

AWARE

A Step Toward Building a Sustainable Economy by Informing Consumer Purchasing Decisions at the Point of Sale



**US Environmental Protection Agency
Final Phase I Report**

**P³: People, Prosperity,
and the Planet Project
Grant #SU831868**

Faculty Advisor:

Steven J. Skerlos
Assistant Professor
Dept. of Mechanical Engineering
University of Michigan
2250 G.G. Brown
2350 Hayward Street
Ann Arbor, MI 48109-2125
TEL: (734) 615-5253
FAX: (734) 647-3170
skerlos@umich.edu
www.umich.edu/~skerlos

Student Leadership:

Jeremy J. Michalek
Research Fellow
Dept. of Mechanical Engineering
University of Michigan
2250 G.G. Brown
2350 Hayward Street
Ann Arbor, MI 48109-2125
TEL: (734) 647-9402
FAX: (734) 647-8403
michalek@umich.edu
www.umich.edu/~michalek

<http://www-personal.engin.umich.edu/~michalek/AWARE>

Table of Contents

Summary of Phase I	3
Background and problem definition	3
Purpose, objectives, scope	4
1. Marketing 618: Survey Design and Analysis (Fall 2004)	4
2. Mechanical Engineering 589: Eco-Design and Manufacturing (Fall 2004)	5
3. Art and Design 441: Studio Project (Spring 2005)	5
4. Mechanical Engineering 450: Design and Manufacturing III (Spring 2005)	5
5. Mechanical Engineering 490: Independent Study 02 (Spring 2005)	6
6. Mechanical Engineering 490: Independent Study 01 (Spring 2005)	6
7. Engineering 490: Engineering for Community (Spring 2005)	7
Data, results, findings	7
Discussion, conclusions, recommendations	10
References	11
Proposal for Phase II	12

Summary of Phase I

DATE OF FINAL REPORT: April 10, 2005

EPA AGREEMENT NUMBER: SU831848

PROJECT PERIOD: Sept. 30, 2004 – May 30, 2005

PROJECT TITLE: AWARE: Facilitating Informed Consumer Purchasing Decisions through Point-of-Sale Access to Product Sustainability Information (*original title of proposal*)

FACULTY ADVISOR:
Steven J. Skerlos
Mechanical Engineering
University of Michigan

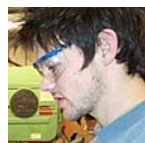


STUDENT TEAM MEMBERS*:

Jeremy J. Michalek
Mechanical Engineering
University of Michigan



W. Ross Morrow
Mechanical Engineering
University of Michigan



* Other students listed under projects

Background and problem definition

The AWARE concept is proposed as a tool for moving toward a sustainable economy by informing consumers about the social and environmental impact of their purchase decisions at the point of sale. Consumers in developed markets such as the United States make a large number of purchase decisions every year, and the number of products from which to choose is often overwhelming (see Figure 1). Consequently, decisions are generally made primarily based on easily-observable information such as price, packaging and label. Determining the social and environmental characteristics of products and their producers requires extensive research – which is impractical for individual consumers. As a result, social and environmental considerations are undervalued in the marketplace, and producers seeking market share and profit for shareholders are driven to reduce cost – often at the expense of social and environmental performance. We believe that providing convenient, customizable information about the social and environmental performance of products and their producers to consumers at the point of purchase will affect consumer purchasing patterns. If a sufficient level of change is realized, resulting market forces will create incentives for companies to put more emphasis on their social and environmental



Figure 1. Consumers in developed markets are typically bombarded with a large number of products that have few fundamentally differentiating factors, and hence make decisions based mostly on price, brand, and packaging alone.



Figure 2. Handheld computers (PDAs) outfitted with UPC barcode scanners could function as an effective means to providing additional information, such as environmental characteristics, to consumers at the point of sale.

performance. AWARE is proposed as a means to inform consumers by scanning standard product barcodes and automatically retrieving product and company information from an online database. The device may take the form of a PDA (see Figure 2), mobile phone, a small keychain design, a store-owned cart-mounted design, or other possible manifestations.

