APGRADE.COM

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ABSTRACT:
Noticeable energy and financial savings can be achieved through educated purchases of major household appliances. Consumer-purchasing trends show that consumers are increasingly more likely to visit several retailers, as well as seek out energy efficient appliances to save on energy costs. Few retailers advertise total cost of ownership or appliance energy consumption. Consumer behaviors portray a need for convenient, thorough education regarding total cost of ownership of appliances and potential savings incurred from buying energy efficient devices. We evaluate several possible means to meet this need, and propose a website that services this need and promotes energy conservation by highlighting potential savings and educating the user on total cost of ownership.

EXECUTIVE SUMMARY

The household appliance industry, including such appliances as refrigerators, dishwashers, washers, and dryers, is currently a $21.3 billion per year industry with major manufacturers and retailers vying for market share. The industry operates by manufacturers selling products to retailers, who then handle most of the advertising and reselling of the product to consumers. Each retailer has its own website listing the appliances it carries and allowing the customer to browse and filter results based on their needs.

After researching customer purchasing behaviors and attitudes toward energy conservation, we found that the majority of customers will search online or visit multiple stores before selecting a product. This trend shows that consumers exhibit a need and desire to be educated on all available products and prices to receive the best value. Regarding energy consumption, we found that the majority will only purchase a new major appliance if their old one broke, and not for the sole purpose of conserving energy. However, we found that most consumers are interested in appliances that are energy efficient, but are not willing to pay the extra price.

In order to begin developing concepts we built a list of requirements that our service needs to fulfill for it to be considered a success. These requirements were generated from our extended ethnographic research. Once we had the requirements we translated them into quantitative specifications for verification purposes. From this, we generated a number of concepts that would alter consumer's buying behavior into products with higher efficiency when making purchase decisions on these high-usage products. We brainstormed a number of concepts for each sub-function of our service including medium of information delivery, technical functionality and business model. After concept generation of each sub-function, we developed full service models and graded them against design criteria developed from our requirements in a Pugh chart. From all this, our team selected an alpha concept of a shopping website with a number of novel features related to energy usage would provide an efficient solution to consumers' needs.

After receiving feedback from our users and conducting follow up surveys showing our alpha design, we have developed a final design. Our final design functions similar to a traditional shopping site, but provides additional information to consumers that is not typically readily available. As a consumer browses our website, he/she receives the same price comparisons available from other sites, but also is presented with energy efficiency and resultant adjusted cost information. The purpose of the website is to both make users aware of these hidden intrinsic differences in lifetime cost and encourage environmentally conscious buying decisions. Currently, when it comes to cost, most retailer websites leave users uneducated on how much per year they will have to pay in utilities for the appliance, as well as how that compares to their current appliance. Our website will help to increase the willingness to pay for higher cost, more energy efficient appliances by incorporating statistics and functions to show the true cost of ownership, which may differ greatly than the sticker price. To evaluate the sustainability of this service we would need to conduct extended studies on the increase in number of people purchasing energy efficient products through the use of our website. By determining this number we can translate this to a reduction in societal carbon footprint. We have also included a number of short and long term recommendations to further develop this product in the future.

We have written an extensive business plan to accompany the product and make it successful in the market. Our business plan includes a market analysis, market penetration strategy, communication strategy, channels of distribution, growth strategy, and financial projections over the next three years.

This project has the potential to encourage millions of consumers to be more energy conscious with their purchases. We believe that our website will be a viable, market disrupting service that will be a success within the appliance retail industry and will lead to increased sales in energy efficient appliances.

INTRODUCTION

Household appliances are a large source of energy consumption in any home today. Cutting down the energy consumption of these appliances by purchasing more energy efficient products would result in a significant decrease in monthly energy expenditure on these products. However, most people today are unwilling to spend extra to purchase these more efficient products. To solve this problem we are designing a service that would encourage consumers to pay the higher prices by showing them the true cost of ownership. We strongly believe that if people were better educated on the financial benefit of energy efficient products, they would be willing to change their habits.

Currently, to appeal to energy-conscious customers, retailers such as Best Buy and Sears include energy ratings of their products in their catalog. Consumers are given the choice to include Energy Star certifications in their search filters and are provided an estimate on the energy consumption of the products they view. However, this information often does not convince customers to purchase a product with higher energy efficiency. It has been found that only about 35% of consumers are buying ENERGY STAR certified refrigerators each year. [7]

Interviews with typical appliance consumers were conducted to supplement previously conducted works and studies in ethnographic research. Several of the conclusions gathered from the interviews match the outside research data. Additional new insights into the consumers' mindset were gathered. These interviews proved critical by supplying ideas for features and services to include on the proposed website.

In order to help the consumers compare different options when they shop for a new appliance, Apgrade.com would provide more detailed information regarding ownership cost and environmental impact in addition to the already standard details. Currently, retailers' websites do not show ownership cost; thus the consumers would have to do ownership cost calculation on their own. With this in mind, the proposed business is aiming to provide additional data such as expected future operating cost associated with the new appliance and comparison to the consumers' current appliance to ensure a greener shopping experience.

Direct stakeholders to this business include appliance consumers and manufacturers, appliance retailers, and the host of the webserver. It is expected that the website would be directly affecting the consumers' decisions and in turn, modifying the market space by incentivizing manufacturers to design more energy efficient appliances and retailers to stock these products.

DESCRIPTION OF BASELINE PRODUCT

EnergyGuide Label and ENERGY STAR
The baseline of our project is the EnergyGuide Label and Energy Star Certification. All the heating and cooling appliances including refrigerators must carry EnergyGuide label on them. The label includes estimated yearly energy use and ENERGY STAR certification status as seen in Figure 1.

The energy consumption of a refrigerator is measured using the standard set forth by the Department of Energy using its test procedure [9]. ENERGY STAR certification is awarded based on the procedures set forth by Environmental Protection Agency and its affiliated partners [10]. ENERGY STAR certified products are more efficient than most of the products within the same category; however, the ENERGY STAR label does not guarantee the lowest possible energy usage in a given category of products. Even among the products that are ENERGY STAR qualified, one product might be more energy efficient than others, but such factual information is not easily communicated to consumers. The consumers would need to spend their own time to rank the energy efficiency.
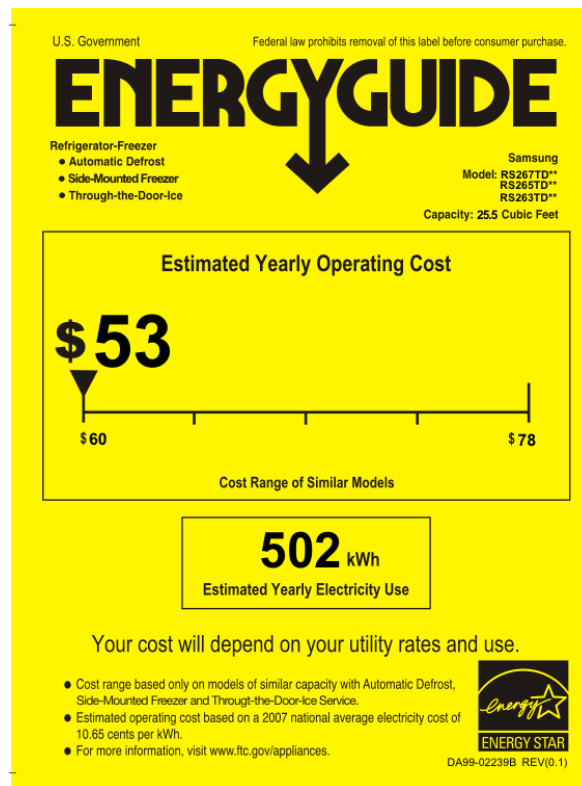
Figure 1. EnergyGuide label of an ENERGY STAR certified Samsung refrigerator [8]

As mandated by law, EnergyGuide label must be affixed to products retailers sell on their shop floor. The label is usually visible when visiting retailers in person, however consumers may specifically need to look for the label on retailers' or manufactures' website under specification or literature page. By inspecting and comparing operating energy use and cost data on EnergyGuide label and creating their own database, consumers can compare different products' efficiency levels. This added efficiency information could be used to estimate the yearly operating cost, but consumers must carry out the building and comparing data procedures on their own as there is no such service available.

