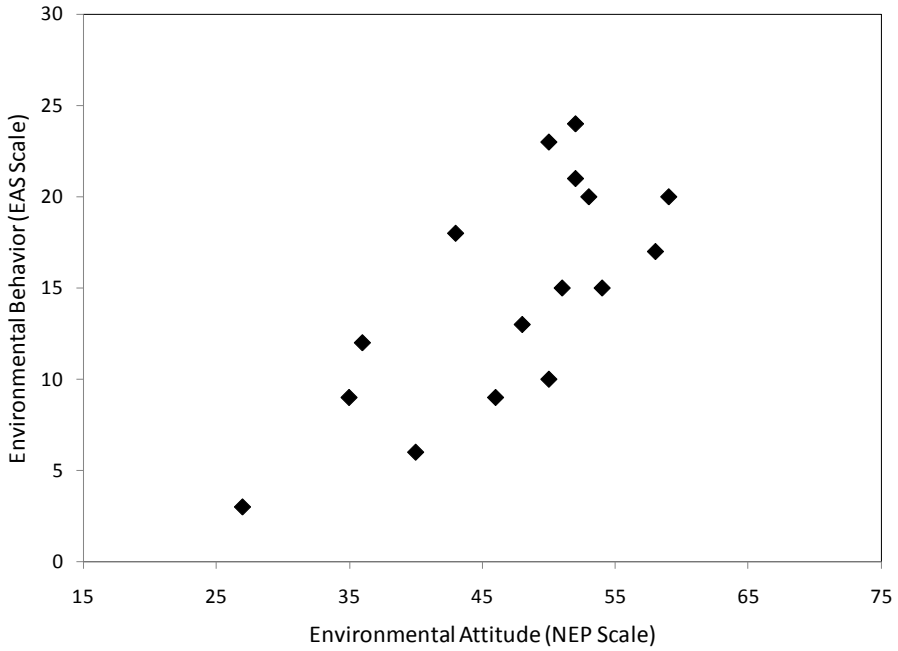

Figure 10. The strong positive correlation between environmental attitude and behavior.

Demographic variables

Previously, several hypotheses were made relating demographic variables to environmental consciousness. Younger, more educated people with liberal political beliefs were assumed to be more concerned with the environment than their counterparts. The sample for this experiment did not vary enough demographically to be able to test most of these hypotheses. Political ideology was the only demographic variable that had enough contrast to consider analyzing. Political ideology was compared

to environmental attitude and a value of 0.53 for Pearson's correlation was calculated. Figure 11 illustrates this slight correlation.

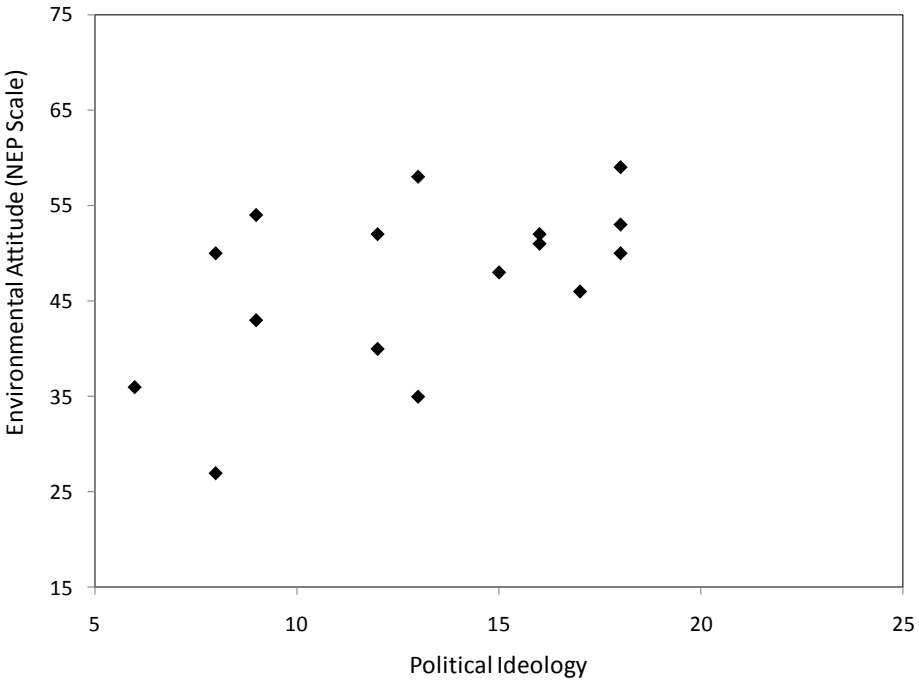

Figure 11. Political ideology versus environmental attitude.