Purpose, objectives, scope

The eight-month P³ project for AWARE was pursued with the intent to build working prototypes with real product and producer data to validate feasibility, demonstrate the concept, and test with in-store use. Furthermore, conceptual design alternatives were explored and a survey was implemented to estimate the degree to which access to social and environmental information might change consumer purchasing behavior. The scope was limited primarily to studying the collection and use of social and environmental information to consumers. A business model for production and sales of AWARE units was outside the scope of the project, and possibilities of including other types of information on AWARE devices to increase interest and reduce cost (ex.: advertising, coupons, recipes, price watch features, etc) was not pursued directly. It is the hope that the prototypes produced in Phase I will help in addressing these issues during Phase II.



During the eight-month P³ AWARE project, seven student teams were formed to develop projects that address different aspects of AWARE including concept development, design, prototyping, and assessment of impact. A summary of the projects is provided below:

1. Marketing 618: Survey Design and Analysis (Fall 2004)

People: Scott Jamison, Pierre Baudot, Mitsuaki Sato, Abhishek Roy, Gabriel Zhou, Jeremy Michalek (client), Professor Fred Feinberg (instructor)



Median premium for company color-code rating:

	Detergent	Cleaner
		
Red	Baseline	Baseline
Yellow	0%	16.7%
Grey	16.5%	24.7%
Green	16.7%	33.3%

Project: Design and implement a survey to determine the extent to which access to information about the social and environmental performance of products and their producers would affect consumer behavior.

Method: To reduce survey bias, different survey respondents were shown products with different characteristics and asked to price each product. Median responses were compared across respondents.

Results: Price premiums (i.e.: the additional amount customers will pay) for products with social and environmental performance ratings were estimated from 1100 respondents for a handful of products. Customers were consistently willing to pay significant premiums to buy products with environmental characteristics and to buy from companies rated as being more responsible. Selected data is shown here using color-coded company ratings from the watchdog group Co-op America.

Conclusions: The survey provided strong evidence that consumers state an expectation to pay premiums for green products from responsible companies if the information is there. Further studies are needed to determine the extent to which this survey data matches market behavior.

2. Mechanical Engineering 589: Eco-Design and Manufacturing (Fall 2004)

People: Arnaud Bizard, Brett Lee, Karen Putterman, Professor Steven Skerlos (instructor)



Project: Study environmental labeling programs and report on appropriateness for AWARE

Results: Reviewed existing labeling systems and mapped out preliminary AWARE interface sketches

Conclusions: More transparency is needed in the marketplace in order to provide objective and effective product-level information via AWARE.

3. Art and Design 441: Studio Project (Spring 2005)

People: Dena Bai, Kirsten Climer, Elizabeth Fagan, Evan Fulford, Sabina Rahaman, Brian Rhee, Ryan Wainwright, Jeremy Michalek (client), Professor Jan-Henrik Anderson (instructor)



Project: Explore innovative conceptual design possibilities for AWARE and build aesthetic prototypes.

Results: Several concepts were explored for variations on style, interface, and dual-use functionality.

Conclusions: Different target markets could be reached with different design concepts, for example, a 'badge of honor' theme to help the owner communicate pride about her/his commitment to social responsibility.

4. Mechanical Engineering 450: Design and Manufacturing III (Spring 2005)

People: Dan Bartz, Halil Hamut, Dannielle Sita, Tyson Smith, Jeremy Michalek (client), Professor Steven Skerlos (instructor)



Project: Develop a functional prototype for a small, portable, inexpensive, "keychain" version of AWARE, and explore other potential design alternatives.

Results: Oversized functional prototype of keychain concept developed with separate housing to show scale of the final product. Cart-mounting developed for the PDA concept. Preliminary prototype of cellular phone scanner concept developed.

Conclusions: Cellular phone concept allows greater flexibility to make AWARE attractive to average consumers. Key chain concept could be an attractive way to reduce cost, although it can provide only aggregated information.