Appliance Retailer's Shopping Websites
An indirect baseline to our project are websites of retailers who sell appliances. As of 2011, the US household appliance[1] market had total revenues of $21.3 billion [1]. With such a large market, several retailers vie for position within the industry. The top five major retailers of kitchen appliances, by market share, are Sears (30.9%), Lowe's (22.1%), Home Depot (14.6%), Best Buy (6.90%), and Walmart (3%) [4] (Appendix 6). Each of the main retailers hosts a website showcasing its appliances and online tools to help users choose which appliance best fits their needs. After benchmarking several of the major retailers' websites, we recognized several common features that assist in the users buying experience. For example, if one were to buy a refrigerator on Best Buy, they would first be prompted to select their desired

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1 Kitchen appliances refers to refrigeration appliances, which include fridges, freezers and fridge freezers; cooking appliances, which include cookers, microwaves, ovens, cooker hoods, food processors and toasters; washing appliances, which include washing machines, clothes dryers and washer dryers; and dishwashers. The market value has been calculated using manufacturer selling prices.

orientation (Side-by-Side, Top-Freezer, Bottom-Freezer, etc.) or go through Best Buy's custom Refrigerator Finder application. The Refrigerator Finder application is a shopping tool to help users decide which type of refrigerator they would like to buy, given their needs and desires. If they choose to select an orientation, they would then be able to filter the selection of refrigerators by common qualities such as customer reviews (1-5 stars), brand, price range, features, color, and dimensions. Users are also able to select multiple products to generate a side-by-side comparison of the product features and specifications. In regards to energy savings, product descriptions are quick to mention their Energy Star certification, and often include their estimated energy consumption, in kWh. We even found Best Buy went as far as to estimate the yearly operating costs for some of its products. However, these energy ratings were typically buried deep within the specifications list, often found after scrolling toward the bottom of the page. Appendix 4 shows a screenshot of a typical Best Buy product page. After deciding which refrigerator to purchase, the user is directed to purchase warranties, payment plans, and to select method of obtainment, either through delivery or store pick-up. This buying process is typical across all major retailers and appliances. The major retailers carry many of the most popular brands, but price, variety, and selection often varies greatly.

Project Goals
As indicated in subsequent sections, the majority of consumers are not buying energy efficient appliances due to the lack of easily accessible efficiency related cost information. The project design aims to provide more information to the consumers that their purchase decisions will gradually shift towards more energy efficient appliances; thus reducing overall energy usage. In turn, this may also encourage manufactures and retailers to change production to favor more energy efficient appliances to comply with the market shift. The goal of this project is ultimately encouraging sales and use of major appliances into a more sustainable direction.

DESIGN ETHNOGRAPHY

Household Appliance Market
Several key patterns and consumer-buying habits were found within the US home appliance market through in-depth market research. All studies were conducted through a sample of approximately 2,000 individuals, over the age of 18, and have access to the Internet [4]. The studies involve Washer and Dryer or Refrigerators, Freezers, and Dishwashers, but since the numbers are consistent across, the studies were combined for a representation of the entire US household appliance market. Appendix 5 shows purchasing behaviors and attitudes before or during actual shopping. Of those who bought appliances in the past two years, it showed that 28% visited multiple stores or did research online before visiting stores, and 27% waited for a sale. This included a 10% increase in the number who did research online before visiting stores, compared to who bought an appliance two or five years ago. This trend, combined with a 4% increase in those who used a mobile phone to compare prices while shopping, shows a trend that online comparisons of products have become more prevalent among appliance consumers [4].

Appendix 7 details the main reason for the consumers' most recent purchase. Both tables show that the main reason for buying a new appliance is because the previous one broke down or needed significant repair at 51%. This indicates that consumers are likely to hold onto their appliance for lengthy periods of time or until it breaks. Only about 7% upgraded to save money on energy costs. Figure A in Appendix 7 segments the responses by household income, and shows that household income has little impact on purchase motivations, even among affluent customers. Although, there was a 3% increase among affluent ($150k+) customers who were willing to upgrade to save money on energy costs. Figure B separates the responses by length of time since purchase. Figure B shows that energy conscious purchasing behaviors are becoming more prevalent, as seen in the 7% increase in percentage of those more likely to upgrade to save on money or energy costs, compared to those who purchased more than five years ago [4].

Appendix 8 details the importance of product attributes, showing that reliability and price are the most important attributes at 84% and 71%, respectively. Energy-efficiency rating is third at 58%. However, Appendix 9 details which special features consumers would be most likely to pay more for, and "Highest energy-efficiency rating" topped the list at 38%. On the contrary, at 58%, the majorities of appliance owners are interested in the highest energy-efficiency rating, but are unwilling to pay for it [4]. Appendix 10 shows that of all the energy efficient products on the market, consumers are very or somewhat interested in buying major appliances, at 86%, only trailing light bulbs at 89% [2]. All of these statistics well described the consumers' attitudes and purchasing behaviors toward major appliances and aided the project team develop ethnographic research paths.

Ethnographic Research
The primary target demographic is people who use online/mobile shopping methods for purchasing appliances. These users don't necessarily need to be environmentally conscious, the proposed service needs to be useful to anyone who wishes to save money; virtually everyone is in this category. However, homeowners who are environmentally conscious might be especially interested in the proposed product since it allows them to be economically conscious while possibly purchasing the appliance that is more energy efficient. The stakeholder base is even broader. Not only does it include all of the users, who stand to benefit from more informed financial decision-making, but also retailers, manufacturers and any middle-men involved in the distribution of the products the service handles. While the stakeholder network is broad, only those with specific experience in front-end and back-end web development are considered to be experts.

From the market research it has been found that some services exist that allow consumers to compare and contrast competing products. Ultimately though, none of the resources available on retailers' websites provide comprehensive cross-competition comparisons or thorough cost and energy use analysis. Ethnographic studies were conducted to learn more about the online purchasing behavior of consumers. A sample of all the surveys can be seen in Appendix 11, 12 and 13.

First, this study showed that online shoppers tend to search through multiple websites looking for the best deals and usually spend a lot of time doing so. When asked about using aggregators instead of individual retailer websites, most people said that they would gladly use it, assuming that the aggregator has been proven to be trustworthy. This information indicates that the proposed service needs to ensure that it never skimps on the accuracy of data being provided; the users will stop using the service if proven otherwise. When shown information on True Cost of Ownership (TCO) and Net Present Value (NPV), many of these consumers clearly expressed that this additional information would be extremely useful for them to make a more informed purchase decision. Certain individuals surveyed did express their interest in knowing and understand the math that goes behind the NPV and TCO calculations so there needs an easy way to express such data in a clear and concise fashion. In all, this survey provided key details on the buying process and validated the initial assumption that current day consumers see potential in the proposed service.

The ethnographic research supplemented much of what was found in the overall market research and supplied other valuable insights. Through the market research it has been found that people only replace major appliances when they break or need significant repair, which happens about every 5-10 years. This was consistent with research done by others. It was found that users place high priority on price and reliability of appliances, but style and dimensions are also major factors. Energy consumption seemed less important but did come in third from one of the subjects. Regarding energy conservation, it has been found that the subjects were energy conscious, but only relied on readily available energy data to satisfy their conscience. ENERGY STAR certification was the most common form of judging energy efficiency. None of the subjects looked at power consumption or yearly operating costs. However, one of the interviews did reveal that they would like to be able to easily compare yearly energy consumption and

how that impacts yearly savings. Other major revelations made through the interviews were the need to know if the company would take away the old refrigerator, as well as energy comparison to neighbors. One subject specifically mentioned that it was very important whether the retailer would take their old appliance and if they would dispose of it properly. In regards to energy comparisons, one subject mentioned that the gas company sends information on how his energy consumption relates to his neighbors. They mentioned that this was helpful information and would encourage energy use reduction if they realized they were using more energy than their neighbors.

In general, it has been found that consumers have a need to compare several retailers before making purchases. In addition, the majority of consumers are energy conscious but lack the proper knowledge of energy usage to make educated decisions on which appliances to buy that will save them the most energy and money.

PERSONA

Based on the ethnographic research, we developed a persona who would strongly benefit as a consumer from the service. The target demographic is broad, spanning energy conscious individuals looking to minimize their carbon footprint to people who are just looking to save the most money. Our persona is someone who is slightly frugal in spending, either by nature or financial constraints, and therefore intensely researches each purchase to maximize his value and minimize his expense. Our persona is someone who puts in the time when making purchase decisions; someone who will carefully look through all the different options present to ensure that he/she's getting the most value out of every dollar. The target customer is willing to spend time visiting multiple stores or websites to compare products and offerings to make sure his purchase will get him the best overall package, including price, delivery, taxes, warranty, and etc. The target customer also understands the long-term benefits associated with the purchase, and is willing to spend a higher amount up front to receive net savings later on. At the same time, this person is someone who understands the monetary value of time spent, and would like to save on this too, by spending as minimal time as possible on making these important decisions. Finally, the target customer is environmentally conscious and pays attention to power consumption and his environmental footprint. It does not have to be someone who is intensely environmentally conscious, but one who has a desire to reduce his energy consumption, either for the environmental impact or to reduce his energy bills.