Product evaluation data

The participants were given surveys to evaluate each product they tested to determine several factors. The first part of the survey asked the participants to rank the environmental friendliness of several products, including the product they tested on a scale of 1-7 where a score of one was least environmentally friendly and seven was most environmentally friendly. The results of this survey question are shown in Figure 12.

The speaker was considered more environmentally friendly than the Eco-button by a small margin, and both the crank and solar speakers were the same. The fact that the products were all very close in their ranking of environmental friendliness is important when evaluating for confounds.

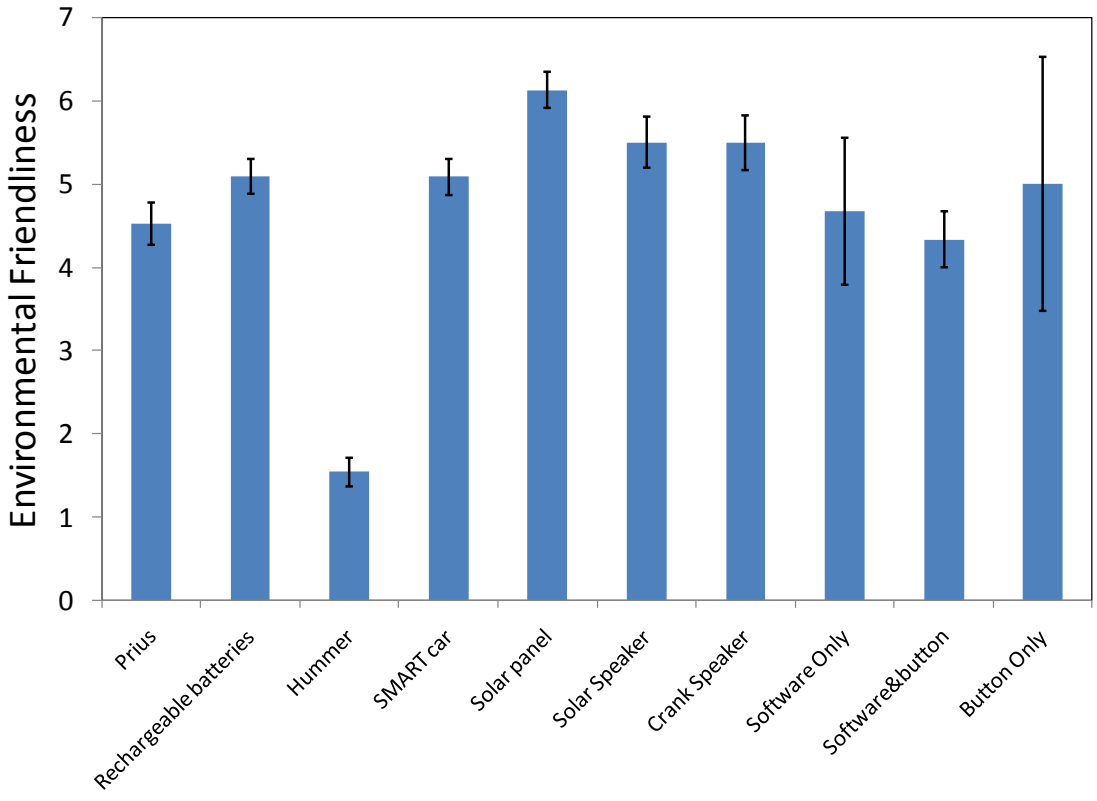

Figure 12. Participants' rating of environmental friendliness for each product with standard error bars.

The second part of the product evaluation survey asked the participants whether they would recommend the product to a friend or family member. Figure 13 demonstrates the average responses to this survey question. All products had an average rating below

"recommend" and the crank speaker was given the highest recommendation. The software only condition was the least recommended with a below "neutral" rating.