5. Mechanical Engineering 490: Independent Study 02 (Spring 2005)

People: Garlin Gilchrist II, Jeremy Michalek (facilitator), W. Ross Morrow (graphic design), Professor Steven Skerlos (instructor)



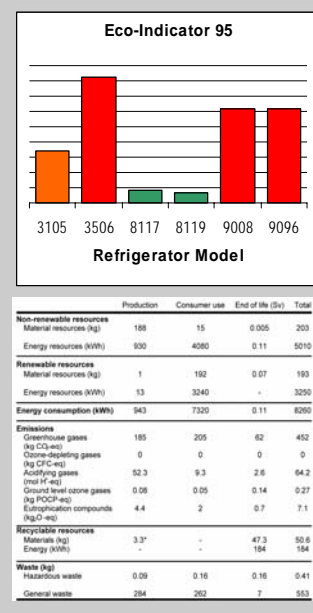
Project: Develop a functional PDA barcode scanner prototype that will provide (1) producer-level data about the scanned product from Co-op America's Responsible Shopper database and (2) product-level data for the products compiled by Katie Kerfoot (ME490 project).

Results: A PocketPC prototype was successfully developed for a database of products and companies using an existing scanner accessory. The software can also be used without the barcode scanner to look up information manually.

Conclusions: The prototype demonstrates the AWARE concept and can be used to assess usability and identify areas for improvement to make AWARE more attractive and more likely to be used. The prototype can also be used to measure the extent to which access to information affects consumer behavior and creates sufficient market conditions for change.

6. Mechanical Engineering 490: Independent Study 01 (Spring 2005)

People: Katie Kerfoot, Jeremy Michalek (facilitator), Professor Steven Skerlos (instructor)



7. Engineering 490: Engineering for Community (Spring 2005)

People: Michael Miller, Juan Novella, Annisha Russell, Coriel Greene, Miguel Verdejo (facilitator), Shauna Puhl (facilitator), Jeremy Michalek (client), Professor William Schultz (instructor)



Project: Study the current AWARE direction and assess impact from a community perspective. Provide recommendations and develop a semester project of appropriate scope, for example, developing a prototype or doing research on the information that AWARE may provide.

Results: Developed a website to compile efforts on the AWARE project and created a wristband campaign concept for publicity. <http://www-personal.umich.edu/~juampisn/aware%20main.htm>

Data, results, findings

Full reports from the student teams who worked on each of the seven investigation projects can be found at <http://www-personal.engin.umich.edu/~michalek/AWARE>. At the time of writing this P³ summary report, deadlines for final individual AWARE investigation reports from several of the student teams have not yet occurred; however, these reports will be posted to the website shortly after the University of Michigan last day of classes - by May 1, 2005. This report serves primarily to summarize general results from the seven investigations.




The most concrete measurable test of the success of AWARE in creating a move toward sustainability is to estimate the number of consumers who would potentially own or use an AWARE device and the extent to which use of AWARE impacts consumer purchasing behavior. Estimating the number of potential users is a difficult task even for large established companies, and results will depend on the business model used to sell AWARE, which is outside the scope of the P³ project. Therefore, estimation of the number of potential users is left for future work when funds are available to consult with a marketing research firm. The extent to which use of AWARE changes consumer purchasing behavior can be estimated using the AWARE prototypes; however, timing logistics mandated that the survey be completed before the prototypes, so instead an online survey was conducted by MBA students at the University of Michigan business school to answer this question as closely as possible.

AWARE Marketing Research: It is reasonably well-established in the literature that asking survey respondents if they are willing to pay more for environmentally friendly products will result in overestimating true market demand for such products. In part, this is because respondent statements on an environmentally-focused survey do not necessarily match what consumers do in practice with real money under market conditions, and people like to think of themselves as socially responsible regardless of purchase behavior in practice. To mitigate this bias, the marketing team developed a survey where respondents were randomly assigned to groups such that each group would see only one variant of each product in the survey – for example, one group might see the phrase “100% environmentally friendly manufacturing” on the list of descriptive characteristics for coffee beans, while another group would see the same coffee with the environmentally friendly descriptor removed. In this way, no single respondent was asked to compare their willingness to pay for environmentally friendly vs. presumably unfriendly coffee. Rather, the median estimated price was compared across the 1100 survey respondents who fell into each group. On average, people who saw the environmentally friendly descriptor quoted a higher price across products (see table below) with one exception: Respondents were not willing to pay more for organic cotton t-shirts. This anomaly may be due




to the context of the other constant descriptors used for t-shirts, including the phrase “Imported from Malaysia” (see survey [1]).