To better understand and empathize with our persona, we have illustrated a fictional person who exhibits the traits of our persona and will use Apgrade.com. Sid Skerlos is a 35-year-old father of three, making $85,000 per year as a veterinary practitioner. He owns his own house and the appliances within. Because Sid is the sole earner in his family, he looks to maximize the value of all of his expenditures. This includes not only looking at the base cost of a purchase, but the cost of the total package, including delivery cost, taxes, and etc. Sid hates to pass up a good deal and becomes bothered if he makes a purchase only to find later he could have made a better purchase if he had put in more time. At the same time, Sid is someone who understands the monetary value of time spent, and would like to save on this too by spending minimal time when making purchase decisions. Due to other major life commitments like his three children, Sid needs to be frugal about the amount of money he spends on upgrading or replacing his household appliances, and as a veterinarian, he has a lot of empathy for his environment and would like to do his part in reducing his environmental impact such as greenhouse gas emissions. Sid often uses other data aggregation and price comparison shopping websites such as Kayak.com and Amazon.com. If he sees aggregated retailer information on total cost of ownership over lifetime that includes purchase price, taxes, shipping, and operating cost from a reputable source when it comes to time for buying a new appliance, he would gladly use the service.

REQUIREMENTS AND SPECIFICATIONS

Overview
To begin developing concepts for service, important requirements of the project were identified. There are two major direct stakeholders, the consumers who would be using the service to make better purchases and the manufacturers or retailers the service needs to be associated with. Each of these groups had different requirements for the design team to fulfill. The ethnographic research clearly shows a need from consumers for clear and succinct total cost of ownership and lifetime cost calculations, with accurate data tabulated from the major products available in the market. Thus the major task is ensuring the service to address the consumers need in a clear and direct manner.

Manufacturers and Retailers
If the service is to succeed, a good working relationship with either the manufacturers or the retailers of household appliances needs to be established. All the products that are listed on the service or saved on database must be complete and accurate, to ensure that the credibility with the manufacturers and retailers is untarnished. To achieve this there should be no missing appliance when making a regular update to the database. Any new products entering the market must promptly be reflected. A full list of requirements and the translated specifications relating to manufacturers and retailers can be seen in Table 1 below:

Table 1: Manufacturer and retailer requirements and specifications.

Requirement	Specification	Relative Importance (1-3-9)
Accurately represent all available products with respective specifications.	95% consistency between products and confirmed specifications	9
Constantly update product listings from manufacturers.	Database updated weekly.	3

Consumer
The biggest stakeholders are the consumers who will be using the service to make more informed appliance purchases. Our first and one of our biggest concerns with the consumers is ensuring that they completely understand how to use the service with little hassle. From the ethnographic research, it has been found that there is a varied amount of technological competence amongst people and working under this understanding, the service must be easy to navigate and work with. Along these same lines, for marketing purposes the service must also have an attractive and easy to use interface with a memorable name that catches on quickly in society. On a service side, all the major household appliances need to be tabulated on the service. This list includes the six major appliances: refrigerator/freezer, dishwasher, dryer, washing machine, stove and oven. One of the key success indicators of the service is the number of choices shown to the users for the appliance that they are looking for. The ethnographic research had shown that people enjoy having options, and if provided with similar choices different people would pick differently based on personal preferences. The more detailed choices shown to them the better the service will be and the better informed this decision will be. In the same vein, for us to be able to better down select the choices for our customers we must include a multitude of categories from which the users can filter their needs for the appliance. Once they have selected the options they would like, we would like to show them at least four products that have all the features they are looking for. To help them down select, accurate calculations of Total Cost of Ownership and Net Present Value must be shown clearly, in a method by which even the least educated of the users can understand. Another often-overlooked requirement to satisfy the users is a need for a complaints forum. A full list of requirements and the translated specifications relating to consumers can be seen in Table 2 below:

Table 2: Consumer requirements and specifications

Requirements	Specifications	Relative Importance (1-3-9)
User friendly, easily understood and navigated by even the least tech savvy person	90% of people understand how to use the service within 10 seconds of first exposure	9
Visually appealing and attractive GUI for the user	90% approval rating	3
Memorable service name	90% of people remember business name 1 day later after hearing for the first time	3
Appliance listings comprehensively cover consumer needs.	All six major household appliances are included (refrigerator/freezer, dishwasher, dryer, washing machine, stove, oven)	9
Compares prices from several retailers, local and national	At least 3 different retailer prices compared for each product	9
User can filter results by several categories (price, orientation, dimensions, style, rating, etc.)	User has at least 10 filter options for each appliance	3
Able to select and compare different product specifications against each other including prices across retailers	User can choose up to 4 selected products for comparison	3
Provide detailed financial information on True Cost of Ownership	User can find detailed calculation information within 30 seconds of selecting a product	9
All calculations are easy to understand even by people with no knowledge of finance	90% of people understand calculations after reading our descriptions	3
Include link for consumer complaints and suggestions	User can find complaints forum within 20 seconds of website exposure	1

The last set of requirements and specifications are more related to the function of the proposed service and can be seen in Table 3 below. Whatever medium it may be, the service must accurately source all the relevant information for appliances, like product prices, sales information, average wattage, average lifetime and more. It also needs to provide easy to find links to the actual retailer websites and on a more technical side, must function with minimum lag. If there is a problem in processing or finding the data that the users requested, the users need to be informed of the error as soon as possible and the service needs to attempt to find a work around it.

Table 3: Requirements and Specifications for the technical function of our service

Requirement	Specification	Relative Importance (1-3-9)
Accurately scrape product prices, sales information, and delivery and warranty options from retailer websites.	Algorithm tested to be scraping accurately in at least 95% of cases	9
Service navigates, aggregates and calculates data quickly and without noticeable lag.	Less than 10 seconds for navigation, independent of service platform type	3
Returns an error message and prompts manual submission from administrator when price is not able to be scraped	Manual submission needs are recognized within 5 minutes of being unable to scrape data	3

Weighting Requirements and Specifications

Given a large number of requirements and specifications, there needs a mean of prioritizing the requirements and specifications for developing concepts. The project team referred to the results on consumer behavior research based on surveys and market analysis as described in the Design Ethnography section. On the manufacturer's side, the biggest priority was ensuring that the service accurately represents their entire catalog and the individual specifications. In addition, the service must be capable of using data-scraping techniques to tabulate these numbers accurately. On the consumer side, the ethnographic survey indicated that consumers enjoy being given options based on total cost of ownership and net present value calculations. Also, to best serve the users, these calculations need to be offered for a broad range of household appliances. Surveys also showed that there is a varied amount of familiarity with technology amongst the potential users, so the proposed service needs to be user friendly.

SUSTAINABILITY EVALUATION PROCESS AND STATUS

Stakeholder network

Before beginning the sustainability evaluation process, the stakeholder network was identified. It is constituted of consumers, retailers, and manufacturers of household appliances. The manufacturers, such as Samsung, LG, Frigidaire, Whirlpool, GE, and etc. supply their products to the retailers. The retailers, such as Sears, Lowe's, Home Depot, Best Buy, and etc. would distribute, advertise and sell the products to the consumers. The consumers are most likely homeowners and rental property owners. The manufacturers usually provide product specification such as the capacity and the energy consumption rate, and the consumers use the provided information along with the price when they make shopping decisions at the retailers. Products flow from the manufacturers to the retailers and then from the retailers to the consumers, while profit propagates in the opposite direction. Retailers are most interested in stocking high value products from the manufacturers, and the consumers expect the retailers to provide them a good variety of potential options.

In market economy, everyone seeks the maximum profit through business transaction. The manufacturers seek the maximum profit by providing the most appealing product portfolio to the consumers and the retailers. The retailers want to have products catalogs that will sell well and appeal to the consumers while the consumers seek to have the highest return in product attributes from their spending.

Use context

The proposed service would mainly be used by consumers when they see need for comparing different products available in market. The service would help the consumers choose which model to buy based on their feature preference and valuation of the operating cost. In addition, the manufacturers and the

retailers can use the service for benchmarking purposes. They can see how their product portfolio compares against their competitors and adjust the design and pricing decisions accordingly. We found that a number of people are using price aggregators when shopping online. The majority of consumers is interested in maximizing the value of their purchases by minimizing cost and is happy to use any trustworthy tools available to them.