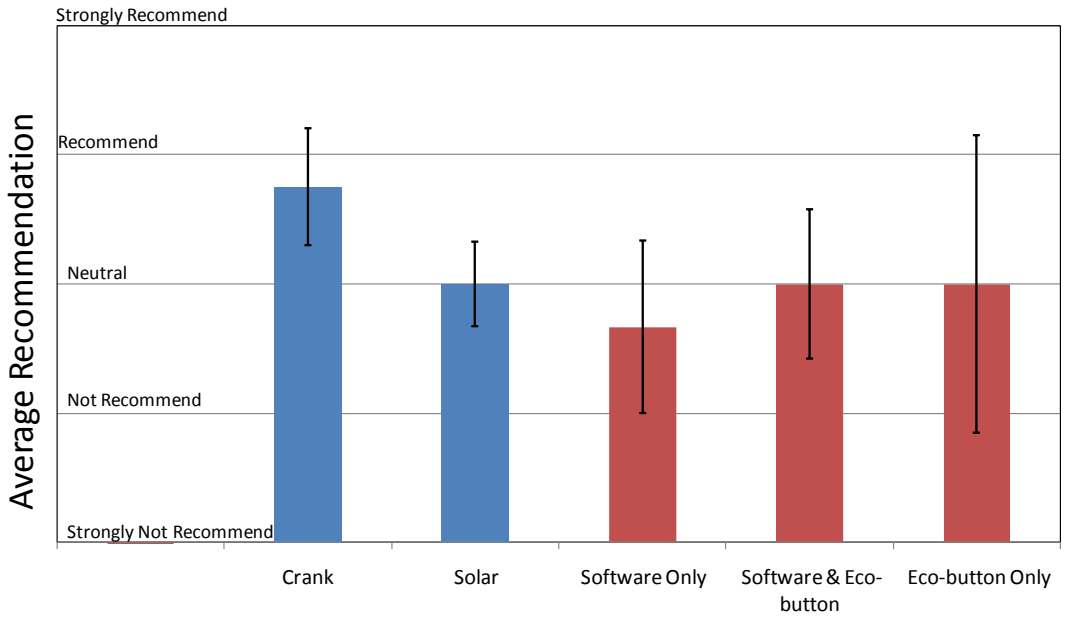

Figure 13. Average recommendations for each product with standard error bars.

In the next part of the survey, the participants were asked if they would continue to use the product if it was given to them. There were four answer choices: yes, no, maybe, and not sure. For future versions of this experiment, the "not sure" answer choice would be removed since it is too similar to the "maybe" answer choice. Table 6 gives the participant responses for this survey question. It seems that most of the participants would continue to use the speaker if it was given to them but would not use the Eco-button.

Table 6. Participant responses when asked whether they would continue to use the product.

	Yes	No	Maybe	Not Sure
Crank	5	1	1	1
Solar	4	1	3	0
Software only	1	1	1	0
Software & button	0	2	1	0
Button only	1	2	0	0

The next part of the survey asked to rate the product on a scale of 1-7 where one is the worst product they have ever used and seven is their absolute favorite product ever used. Figure 14 shows the average rating for each product. The crank speaker was ranked slightly over the solar speaker and the Software & Eco-button was ranked slightly over Software Only and Eco-button Only. Not only did the crank speaker have a higher recommendation than the solar speaker did, but it also had a higher rating. A strange result is that the Software & Eco-button was ranked the highest of the Eco-button conditions, yet it was used the least amount of times. This may be a result of the errors in the Eco-button experimental design that were described earlier. These errors include the problems with downloading the Eco-button software and the mistake of only asking the participants to record each time they used the product instead of each time they shut of their computer.