Because the estimates were made *across individuals* instead of being made from a single individual, much of the bias can be eliminated from survey results. The predicted median price premiums are significant – suggesting that companies can successfully charge more for products with positive social and environmental performance, if that information can be made available to consumers at the point of purchase. Furthermore, retailers may also have interest in encouraging consumers to move toward these responsible products because products with significant price premiums are often sold at higher retail profit. While these results are encouraging, two limitations of the study must be noted. First, while the survey respondents were numerous and quite satisfactory for statistical significance (1100 respondents), the demographics of the respondent population are not representative of the mainstream US population. In particular, the highly educated segment is overrepresented in the sample. Secondly, the survey asked respondents to suggest the amount they would “expect to pay” for each product listed in the survey. The relationship between the amount respondents report and what they actually pay in practice is not fully understood. Still, despite these limitations, the survey results provide a helpful quantitative, if preliminary, look at the potential impact of AWARE.

Median Price Premium for Presence of “Green” Characteristics

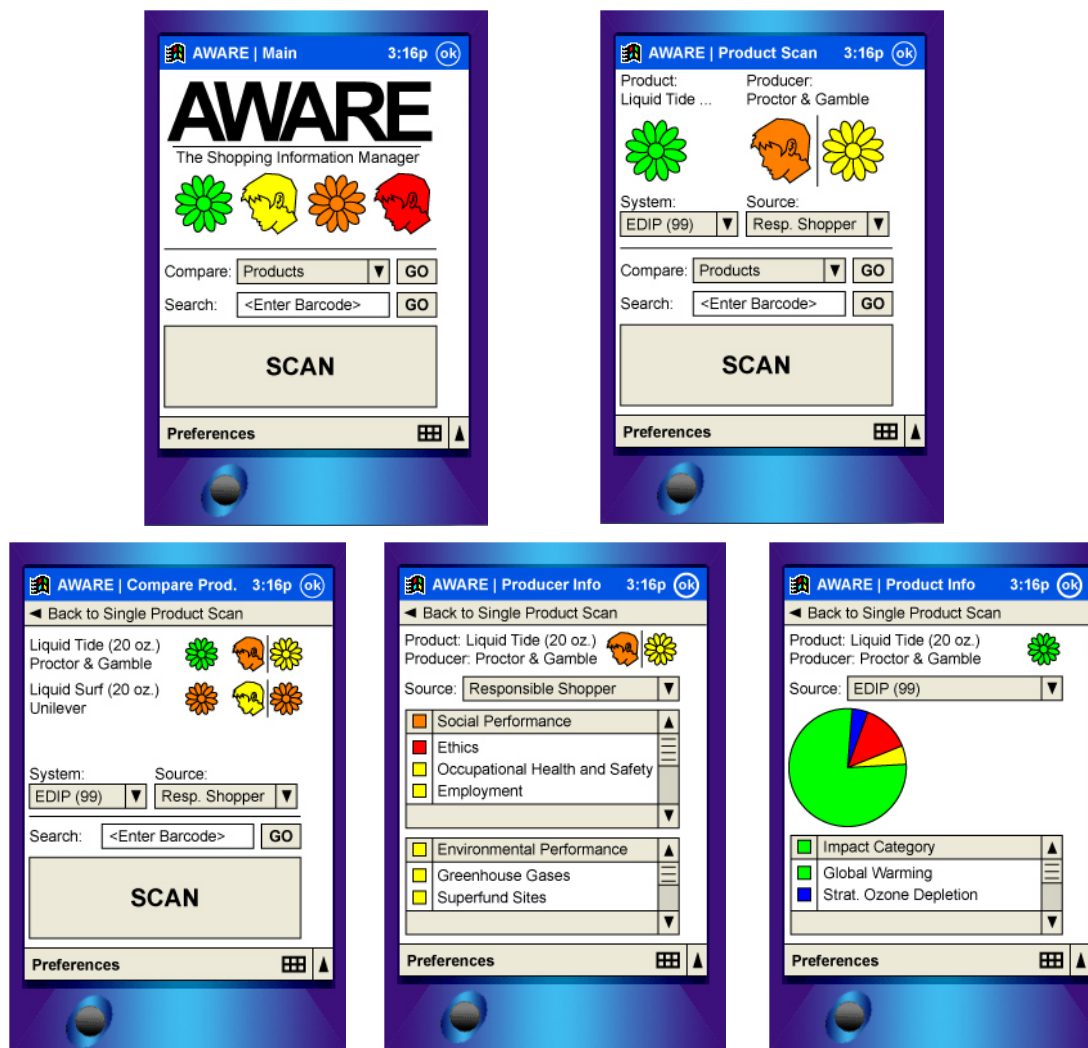
	Coffee 	T-Shirt 	Shampoo 
“Green” character-istic	100% environmentally friendly manufacturing	100% organic cotton	Natural frag-rance, no chemicals added, 100% biodegradable ingredients
Control	- -	100% cotton	Balancing formula, floral scent
Median premium	7%	0%	25%