Overview
Overall the service provides a level ground for comparing the true cost to operate any home appliance. By providing true ownership cost including utilities expenditures, the consumers are better informed of what they are buying into and have a somewhat better idea of how their purchase affects the environment.

Social change and sustainability
By providing publicly accessible information online, the website helps the consumers understand the true cost associated with their new buying decision. It also gives incentives to the manufacturers to design more energy efficient products and to the retailers to have more appealing products catalogs. With all the information made available to the public, society is expected to increase its demand for more energy efficient household appliances. Through encouraging the use of energy efficient products, the design team hopes that the design will decrease energy consumption, thereby causing a positive environmental impact.

ENVIRONMENTAL IMPACT OF THE BASELINE

The U.S. refrigerator market is between 9 and 11 million units per year while only less than about 35% of the products sold were ENERGY STAR certified as seen in Figure 2. More than 80% of the refrigerator shipment was for replacing existing unit.
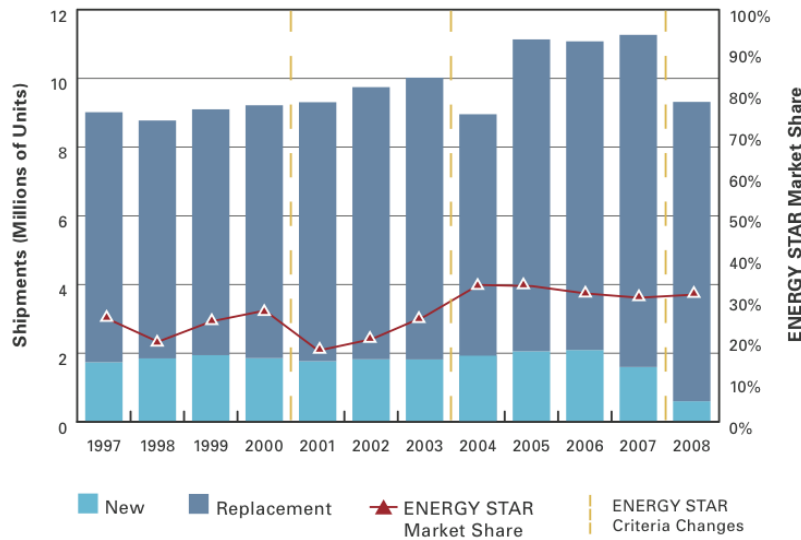
Figure 2. U.S. Refrigerator Sales and ENERGY STAR Market Share [11]

With about 145 million total refrigerator units installed as of 2009, the average life of a refrigerator is about 12 years [11]. Per unit average annual energy usage difference between ENERGY STAR qualified

products and non-ENERGY STAR qualified ones is about 105 kWh. This annual energy usage difference translates into about $12 difference in operating cost and about $140 in 12 year-life span as seen in Figure 3. However as mentioned before, only about 35% of the new refrigerator sales have ENERGY STAR certifications.

Purchase Decision	New Non-ENERGY STAR Qualified Refrigerator	New ENERGY STAR Qualified Refrigerator
Annual Consumption	540 kWh	435 kWh
	$60	$48
Annual Savings	–	105 kWh
	–	$12
Average Lifetime	12 years	12 years
Lifetime Savings	–	1,260 kWh
	–	$140
Price Premium	–	$30 - $100
Simple Payback Period	–	3-9 years

Note: Calculations based on shipment-weighted average annual energy consumption of 2008 models. An ENERGY STAR qualified model uses 20 percent less energy than a new non-qualified refrigerator of the same size and configuration.

Figure 3. Energy Saving Potential for ENERGY STAR Certified Product [11]

Even though the baseline data are about three years old, the refrigerator sales trend would have not drastically changed since then as suggested by the trend of past 10+ years. The baseline survey indicates that there still is a huge potential for saving energy even though the ENERGY STAR certification process has been established for years.

To quantify the environmental impact of the ENERGY STAR certification we translated the annual savings of 105 kWh into reduction in greenhouse gas emissions based on what greenhouse gases a power plant produces per kWh. By switching to an ENERY STAR certified appliance, a consumer would save 0.0105 pounds of sulfur dioxide (0.1 lb/MWh), 0.1785 pounds of nitrogen oxide (1.7 lb/MWh), and 119.175 pounds of carbon dioxide (1,135 lb/MWh) per year [18]. One indirect impact of the program would be to compare average household appliance energy usage before and after the program was initiated. This would compare the energy usage in appliances, throughout the US, and how it shifted after the ENERGY STAR program was implemented. One could then deduce the energy savings and reduction in greenhouse gases because of the higher prevalence of more efficient products in the market. However, since ENERGY STAR appliances are only more efficient and do not necessarily use less energy, we were unable to find accurate data to calculate this environmental impact.

CONCEPT GENERATION METHODS

The following sections detail the processes used to develop acceptable concepts for this project. Analysis of each design stage is given along with a thorough analysis of the final alpha prototype.

Overview of Concept Generation Process
We began our concept generation process by taking a root-cause view of the problem. At the heart of the problem, price and environmentally conscious appliance shoppers weren't being provided with enough information regarding total cost of ownership and operating cost for the appliances. In addition, if this information was available, it was inconveniently located and hard to compare across products. We began by brainstorming methods of information transfer, from the manufacturer or retailer, to the customer. This resulting list included a magazine advertisement, an email subscription, a television advertisement, a

kiosk or display at a retail store, an integrated button on a retailer website, a web browser extension, a smartphone application, an independent website, or an in-print mail flier. We then conducted a feasibility analysis on these concepts to eliminate those that would not appeal to our user or would not be successful on a mass scale. We eliminated magazine advertisement, email subscription, television advertisement, and mail advertisement because we didn't believe these were feasible options to effectively attract users and efficiently convey our information. All of the eliminated options are limiting in their ability to reach the end users. For example, mail advertisements and television advertisements have very low conversion rates, which would be even lower since not all of the viewers are currently shopping for a new appliance. Email subscription would not work because the information would need to be constantly updated, which would require several follow up emails. This is likely to annoy the users or potentially go unseen and automatically be filtered into the junk folder. We eliminated a button on a retail website because, although it would easily convey our environmental information, it would require adoption by the retailer, who would most likely not allow the button to compare the product price to other retailers' prices. The remaining concepts were a smartphone application, a web browser extension, a website and a kiosk. At this point, we continued our brainstorming by breaking down our service into several sub functions and generating concepts for each function. The sub functions are the calculation models used, how the service functions, and the business model to generate revenue. The analysis of these different sub functions is detailed in the following sections.

Models and Calculations
The first sub function of our service is what models and calculations would be used to determine environmentally related price figures. What models and price calculations are shown heavily depends on why the user is shopping for the appliance. We broke this down into two types of shoppers; those who are buying an appliance for the first time or replacing one, and those we are upgrading an appliance.

For customers buying new or replacement appliance, their needs are more focused on finding a suitable appliance quickly and at the right price. One concept the design team came up with was to have the model show monthly or yearly operating costs and lifetime operating costs. Important variables in the calculation are the cost of electricity and power usage of the appliance. The power usage specifications would be pulled from the database, and the electricity costs could be determined through the users location and the local electricity costs of that state or country. Their location could be determined by manual input of their zip code, or through pulling the IP address of the computer and using the electricity costs for that location if the service is web enabled. By comparing these calculations across multiple products, the users can prioritize whether they would like to spend more on an upfront cost, or overtime in their home energy bill.

For customers upgrading an appliance, their needs are more focused on saving on their energy bill and finding the appliance with the feature that suited their needs. To appeal to the customers looking to save on their energy bill, one concept the design team generated allows the users an option to input their current appliance model, electricity costs, and typical usage data, if relevant. If any information is omitted, the model could use an average of past customers, or data from a national survey to provide salvage values, electricity costs, or usage patterns. For each product, the model could predict the net present value of the investment over the course of the life of the appliance. The internal rate of return could be manually input by the user, or the model could use the average internal rate of return of common investment options such as stocks, bonds, or mutual funds. For example, if the customer's current appliance costs $50 a year to operate, and the new appliance operates at $20 a year but costs $1000, the customer would essentially be investing $1000 but getting paid $30 a year by upgrading to the new appliance. Using the new cost of the appliance and an estimated salvage value of the user's current appliance, the model could predict the payback period for upgrading to the new appliance. These types of calculations could be calculated for each product and then compared across products to help the user choose which product would be the best investment purely from a cost perspective. Another concept was

to create our own rating, for instance from 0-100, which incorporates all of the previous calculations and assigns a number rating to the appliance, which the users can then take into account when making their decision. Of course, a link would be needed to provide an in-depth explanation of the rating system to gain the users' trust.