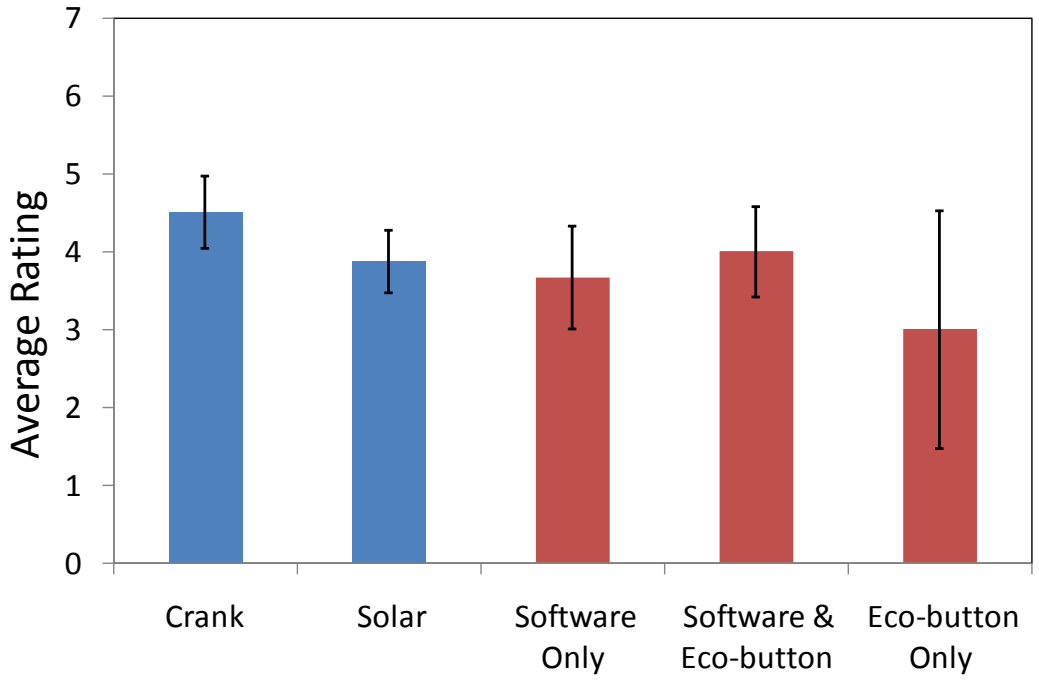

Figure 14. Average rating for each product where one is the worst product and seven is the best product ever used.

An important part of the survey was for the participants to explain what they liked most and least about the products they tested. The responses for the crank speaker are shown in Table 7.

Table 7. Likes and dislikes of the crank speaker.

Like Most	**Like Least**
Fun to crank, I worked for the music	Crank time
Compact	Crank time, sound quality
Compact, easy to carry around	Sound quality, cranking time
No electricity, eco-friendly	Crank time
No cord or outlets, nice radio feature	Cranking makes a lot of noise
Work to make speaker work	Waste of time
Nice radio feature	Charging time, bad quality
Multi-functional	Sound quality

The crank speaker had a wide variety of properties that the participants enjoyed most. A few participants commented that they liked to be able to carry it around, and this was possible because the speaker did not have any type of cord attached. Only one participant commented that they liked that it was eco-friendly. The two most common complaints were that the speaker took too long to crank and that it had poor sound quality. This shows that even though the product was eco-friendly, the participants still held their standards for quality and functionality. The participant responses for their likes and dislikes for the solar speaker are shown below in Table 8.

Table 8. Likes and dislikes of the solar speaker as reported by the participants.

Like Most	**Like Least**
Eco-friendly	Sound quality
Eco-friendly, can use outside	Radio not clear enough
Compact, easy to use	Poor sound quality, solar panel not efficient
Can use outside	Not loud enough
Portable, convenient solar panel	Sound quality
Nice radio, clear sound	Solar panel not effective
Eco-friendly, can be used indoors or outdoors	Sound quality
Multi-functional	Sound quality

Three participants reported they liked the eco-friendly quality of the solar speaker as opposed to one participant from the crank speaker. The students may have had perceptions that a solar panel is more eco-friendly than a crank device, or it may be true that other factors in the crank device were simply liked more than its eco-friendliness.

Another common response was that the participants liked to use the solar speaker outdoors. The most common complaints were that the solar panel was not effective and the speaker had poor sound quality. Nearly every participant reported the bad sound quality of the speaker, so obviously sound quality is of major importance to the students. This result may have been amplified by the fact that music is very important to most college-aged students. Middle-aged consumers may not value music as much, so they might believe that the speaker sound quality is acceptable.

A potential reason the crank speaker was liked more than the solar speaker was that the solar speaker was limited when it came to charging. The crank speaker was portable and could be taken virtually anywhere to charge. In fact, many participants commented that they liked this feature of the crank speaker. On the other hand, if the solar speaker was charged with the wall charger, the participants were confined to one place while the speaker charged. In addition, the solar panel was not very effective indoors so if the participants wanted to use the solar panel effectively, then they were confined to the outdoors. Another possibility the participants enjoyed the crank more is because it presented them with a new feature to a familiar product and they likes having something new and different.

The participant responses to their likes and dislikes of the Eco-button software are listed in Table 9.

Table 9. Likes and dislikes for the Eco-button software only.

Like Most	Like Least
Tells you how much you save	Slows down speed to turn off and on
Shuts down quickly	Hard to turn on, difficult to run
Results make you realize that sleeping your computer makes a difference	Not convenient to wake up

The feedback tested in the software only condition was the visualization of energy savings. Two of the three participants that tested this condition commented that their favorite thing about the Eco-button software was seeing the energy savings. One participant even said that it made them feel like they were making a difference. The biggest problem they had with the software was that it made it difficult to turn their computer back on. The participants claimed that in order to wake up their computer, they had to press the power button, which took longer for their computer to start back up. The likes and dislikes for the Eco-button and software condition are represented below in Table 10.

Table 10. Likes and dislikes for the Eco-button and software condition.