Median Price Premium for Company Color-Coded Ratings (via Co-op America):

	Detergent 	Juice 	Cleaner 
Red	Baseline	Baseline	Baseline
Yellow	0%	11.7%	16.7%
Grey	16.5%	11.7%	24.7%
Green	16.7%	11.7%	33.3%

AWARE Prototypes: Three functional prototypes and several aesthetic prototypes were developed to test feasibility and demonstrate the different forms that AWARE can take: PDA, mobile phone, keychain device, wearable device, etc. The most complete prototype was implemented on a PDA and is available for download at the AWARE website [1]. This PDA application includes a database of product-specific information about environmental LCA and producer-specific information about general corporate social and environmental performance.

AWARE PDA Implementation User Interface Design



Producer-specific information is necessarily subjective and relative to a particular set of values. The Responsible Shopper database [3] is used as an example dataset in the prototype; however, in general consumers could select their information sources and find one that is most closely aligned with their own value system. Layers of information provide a convenient aggregated metric for quick comparison as well as more detailed information about specific aspects of corporate social and environmental performance at the click of a button.

Product-specific information has the potential to be more objective in nature, with specific measurements determined through standardized life cycle analysis (LCA) procedures. In the prototype, layers of information are used to compare products, with detailed numerical life cycle inventory (LCI) data at the lowest level, aggregation into categories such as greenhouse gasses, acidifying gasses, and eutrophication compounds at the second level, and finally a

single aggregation metric such as Eco-Indicator 99 or EDIP (selectable by the user) for quick comparisons. A standardized color-rating scheme was developed to compare products with respect to statistical information about products within the product category (a bell curve method). The primary obstacles to providing product-specific information are the sheer number of products to research and the effort involved in compiling LCA data. Today, publicly available brand-specific LCA data exists for very few products. The AWARE prototype compiles existing data for refrigerators, detergents, and printer ink cartridges; however, even this data is incomplete. A need exists for more detailed data. It is the hope that applications such as AWARE that can make use of such data may help to drive data collection and reporting. In particular, companies that focus on environmental responsibility may be eager to report results in order to gain competitive advantage; however, it is likely that legislative action would be necessary to attain widespread reporting, and this may be impractical for many product classes, at least in the current environment. Still, it is clear that significant action must be taken to make a major move toward environmental responsibility if we are to drive our current system to become sustainable, and legislative options such as mandatory LCI reporting for new products may be more realistic in the future than today.

Discussion, conclusions, recommendations

The AWARE project takes a market approach to balancing people, prosperity, and the planet. While it is well-established that market externalities and phenomenon such as the “tragedy of the commons”¹ prevent free markets from fully accounting for certain public interests in practice, and while regulation adjustments continue to be necessary to a feasible and functioning market economy, positive impact can be made within the market system itself through better access to information. In a market economy, industrial production of consumer goods and services is driven by patterns of decision-making in the marketplace. With purchasing decisions, consumers support the conditions of production and provision, while they seldom have any knowledge or understanding of these conditions and therefore cannot make informed tradeoffs. Even theoretically rational, fully informed, self-interested consumers have an interest in the public consequences of their private decisions, yet in practice consumers lack the information to rationally make even these “self-interested” tradeoffs. By providing consumers with information about social and environmental performance, AWARE allows individual consumers to make tradeoffs, such as the tradeoff between additional cost and improved environmental performance, rather than relying entirely on legislative bodies to make such tradeoffs.