Service Function
The next concept generation sub function relates to how the product will physically function and where it will obtain data. Four concepts we generated were to data scrape, cooperate with retailers, get product specifications from manufacturers and scrape prices from retailers, and crowd-source product information. Data scraping is when a computer program visits the various retailer websites and copies the price and product information right off the website. This method can be useful but is very difficult to do and is often not very accurate. In addition, companies can employ tactics that prevent data scraping programs from accessing their website information. For these reasons, we decided it was best not to use this method, or to use it in a limited fashion. Cooperating with retailers would entail obtaining product specifications and prices directly from retailers. This option would prove advantageous for both companies because it would be very accurate for our service and also help direct customers to the retailers website. However, retailers might not want to cooperate because they do not want consumers to see lower prices at other retailer locations. We were unsure of how retailers would react but decided that this was a viable concept to consider going forward. A third concept is to get product specifications from manufacturers and just data scrape limited information such as price from retailer websites. This is a feasible concept because it would provide our service with a very accurate database of products and specifications that can easily be accessible and constantly updated. This method would also minimize the use of data scraping in the hopes of reducing inaccuracies. It would also not rely on the consent of retailers and would therefore promote the unbiased nature of our service. Our fourth concept involved crowd sourcing product information and prices from the users. We decided it was not feasible because this method would not be able to collect all appliance data from users in an efficient or timely manner. The accuracy and completeness of the collected data would also be suspect and would take many hours of manual labor to confirm. Overall, the two remaining concepts were to cooperate with retailers, or get product information from manufacturers and data scrape retail websites for product prices.

Business Model for Revenue Generation
The final sub function is what model to be used to generate revenue for the business. We generated four concepts for revenue generation; revenue from advertisements, a "Freemium" model, retailers pay us a percentage of the sale or for direct traffic to their website, we process transactions on our service and act as a middle man, or we sell our own appliances. Advertisements are a very popular and often successful way of bringing in revenue. We decided it was certainly a feasible option to include advertisement banners on our service. We could also have sponsored links or products, but want to make sure to keep our service unbiased and try not to influence the consumers' decision toward a specific brand or retailer. A "Free-mium" model is when a user is able to use certain features of a website or product for free, but must pay for the advanced features. We decided that this was not feasible because there were too many substitutes where the users can obtain similar information and therefore there would be no willingness to pay. Another reason why it was infeasible is that people do not often purchase appliances and therefore would not be willing to pay or subscribe to a service for features they use once every few years. The third concept of having retailers pay for every user directed to their website or as a percent of sales is a feasible option. Many current data aggregation websites, such as Kayak and Orbitz, use this model to generate revenue. We could charge a fee from the retailer for every user we direct to a retailer's website. If possible, we could also collect a percentage of the final sale of the appliance if a user goes on to purchase the appliance online from the retailer after using our service. We did not think it was feasible to sell our own appliances and establish ourselves as a competitor to the major retailers such as Best Buy and Sears. We do not think it is an attractive industry to enter and would not have the capacity to buy inventory from manufacturers and store it. Also, the nature of the product leads many consumers to want to see the

appliance in person, which would mean we would need a store front and we did not think this was feasible either. We believed it was also feasible to have our own pay service. This would be advantageous because it would eliminate the need for the consumer to be redirected to the retailers' website and they could just purchase the appliance from our website. We could then take a percentage of the sale and give the rest to the retailer. Overall, we believe revenue from advertisements, from visitor redirection, and from a pay service are three viable concepts for future consideration.

CONCEPT REFINEMENT

After refining the initial list of concepts through the feasibility analysis, concepts were generated by selecting one concept from each sub function and combining them to form one product or service and accompanying business model.

Concept 1: Smartphone App
The first concept was designed to take advantage of the rapid increase in the number of smartphones currently in use. With smartphone penetration at almost 50% of its possible market, the first concept can reach a large number of people by developing an Apgrade application for mobile devices. This app will allow users to input their specifications into the customized search engine. The app will then scour the database and present the users with a list of choices for the appliance and where each of these choices can be purchased. Additionally, for each of the choices the users can also see a detailed total lifetime cost analysis based on the expected monthly expenditure and the average lifetime of the appliance.
Being a smartphone app allows the proposed service to be mobile; the customers can use it on the go with relative ease. It also allows having options to include advertisements in a free version of the app or introduce a paid app if users would like to use the ad free version. However, there are a few disadvantages to a smartphone application. Currently the two major operating systems for smart phones are the iOS for iPhones and Android for many other phones. Having to develop and maintain two separate applications to cater to the two different markets can be tiresome. Also, a smartphone app requires the users to be slightly tech savvy and know how to download, install and update the app on a regular basis. Thus despite the advantages to the users, implementation difficulties might prove to be a shortcoming for this concept.

Concept 2: Kiosk
The second concept is a kiosk to be installed in each of the retailer's storefronts. When costumers enter one of these storefronts, they can approach the kiosk and input the specifications for the appliance they are shopping for. Once they do so, the kiosk will search through the database associated with that specific storefront and retailer to identify the best choice available to them at that specific store. This best choice will then be presented to the customers on the service's own scale that runs from 0 to 100. With this scale, detailed analysis is already done for the users and the users will always be able to find the best product at that retail location.

This kiosk is convenient for the customers since it would be present for them when they are already in the process of shopping. The revenue stream is also simplified since the company would just be making money by selling or leasing the physical kiosk to different retailers to install in their storefronts. However, this idea has a major fundamental flaw; it does not provide perfect information intended initially when the project started. Given that these kiosks would be installed in specific storefronts, it is possible that competitors' data cannot be provided. This means that the only advantage of this kiosk would be to speed up purchase time for the customers and not actually assist them in making the best decision. Also, it can be argued that some retailers may not actually welcome this kiosk since it will invalidate the customer assistance employees they already have at these storefronts. A significant environmental impact is expected from this concept when compared to other concepts as the kiosk involves an actual built system that will make use of natural resources.

Concept 3: Website with Redirection

Concept 3 involves creating the service's own website, using a layout similar to other retailers' with filters on the left and product listings on the right, using the service model to show financial values, using a combination of data aggregation and scraping, and generating revenue each time a customer is directed to a retailer's website. The website would be similar to Kayak.com, where customers can compare appliance prices and specifications across multiple retailers. The graphical user interface would be set up so that users can filter results depending on their needs, using such filters as price, customer reviews, dimensions, yearly operating cost, and more. This website layout is similar to other retailers' websites and would already be intuitive to most users. For each product, and especially when comparing products, the user would be shown an array of financial data relating to yearly cost of ownership, net present value of upgrading, and payback period. What information is shown will depend on whether the user is upgrading or replacing their appliance which can be an option for input when the user first logs onto the website. The website will acquire product listings and specifications through partnerships with manufacturers and will scrape price and select other information from various retailer websites. This eliminates bias from retailers and limits the amount of web scraping needed. To generate revenue, a retailer will pay for each customer that is directed from the website to theirs. Retailers will want the additional traffic, especially since a certain percentage of the redirected visitors will eventually buy an appliance. The business could also take a percentage of the final sale price from the retailer, much like Kayak.com does, if the user ends up purchasing an appliance after being direct through the website.

Concept 4: Website with Pay Service

Concepts 4 is similar to concept 3 in that it is also a website but has its own unique features and associated models that make it a unique concept. For concept 4, the design team considered ways to make accessing the service as intuitive and painless as possible. While the standard "Amazon mode" of website design is powerful for drilling down to a precise product, it may be more useful for a less web-savvy consumers for the interface to be simpler and the total cost information less dense. The fourth concept is a website in which the user is presented with a generic image of a refrigerator and a number of options in large friendly buttons. Text presented on the page should be minimal, but there may be some describing the purpose of the page and its basic usage. As the user drags options onto the appliance, the image of the refrigerator changes accordingly to an image/link of the highest score make/model given the specifications entered so far. Behind the scenes, this data is precompiled via web scraping and algorithmic analysis. At any given time, the user will see a refrigerator, its cost, and its generated score describing its relative energy efficiency and subsequent lifetime cost. The user can, at any point, choose to purchase the currently recommended appliance or request other related top matches. For ultimate simplicity, in this concept purchases are completed directly through the website with the orders fulfilled behind the scenes by an appropriate retailer. It is expected that in this concept, the profits would come from the retailers who would essentially pay commission for appliances sold.