Like Most	Like Least
n/a	Only for computers
Statistics of how much you save	Used up a USB port
Eco-friendly	Not useful

Both the energy savings feedback and the visual reminder feedback were tested in the Eco-button and software condition. The responses for this condition are very mixed,

though one participant did comment that they liked the energy savings feedback. The results to this question seem odd, so it may be attributed to the fact that the participants had a hard time downloading the software onto their computers. It seems that some of the participants did not understand the product because the comment that it is "only for computers" does not make much sense.

The results for the likes and dislikes of the Eco-button only condition are shown in Table 11.

Table 11. Participant responses for the Eco-button only condition.

Like Most	**Like Least**
Compact	It doesn't offer any new features
Easy to use and efficient	Nothing
Easy to use	Inconvenient waking up computer

The feedback tested in the Eco-button only condition was the visual reminder feedback. The button was described as efficient, compact, and easy to use. The responses to this question give the impression that the Eco-button was easy to use but it really did not offer new features to the participant since the button simply just shut down the computer. The next question that the participants were asked was whether the product functioned as expected. The results for each product are listed below in Table 12.

Table 12. Participant responses to whether the product functioned as expected.

	Yes	No	Maybe	Not Sure
Crank	7	1	0	0
Solar	6	2	0	0
Software only	1	1	1	0
Software & button	0	2	0	1
Button	3	0	0	0

Most of the participants said that the crank and solar speakers as well as the button functioned as they anticipated. There were mixed reviews for the Eco-button software and the Eco-button software with Eco-button had mostly negative responses. Therefore, the two Eco-button conditions that used the Eco-button software had some issues with functionality. The participants were told about the product functions when they received the products so they were aware of what the products did. So why did the software not function as they thought it would? One participant that tested the software and Eco-button condition reported that the software made their computer make funny noises. Another said that the software did not function correctly because they might have set up it up incorrectly. Multiple participants claimed that it was more difficult than expected to wake up the computer. While some of these issues cannot be corrected, there may be a solution for correctly setting up the software. If the students could bring their computers with them, then the program could be installed for them to insure that it was working correctly. This process may resolve many of the problems that were encountered with the Eco-button software.

The participants were also asked if the product they were testing fit into their lifestyle or if they had to force themselves to use the product. The responses to this question are shown in Table 13.

Table 13. Participant answers to whether the product fit into their lifestyle.

	Yes	No	Maybe	Not Sure
Crank	5	2	1	0
Solar	4	4	0	0
Software only	0	3	0	0
Software & button	0	2	0	1
Button	2	1	0	0

Most of the participants that tested the crank speaker believed that the product fit their lifestyle while the solar speaker was split between “yes” and “no”. Again, both conditions that included the Eco-button software had mostly negative responses. Some of the participants said that they already had a habit of turning off their computer, so they had no need for the Eco-button.

Summary of results

The results from the user activity experiment have shown that even though the crank speaker required more user activities than the solar speaker did, the crank speaker was still used more by the participants. The crank speaker also consistently scored higher on the product evaluation questions, meaning the participants enjoyed using the crank

speaker more than the solar one. It was also learned that the eco-friendly speakers are expected to be comparable in quality and functionality to other speakers.

The results from the product feedback hypothesis have shown that several errors occurred within the experiment. This was an unfortunate result, but these problems can aid in the design of future experiments. An important lesson learned in the experiment was that the difficult installation of the product acted as a hindrance in beginning to use the product.

Another consideration of this study was to examine consumer motivation to use eco-friendly products. The survey results have shown that a positive environmental attitude and a willingness to change for the betterment of the environment act as motivators to participate in environmentally responsible behavior.

CHAPTER IV

SUMMARY AND CONCLUSIONS

It was hypothesized that consumers would not like a product that added user activities, and the results show that this may not always be the case. Overall, the crank speaker was used more and liked more by the participants than the solar speaker was. Why did the participants like the crank speaker so much? While several speculations to this question can be made, there are no concluding remarks as to why this is the case. The participants may have enjoyed the freedom of the crank speaker since it could be used virtually anywhere. It is also possible that the participants thought the cranking mechanism was new exciting feature to a familiar product and that it was fun to use. The truth is that the question cannot be answered entirely with the data collected in this experiment. More in-depth participant interviews might allow insight into why the participants liked the crank speaker more than they liked the solar speaker. An interesting idea to pursue in the future would be to add a third condition to the speaker experiment. The additional condition would include a speaker that had both the crank and the solar charging capabilities. The participants could be asked which charging option they preferred and why this is the case.