Of course, the sources of information are important considerations in the AWARE model; however, models in other fields such as the Consumers Union publication Consumer Reports [2], have been successful at gaining and maintaining consumer trust and supporting their work with membership fees. Organizations such as Co-op America [3] provide similar information services for research on corporate social and environmental records, and increased consumer access to that information could make such projects more viable and sustainable, as well as increase impact.

Access to product-specific information is more difficult to collect and maintain; however, there does exist an international standard, ISO 14040 [7], specifying appropriate procedures for data collection, presentation, and product labeling, and other standards such as the Swedish Environmental Product Declarations (EPD) [8] have an increasing amount of product data available. It is the hope that active use of this data with projects such as AWARE may drive

¹ The “tragedy of the commons” states that situations where private benefits are obtained with public costs tend to result in greedy decision-making and negative global consequences [6]. Take, for example, global warming and climate change as a result of distributed air pollution.

demand for the data and possibly result in eventual legislative action to require data for certain product classes if it can be shown that the data is in demand and would result in significant improvements in market incentives for increased corporate social and environmental performance.

Among the main concepts behind AWARE is that significant reductions in environmental impact can be realized by removing barriers to the flow of information between manufacturers and the general public about environmental impact. For example, the Dow Chemical Company found economically reasonable ways to drastically reduce environmental emissions when faced with the requirement of making these figures available to the public through the EPA Toxic Release Inventory (TRI) [5], without any additional direct regulation of these emissions [4]. It is clear that the potential for consumers to react to such information through purchasing decisions can be a strong driver for change, and such incentive-driven improvement brings with it advantages over regulatory compliance. It is the hope that even the potential of consumers having convenient access to information through AWARE might provoke similar preemptive action on the part of corporations to excel in social and environmental performance, with moving targets driven by competitor actions and informed consumer decision-making.

References

- [1] AWARE website, accessed April 10, 2005 <<http://www-personal.engin.umich.edu/~michalek/AWARE>>.
- [2] Consumers Union, accessed April 10, 2005 <<http://www.consumersunion.org>>.
- [3] Co-op America, Responsible Shopper website, accessed April 10, 2005 <<http://www.responsibleshopper.org>>.
- [4] Dow Chemical, "Dow's Michigan operations reports 16% decline in overall TRI emissions compared to 2001," *News Center*, July 10, 2003, accessed April 10, 2005 <http://www.dow.com/dow_news/manufacturing/2003/20030710a.htm>.
- [5] EPA Toxic Release Inventory, accessed April 10, 2005 <<http://www.epa.gov/tri>>.
- [6] Hardin, G. (1968) "The tragedy of the commons," *Science* v162 p1243-48.
- [7] International Organization for Standardization, ISO 14000, accessed on April 10, 2005 <<http://www.iso.org/iso/en/iso9000-14000/iso14000/iso14000index.html>>.
- [8] Swedish Environmental Management Council, Environmental Product Declarations, accessed on April 10, 2005 <<http://www.environdec.com/>>.

Proposal for Phase II

Phase II for AWARE involves using the prototypes developed in Phase I to test the degree to which consumers alter their purchasing behavior when given access to product and producer information. Using this feedback, improvements can be made to the design, and an assessment of the level of impact of AWARE on the marketplace can be undertaken to see if a tipping point could be attained by producing and selling AWARE devices. A detailed business model must also be developed to generate a viable method of production, distribution, and sales without compromising the integrity of the data. In its current state, the AWARE software could be distributed free to consumers with PDA or mobile phone devices, but the convenience of barcode scanning requires financial investment.

Due to the stated EPA focus for Phase II on implementation, rather than further research, and due to constraints on funding allocation preventing payment of graduate student salary, we believe that, although Phase II of AWARE will provide interesting results that may generate positive impact, we do not feel that Phase II of the AWARE project meets the stated intent and restrictions of the EPA P³ funding. It is possible that at a future time the needs of the AWARE project will be more aligned with the P³ Phase II criteria, but it is not yet at that point.