Concept 5: Web Browser Extension

Concept 5 is a browser extension. It compares prices of products as it detects them while a user shops and presents information such as the 12-year cost of ownership and provides options to customize the information and recommendations for how to find the best deal on the product they want. A user with this extension installed would see additional information such as 12-year cost of ownership injected directly into the page whenever he/she visited a relevant shopping website. The user would also see a small prompt at the top of their screen asking the user if he/she would like to view price comparisons of competing websites. Browser extensions like this are typically "freeware," meaning the software is free to download and install, but the user is asked to donate to the developer if the software proves useful. In addition to this, the browser extension could also make some revenue from retailers based on encouraging click-through traffic. While this concept is intuitive and comprehensively helps users regardless of where

they are shopping, it is also one of the hardest to disseminate to users, who are often wary of browser add-ons, and has the weakest revenue model.

CONCEPT SELECTION

The five concepts were compared in several Pugh charts to determine which would meet the customer requirements the best. Each concept was rated on a scale of ±1,3,9 to differentiate between concepts and provide more accurate scoring. We rated each concept together as a group in order to remove misunderstandings and biases toward concepts and increase the overall accuracy of each final rating. All concepts were compared to the current system, the EnergyGuide labels on appliances. The design criteria were weighted from 1-5, with 1 being the lowest and 5 being the highest, to place emphasis on the more important design criteria.

To ensure the validity of the results against bias, we observed the effects of modifying the weights attributed to each quality. We considered weighting all attributes equally as well as modifying some of the weights to represent emphasis on the users, the business, or the environment exclusively. The results of different weighting schemes are presented below in Table 5. In many instances the website with redirection was the clear winner. The average across all evaluations heavily favored the website with redirection model. All of the Pugh Charts that went into Table 5 can be found in Appendix 17.

Table 4: Summary of all Pugh Charts with average overall score, showing Website with Redirect is the best concept.

	Baseline (EnergyGuide)	Smartphone Application	Kiosk	Website w/ Redirection	Website w/ Pay Service	Browser Extension
Intuited Weights	25	95	33	101	61	65
Equal Weights	21	63	27	81	57	63
Focus on User	18	18	36	42	28	24
Focus on Business	11	29	13	61	43	53
Focus on Environment	16	56	10	96	70	62
Average:	18.2	52.2	23.8	**76.2**	51.8	53.4

The design criteria for the Pugh Charts in Appendix 17 were chosen based off the requirements and specifications. We translated the most important specifications directly into design criteria, and grouped others to achieve the greatest granularity to help us accurately rate each concept. User Friendliness and Minimal Learning Curve relates to how easy and intuitive the service's user interface is for a customer. If using our user interface is not a pleasant experience and easy to use, then no matter how good the service offerings are, the customer will shy away from our product. We figured the user would gravitate toward the service that provides them with a simple and efficiency way to shop and compare appliances. To achieve these goals we believe our product has to be user friendly and take minimal time in learning how to use it. Ease of Cooperation with Manufacturers and Retailers refers to the service's ability to interface with manufacturers and retailers to get product specification information and prices. It encompasses how easy it will be to cooperate as well as to update product listings. This was very important because the accuracy of the product information and the ability to include all available products is crucial to success. If a consumer can't find what he/she is looking for or is given inaccurate information he/she will not use

our website. Scalability refers to how easily the service can be scaled up to include more manufacturers, retailers, or products if the need arises in the future. All concepts were scalable, but it was just a matter of how easily scalable each concept would be. Profitability Potential relates to both revenue potential and predicted level of costs. The service needs to be accompanied by a successful business plan in order to be sustainable and continue to operate. Environmentally Sustainable refers to the environmental impact of the service, such as how effective it would be at promoting environmentally sustainable behavior or how much the implementation of the service negatively affects the environment. We did not feel that the environmental impact of our service as crucial to the success of our service. We included Technical Difficulty to represent how difficult it would be to create or implement the service, such as creating a computer program or search algorithm. Even though all concepts were technically feasible, there was a varying degree of how much time and money would be needed to make each concept a reality. Lastly, we included Amount of Information Conveyed because, as part of our competitive advantage, our business differentiates itself by including the unique models and calculations given to the consumer. The final concept should convey a large amount of information to help the users make a decision.

As seen in the Pugh Charts in Appendix 17 and our rankings, each concept has its advantages and disadvantages. Within user friendliness, the websites would be the easiest and most intuitive to use. This is because mostly everyone is adept at navigating websites and has prior experience using websites, but not everyone has experience with a kiosk or browser extension. Although smartphone applications are widely used now, because of the inconsistent internet connections and limited processing power and physical viewing area, we did not think it would be as user friendly as a website. Regarding Minimal Learning Curve, all concepts were worse than the current system, which is just yearly operating cost placed within a range and very easy to understand. The browser extension was particularly bad because non-tech savvy people may not know how to download and install a web browser extension and then configure it to their shopping needs. All of the concepts were worse in regard to outside cooperation because the EnergyGuide label system is a certification that is required by law and must have cooperation with manufacturers and retailers. Among the concepts, the kiosk had the biggest disadvantage in this category because of the need to coordinate with retailers to physically place the kiosk inside their store and because users wouldn't be able to compare prices to other retailers besides the retailer where the kiosk is located. Within Scalability, the websites had the biggest advantage because it is easy to update the website and database without affecting the customer, whereas a smartphone application or browser extension may need to be constantly updated with an additional download. The kiosk was particularly bad in Scalability because of the need to physically build and deliver more kiosks, as well as find additional retailers willing to partner with our service and use the kiosk. For profitability, the Website with Redirection held the greatest advantage because of its potential to generate revenue for every customer that uses our website, whereas the Website with Pay Service would only generate revenue when a customer purchased an appliance. Smartphone and browser extension were particularly bad at revenue generation because typically they are free and because of the intense competition people are usually not willing to pay for them. Even though revenue can be generated from leasing the kiosks, they would also cost the most to physically design, manufacture and transport.

For Environmentally Sustainable, the kiosk had the greatest disadvantage because it would require physical manufacturing, which would likely have bad environmental consequences. All of the other concepts would have minimal physical environmental impacts and would all help advocate environmentally conscious decision equally if adopted. In terms of Likelihood to Adopt by Consumers, The websites held the greatest advantage because of the widespread use of the internet, with Website with Redirect holding a slight advantage over Website with Pay Service because people may not trust giving their credit card information to our website. It would be difficult to get users to download a smartphone application or a web browser extension since it takes one additional step. The kiosk had the biggest disadvantage because it would require people to be at the retailer store and to walk up and use the device. For Technical Difficulty, all of the concepts were similar because they all require similar computer

programs. For the last design criteria, Amount of Information Displayed, the websites held the greatest advantage because they provide the best medium for navigating through several pages of products, specifications, and total cost of ownership information. The Redirect was better than Pay Service because with Pay Service the user would only see the product with the lowest price and not be able to compare across retailers. The information within a smartphone application or web browser extension would be limited because of the limited viewing space and GUI restrictions. The kiosk was the worst because it would only display information for the retailer store in which it was located.

It is evident from the Pugh chart and our analysis that the Website with Redirect is the best concept. We believe this to be the best concept because of its clear advantages and how well it will be able to satisfy the need of our users. Our research showed that many consumers spend a significant amount of time shopping for appliances, both online and at a retail store, to find the product that fits their needs and price range. Since most of the consumers already use the Internet for shopping, it makes sense to create a website which they can easily access, from the comfort of their own home, with just the click of a button. The Internet is also widely available to most people and would give us the largest potential market. This concept was the best because a website provides the best medium in which to display a large amount of information. Websites are able to pull information from databases, compute calculations quickly, and pull information from other places on the internet, giving us the ability to easily compare retailers across prices, calculate lifetime operating cost, and deliver other informative shopping information such as delivery or warranty options. The larger screens of computers and tablets also makes a website conducive to displaying large amounts of information. The Website with Redirect is the best business model because, through examples such as Kayak.com, retailers are willing to pay to increase traffic to their websites, which is exactly what our website would do. We could potentially be making money for each customer that is redirected to a retailer's website for purchasing, which means revenues would be proportional to web traffic and could be sustainable and significant if our website gains popularity. However, the marketing efforts needed to get our product in the market isn't much different across any of the other concepts and will come later after we have further finalized our design. This is better than the Pay Service business model of concept four because we did not think retailers would allow us to be a middle man for their online purchases. Also, we would have to gain consumer confidence in the security and reliability of our website during the transaction process, which is a difficult task to achieve. Finally, the website was the best medium to collaborate with manufacturers and retailers to obtain prices and specifications, as well as keep an updated product listing at all times. With a website, if the database needs updating there is no need to re-download anything, and the consumer will not be affected. This is key for customer retention. For example, if a customer sees that a smartphone application or kiosk is not updated, they are likely to mistrust the service in the future, increasing the potential for loss of customers. For these reasons, the Website with Redirect model is the best concept and is the idea we have chosen for our Alpha Design.