It was apparent in the product evaluation surveys that the participants had problems with the sound quality of the speaker and with the charging efficiency. An observation could be made that consumers demand good quality products, even if they are environmentally

friendly. One participant commented that they try to buy eco-friendly products but also want a performance-oriented product so they are neutral when it comes to eco-friendly products. Some consumers may have perceptions that many eco-friendly products are not up to par when it comes to quality and performance.

The results for the Eco-button experiment have made reason to believe that there were issues not accounted for in the experimental design. While the experiment was well thought out and carefully designed, there were unforeseen issues that arose. It was not anticipated that the participants might be turning off their computers without the use of the Eco-button. The participants should have been asked to record every time they shut off their computer instead of every time they used the product. This would solve the problem that the participants could have been shutting down their computers without the use of the button or software. Another possible issue that may need adjusting is the length of the product instructions. If all the sets of instructions were short and approximately the same length, then the possibility of the instructions hindering the participants in downloading the software would be gone. In addition, the Eco-button software should have been downloaded on their laptops for them. This would solve the problem that many participants had with the downloading and installation of the Eco-button software.

Positive relationships were discovered between attitude and behavior as well as willingness to change and behavior. Environmental attitude and willingness to change for environmental benefit may act as motivators for consumers to behave in more

environmentally benign ways. This would mean that through increasing consumers' concern and knowledge of the environment, we might also increase their positive environmental behaviors. The data gathered through participant surveys showed a positive relation between attitude and behavior, but the product usage data does not. Neither attitude nor willingness to change for the environment played a role in the number of times the participants used the eco-friendly products. However, the sample size for the Eco-button conditions were so small that valid conclusions should not be made for these conditions. Further research that is designed to specifically test this theory would allow a better understand of the relationship between environmental attitude and product use.

Future work

Ideas for future experiments that further explore environmentally friendly product design have stemmed from this research. An investigation into the relationship between environmental attitude and product usage would be an interesting research topic. An experiment designed specifically to test this theory would help determine whether attitudes really have a part in consumers using eco-friendly products or if other factors play a stronger role. There was no correlation found in this experiment, but a small number of participants were used and only short-term behaviors were examined. A larger sample size and a longer product-testing period would be more appropriate in determining whether attitudes are related to eco-friendly product usage.

Another thought would be to repeat the experiment, but to replace the existing products with different environmentally friendly products. These new products could test the same hypotheses for user activities and product feedback or test a new set of hypotheses. Many of the participants reported that the products used in the experiment were of poor quality so if new products were chosen, quality should be a deciding factor in selecting new products.

Research that explores the principles of successful eco-friendly products could also be an area of future work. A rubric outlining the requirements of a successful product would be created and then many eco-friendly products would be examined to determine whether they were successful or not. The products would then be compared to determine whether similarities exist between successful products. Design principles would then be developed from these similarities in successful eco-friendly products.

REFERENCES

Abele, E., Anderl, R. and Birkhofer, H., *Environmentally-Friendly Product Development: Methods and Tools*, 2005 (Springer Verlag: London).

Dunlap, R., Liere, K. Mertig, A. and Jones, R., Measuring endorsement of the new ecological paradigm: a revised NEP Scale. *Journal of Social Issues,* 2000, **56**: 425-442.

Fiksel, J., *Design for Environment: A Guide to Sustainable Product Development*, 2009 (McGraw-Hill Professional: New York).

Fransson, N. and Gärling, T., Environmental concern: conceptual definitions, measurement methods, and research findings. *Journal of Environmental Psychology*, 1999, **19**(4): 369-382.

Fuad-Luke, A., *The Eco-design Handbook: A Complete Sourcebook for the Home and Office*, 2004 (Thames & Hudson: London).

Krause, D., Environmental consciousness: an empirical study. *Environment and Behavior*, 1993, **25**(1): 126-142.

Heath, C. and Heath, D., *Switch: How to Change Things When Change Is Hard*, 2010 (Random House: New York).

H'Mida, S., Factors contributing in the formation of consumers' environmental consciousness and shaping green purchasing decisions. In *International Conference on Computers & Industrial Engineering*, Paper No. ICCIE2009/CIE-5223972, 2009 (Institute of Electrical and Electronics Engineers: Troyes, France).

Mackenzie, D., *Green Design: Design for the Environment*, 1997 (Laurence King Publishing: London).

Mainieri, T., Barnett, E. Valdero, T. Unipan, J. and Oskamp, S., Green buying: the influence of environmental concern on consumer behavior. *The Journal of Social Psychology,*1997, **137**(2): 189-204.

Maloney, M. P., Ward, M. P. and Braucht, G.N., A revised scale for the measurement of ecological attitudes and knowledge. *American Psychologist*, 1975, **30**(7): 787-790.

Otto, K. and Wood , K., *Product Design: Techniques in Reverse Engineering and New Product Development*, 2000 (Prentice Hall: Upper Saddle River, NJ).

Scott, D. and Willits, F. K., Environmental attitudes and behavior: a Pennsylvania survey. *Environment and Behavior*, 1994, **26**(2): 239-260.

Thaler, R. H. and Sunstein, C. R., *Nudge: Improving Decisions About Health, Wealth, and Happiness*, 2008 (Penguin Group: London).

Van Liere, K. D. and Dunlap, R. E., The social bases of environmental concern: a review of hypotheses, explanations and empirical evidence. *Public Opinion Quarterly*, 1980, **44**(2): 181-197.

APPENDIX

Part 1

Listed below are statements about the relationship between humans and the environment. For each one, please indicate whether you STRONGLY AGREE, MILDLY AGREE, are UNSURE, MILDLY DISAGREE, or STRONGLY DISAGREE with it:

	Strongly Agree	Mildly Agree	Unsure	Mildly Disagree	Strongly Disagree
1. We are approaching the limit of the number of people the earth can support.	☐	☐	☐	☐	☐
2. Humans have the right to modify the natural environment to suit their needs.	☐	☐	☐	☐	☐
3. When humans interfere with nature it often produces disastrous consequences.	☐	☐	☐	☐	☐
4. Human ingenuity will insure that we do NOT make the earth unlivable.	☐	☐	☐	☐	☐
5. Humans are severely abusing the environment.	☐	☐	☐	☐	☐
6. The earth has plenty of natural resources if we just learn how to develop them.	☐	☐	☐	☐	☐
7. Plants and animals have as much right as humans to exist.	☐	☐	☐	☐	☐
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations.	☐	☐	☐	☐	☐
9. Despite our special abilities humans are still subject to the laws of nature.	☐	☐	☐	☐	☐
10. The so-called “ecological crisis” facing humankind has been greatly exaggerated.	☐	☐	☐	☐	☐
11. The earth is like a spaceship with very limited room and resources.	☐	☐	☐	☐	☐

	Strongly Agree	Mildly Agree	Unsure	Mildly Disagree	Strongly Disagree
12. Humans were meant to rule over the rest of nature.	☐	☐	☐	☐	☐
13. The balance of nature is very delicate and easily upset.	☐	☐	☐	☐	☐
14. Humans will eventually learn enough about how nature works to be able to control it.	☐	☐	☐	☐	☐
15. If things continue on their present course, we will soon experience a major ecological catastrophe.	☐	☐	☐	☐	☐

Part 2

In terms of your own behavior, circle whether each statement is TRUE or FALSE:

True False I guess I've never actually bought a product because it had a lower polluting effect.

True False I'd be willing to ride a bicycle or take the bus to work in order to reduce air pollution.

True False I feel people worry too much about pesticides on food products.

True False I keep track of my congressman and senator's voting records on environment issues.

True False I would probably never join a group or club which is concerned soley with ecological issues.

True False It frightens me to think that much of the food I eat is contaminated with pesticides.

True False I have never written a congressman concerning the pollution problems.

True False I would be willing to use a rapid transit system to help reduce air pollution.

True False It genuinely infuriates me to think that the government doesn't do more to help control pollution of the environment.

True False I have contacted a community agency to find out what I can do about pollution.

True False I'm not willing to give up driving on a weekend due to a smog alert.

True False I feel fairly indifferent to the statement: "The world will be dead in 40 years if we don't remake the environment."

True False I don't make a special effort to buy products in recyclable containers.

True False I'm really not willing to go out of my way to do much about ecology since that's the government's job.

True False I become incensed when I think about the harm being done to plant and animal life by pollution.

True False I have attended a meeting of an organization specifically concerned with bettering the environment.

True False I would donate a day's pay to a foundation to help improve the environment.

True False I'm usually not bothered by so-called "noise pollution."

True False I have switched products for ecological reasons.

True False I would be willing to stop buying products from companies guilty of polluting the environment, even though it might be inconvenient.

True False I get depressed on smoggy days.

True False I have never joined a cleanup drive. (example: a neighborhood clean-up)

True False I'd be willing to write my congressman weekly concerning ecological problems.

True False When I think of the ways industries are polluting, I get frustrated and angry.

True False I have never attended a meeting related to ecology.

True False I probably wouldn't go house to house to distribute literature on the environment.

True False The whole pollution issue has never upset me too much since I feel it's somewhat overrated.