ALPHA DESIGN

The selected concept, a website that allows users for shopping as well as providing information about the long-term benefits of their purchase, provides a number of advantages. It is the most straightforward to develop, the most intuitive service to use, and it utilizes the most realistic profit model. In creating the alpha design, the three main aspects taken into account are the website layout, the features offered, and the business model. Each of these aspects will be discussed in the following section; however, it is important to note that the layouts and features are still in concept phase and will take further refinement as more ethnography and user needs information are collected.

Website Layout

The first feature of the alpha design is the website layout and how the user will travel through the website. From the ethnographic research and requirements, layouts are designed to be intuitive and user friendly, with its functionality clearly articulated.

When the user first logs onto the website, they will be directed to the homepage and see Figure 4. One important aspect of a good website is to immediately "hook" in the users by conveying the value of the website in an effort to retain the users and prevent them from leaving to a competitor website. Since the competitive advantage, the yearly cost models and energy usage information, isn't evident until a user clicks on a product, it was necessary to show a "featured appliance" box that shows an appliance and its associated 12-year cost example product on the homepage to immediately display the advantage of using the website. By doing this, the users will understand the advantage they are receiving from using the website, and will proceed to continue their search for an appliance. By showing the example and a search bar, a user visiting the homepage will be able to clearly understand its purpose and immediately recognize how to proceed. The different options for searching, both an exhaustive text search or picture representations of the six major appliances, are also be presented on the front page. Ultimately, using any of the elements on the front page should lead the user in a similar direction.
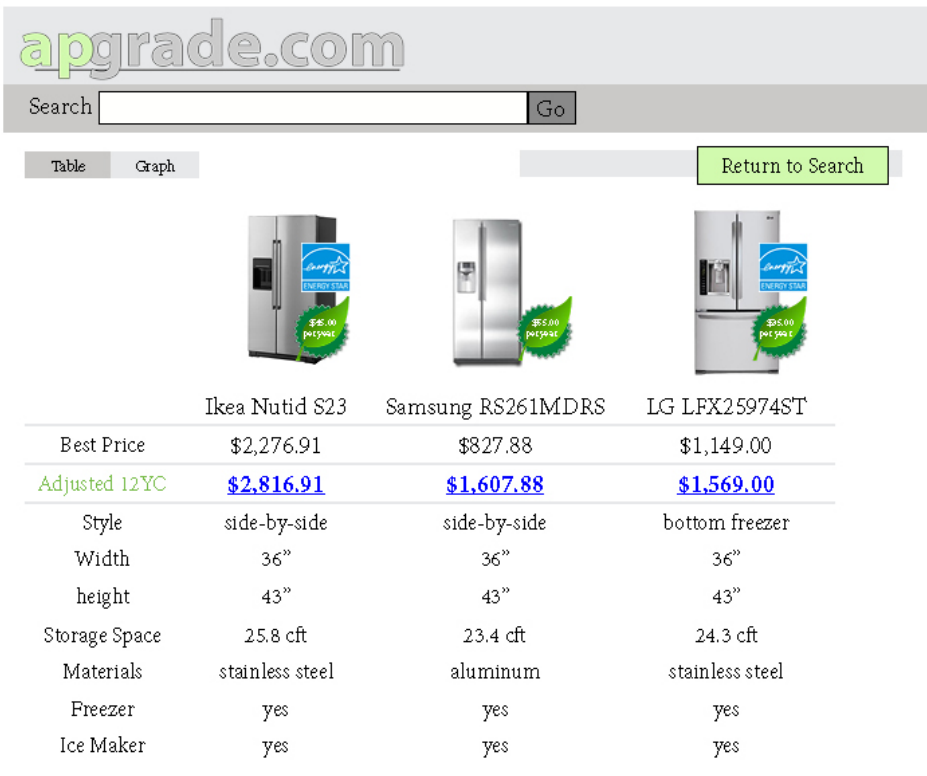

Figure 4: The proposed homepage the user would first see when logging onto our website

After the user has selected what type of appliance he/she is searching for on the homepage, the user will be directed to a list of products with the option to filter the results, as seen in Figure 5. This layout is similar to other shopping websites and has proven intuitive for the user. Based on the user's needs and preferences, the user will be able to filter the product offerings based on several filters, such as price range, style, dimensions, yearly operating cost, color, and brand. This will help the user narrow down the list of available products to help make a decision. As seen in Figure 5, each product will be labeled with the lowest price available from the various retailers.

Figure 5: Product list page showing matching products on the right and a filters list on the left.

From this page the user can select up to four products, as seen in Figure 5 above, and click "View Comparisons" to bring up a comparison page as seen in Figure 6 below. This product comparison page will allow users to compare different products based on several aspects such as their price, yearly operating cost, 12 year cost of ownership, and product specifications. This is where the proposed website differentiates itself from other competitor websites and is where the value is added. If the user is upgrading a current appliance, more rows can be added for Net Present Value and Payback Period to compare and evaluate the investment decision. By comparing not only base price, but yearly operating cost, 12 year cost of ownership, and net present value, the user can make a much more informed financial decision about the product they want. At this stage, the user should be inclined to select the more energy efficient and low cost device, shifting the appliance market to favor energy efficient devices and therefore lowering energy usage and CO_2 and other gas emissions.

apgrade.com

Search [   ] [Go]

Table   Graph   [Return to Search]

	Ikea Nutid S23	Samsung RS261MDRS	LG LFX25974ST
Best Price	$2,276.91	$827.88	$1,149.00
Adjusted 12YC	**$2,816.91**	**$1,607.88**	**$1,569.00**
Style	side-by-side	side-by-side	bottom freezer
Width	36"	36"	36"
height	43"	43"	43"
Storage Space	25.8 cft	23.4 cft	24.3 cft
Materials	stainless steel	aluminum	stainless steel
Freezer	yes	yes	yes
Ice Maker	yes	yes	yes

Figure 6: Comparison page showing a three products and comparing their financial information and specifications

Once the user decides which product he/she would like to purchase, he/she selects that product and will be brought to a page similar to what's shown in Figure 7 below. Figure 7 shows the product picture, description, associated financial information, such as yearly operating cost, 12 year cost, and payback period, and availability at different retailers. The table will show which retailers offer the product and at what price, as well as the tax and shipping information, delivery and old appliance take away options, and the total price. Once the user decides which retailer they would like to purchase from, they will click on the retailer link and be redirected to the actual retailer website for purchasing.

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Figure 7: Product details page showing the product, associated financial information, and a table comparing prices and options for each retailer

Figure 8 demonstrates a basic functional flow for a user visiting the site. While this flowchart is not a comprehensive articulation of all possible functions of the site, it represents how a typical user may explore the front-end functionality during a visit.
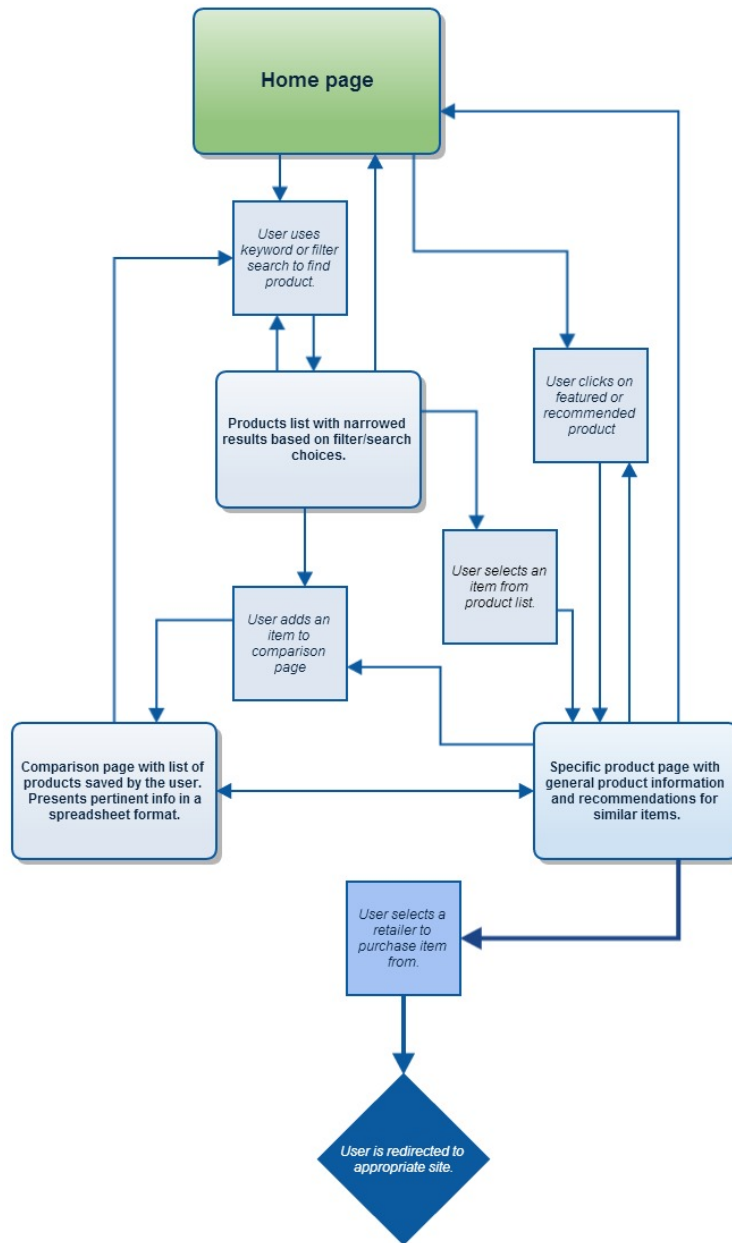
Figure 8: A flow chart representing how a user might traverse our website on their way to purchasing an appliance