True False I subscribe to ecological publications.

True False I would not be willing to pay a pollution tax even if it would considerably decrease the smog problem.

True False I rarely ever worry about the effects of smog on myself and family.

Part 3

Please circle your best possible answer:

All things considered, would you classify yourself as an environmentalist? YES NO NOT SURE

Part 4

Listed below are potential life-style adjustments. Indicate whether you DO THIS, are WILLING TO DO THIS, are RELUCTANT TO DO THIS, or are OPPOESD TO THIS:

	I do this	I am willing to do this	I am reluctant to do this	I am opposed to do this
Use nontoxic products	☐	☐	☐	☐
Practice water conservation	☐	☐	☐	☐
Separate garbage	☐	☐	☐	☐
Turn down heat in winter	☐	☐	☐	☐
Eat less meat	☐	☐	☐	☐
Drive less	☐	☐	☐	☐
Restrict use of private autos	☐	☐	☐	☐
Encourage two-child families	☐	☐	☐	☐
Support international programs	☐	☐	☐	☐

Part 5

Multiple demographic questions are listed below.

Please fill in the blanks:

1. **Gender:** _____

2. **Age:** _____

Please circle your level of education:

3. **Education:**

Freshman Sophomore Junior Senior Graduate

Listed below is a series of statements about political ideology. For each one, please indicate whether you STRONGLY AGREE, MILDLY AGREE, are UNSURE, MILDLY DISAGREE, or STRONGLY DISAGREE with it:

4. **Political ideology:**

	Strongly Agree	**Mildly Agree**	**Unsure**	**Mildly Disagree**	**Strongly Disagree**
1. Regulation of business by government usually does more harm than good.	☐	☐	☐	☐	☐
2. Government regulation and planning leads to bureaucracy, inefficiency, and stagnation	☐	☐	☐	☐	☐
3. The government has too much power over citizens	☐	☐	☐	☐	☐
4. The government should not interfere with the free enterprise system.	☐	☐	☐	☐	☐
5. Government planning inevitably results in the loss of essential liberties and freedoms.	☐	☐	☐	☐	☐

Part 1

Please rate the following products on their environmentally friendliness, where a score of one is LEAST ENVIRONMENTALLY FRIENDLY and a score of seven is MOST ENVIRONMENTALLY FRIENDLY.

	LEAST environmentally friendly						**MOST environmentally friendly**
Toyota Prius	1	2	3	4	5	6	7
Solar powered speaker	1	2	3	4	5	6	7
Rechargeable batteries	1	2	3	4	5	6	7
Hummer	1	2	3	4	5	6	7
Solar panel	1	2	3	4	5	6	7
Crank powered speaker	1	2	3	4	5	6	7
Smart car	1	2	3	4	5	6	7

Part 2

Please circle your best answer:

1. **Would you recommend the speaker to a friend or family member?**

Strongly Recommend Recommend Neutral NOT Recommend Strongly NOT Recommend

2. **If we gave you the speaker, would you continue to use it?**

Yes No Maybe Not sure

3. **If we gave you the speaker, how frequently would you use it?**

Daily 1-2 times per week About weekly About monthly Yearly or less Never

4. **All things considered, what would you rate the speaker on a scale of 1-7, where one is the worst product you have ever used and seven is your absolute favorite product you have ever used?**

Worst product **Best product**

1 2 3 4 5 6 7

5. **Please indicate below your absolute favorite product you have ever used and the worst product you have ever used.**

Favorite: _____

Worst: _____

Part 3

Short answer questions: Please record your response to the following questions in the blanks provided.

1. How long did it take you to learn how to use the speaker? _____

2. How many times did you use the speaker in the past week? _____

3. Approximately how much time did you spend using the speaker during each use? _____

4. What did you like MOST about the speaker? Please explain why. _____

_____

_____

_____

_____

5. What did you like LEAST about the speaker? Please explain why.

_____

_____

_____

_____

_____

6. Did the speaker function as expected? If not, why? _____

_____

_____

_____

7. Did the speaker fit into your lifestyle? Did you have to force yourself to use the speaker? Why?

_____

_____

_____

8. Did using the speaker influence you to be more eco-friendly in other aspects of your life? If yes, describe.

_____ ____ _____

_____

_____

CONTACT INFORMATION

Name:	Nicole Esposito
Professional Address:	Dr. Julie Linsey 407 Engineering/Physics 3123 TAMU College Station, Texas 77843
Email Address:	ne1034@neo.tamu.edu
Education:	B.S., Mechanical Engineering, Texas A&M University, August 2011 Undergraduate Research Scholar