Technical Functionality

Our service will most likely have to use a combination of three data gathering functions: database compiling, web scraping and data aggregation. At its core, the website is a database of comprehensive, current information on refrigerators and other appliances. This information includes the entire list of currently available appliances along with their associated model numbers, physical characteristics, energy efficiency metrics, and MSRP from various manufacturers. Price information, warranties, delivery options and taxes will be dynamically scraped or aggregated from the retailers that are tracked and updated regularly on the back end. Web scraping is an automated computer algorithm that crawls through websites and extracts data from the same human-readable HTML feed, much like a person surfing the

website [5]. Data aggregation websites, such as Kayak.com, capture data from XML feeds of major online retailers or third party databases, which can then be sorted and compared by an end user [6]. Ideally, our service would establish relationships directly with the manufacturers to receive the product information, and then cross reference that with which retailers carry the product and at what price, in order to compare for the users. On the front end, the website functions similar to many popular shopping sites. The proposed design includes a site-wide search, several means of filtering shopping results to dynamically create lists relevant to the consumer, and a means to generate comparison pages based on items saved by the user. When the users decide to purchase an item, they are redirected to the retailer's check-out page that they've selected.

Business Model
This design expects to generate revenue in two ways. First, ads will be sold website-wide using a service like AdSense. Advertising services like AdSense generate banner ads in specified regions of the website and pay the provider based on the volume of "clicks" the ads accumulate. It is expected that the revenue would scale proportionally with traffic to the website. Second, it is expected that direct revenue on a per click basis will be established with the retailers that sell products through the proposed website. Like advertising, this method would scale proportionally with the amount of traffic the website receives. The full business model is described in much greater detail in the Business Model section.

Comparison to Baseline
The selected concept should perform better than the baseline as the concept helps consumers compare different appliance models by displaying the purchase price and estimated operating cost, so that they are steered toward purchasing more energy efficient products. The baseline shows estimated operating cost per year for each model, but fails in ease of comparing models across different brands and retailers. Based on a literature survey, people are willing to spend limited time in price-comparison shopping and their willingness to spend time to save money is related to their hourly wages [11]. According to this study, people were willing to spend about 40 minutes to save $20 and 1 hour to save $40 respectively where their average hourly wage was about $11/hr. Even after accounting for perceived joy of price-comparison shopping, people were only willing to spend about 1 hour and 20 minutes to save $40. It can be conjectured that without knowing potential savings over time, the consumers may be reluctant to jump into the ownership cost comparison shopping scheme that not only needs the purchase price, but also the operating cost information. The alpha design solves this problem with providing the total ownership cost and comparisons among different models in a quick glance.

Using the information shown in Figure 3, an additional 1% sales of ENERGY STAR qualified products would entail saving of 10.5 GWh of electricity per year if the refrigerator market is assumed to be 10 million units per year.

$$\frac{E_{saved}}{\% \text{ add'l sales}} = 10^7 \times 0.01 \times 105 \, kWh = 1.05 \times 10^7 \text{ kWh} = 10.5 \frac{\text{GWh}}{\% \text{ add'l sales}}$$

According to the EPA[18], each MWh of home energy usage generates about 1,307 lbs. of CO_2. This means that the 1% change in sales addressed above would reduce CO_2 emissions by approximately 13.7 million lbs. per year. This 1% change would also cause an approximate reduction of 17,900 lbs. of nitrogen oxides and 1050 lbs. of sulfur dioxide. The USGS reports that between 100 to 500 gallons of freshwater are used per MWh of electricity produced [17]. This corresponds to a potential savings of up to five million gallons of freshwater per year with just this 1% shift.

Electricity consumption has several negative impacts on the environment as a side effect of how electricity is produced. Some generation methods are cleaner than others, but the primary means of production in the US are through the burning of fossil fuels, which is one of the most harmful to the

environment and least sustainable. Even the methods for gathering fossil fuels, like strip mining or oil shale drilling, destroys habitats, creates significant waste, and contributes to greenhouse gas emissions. Once the fuels are mined, burning them in a plant to produce energy has its own effects as well. The plants themselves require several hundred gallons of freshwater per MWh of electricity produced, and burning the fuels emits several greenhouse gases such as CO_2 and other gases like O_3 and NO_2. While it would be outside the scope of this project to attack unsustainable means of electricity generation directly, we hope that by encouraging consumers to decrease their personal energy footprints, we indirectly affect the industry of production. A decrease in consumption is a decrease in need for electricity; less energy produced means less harm to the environment from its production.

With the alpha design, consumers would become aware of true cost of their purchasing decision. Also the manufacturers would have higher incentives for designing more efficient products rather than simply meeting the ENERGY STAR certification standards. The shift in the market toward more energy efficient devices would further decrease greenhouse gas emissions and provide environmentally sustainable benefits.

FEEDBACK AND VALIDATION OF ALPHA DESIGN

In order for us to better our alpha design we had to obtain good feedback on the mockups that we had created for our alpha design. This feedback that we collected was focused on validating our specifications to better understand where our alpha design falls short. Given that many of our specifications were customer centric, the best way to do this entailed a second ethnographic survey. In this survey, we included our mockups and requested feedback from a group of possible customers, many of whom had been involved in the original ethnographic survey. A sample copy of this survey and a sample response from some of our customers can be found in Appendix 14. An additional plan that we could have carried out was to have large focus group sessions with prospective customers. Focus group sessions have the added advantage of being face-to-face allowing us to garner all the feedback that we need. It will also allow potential customers to provide us with some additional comments on our design that we would not receive with targeted questions in a survey.

In order to ensure that our final concept stands up to the specifications that we had set out, these focus groups would be highly beneficial. Many of our specifications are customer approval based, for example ensuring that 90% of users remember the name after a full day or 90% approval of the interface and visuals of our website. For these, open-ended focus group sessions with people who have the characteristics similar to that of our ideal persona would greatly help. The discussions that we lead in our focus groups must be focused on garnering the necessary reactions that would allow us to validate our specifications.

Focus group studies should be conducted with a functional prototype where a large population is used to test if the subjective specifications are met. The size of population should be in the order of hundreds to ensure reducing any statistical error. If results of the initial focus group study do not meet the required specification, the prototype should be further improved until they are met based on the additional open-ended comments requested to the focus group participants at the end of each study. An example study would be one designed to test the specification regarding ease of understanding our website. For this, we would set up an isolated computer with our website on it. A user would be tasked with finding a specific product and will be secretly timed. If they are able to understand the workings of the website and use it with no obvious problems with 30 seconds, that prototype model meets that requirement. This type of test can be run to validate the majority of our specifications. We plan to validate all specifications in a similar way, placing special emphasis on the website layout and the financial models. On the back end, as the providers of this service, there are some internal validations tests we would run with the completed

prototype. In order to test the speed of navigation of website, we would run a battery of controlled tests moving from site to site, ensuring that no navigation takes longer than 10 seconds as per the specification on our website.

In order to assess the impact of the alpha design on the appliance market and beyond, rather more detailed analysis should be applied to have more accurate results. However, at this stage the design team has limited accessibility to the appliance market model that includes consumer behavior and reaction. At this time, the estimated energy saved would be calculated based on "if X number of people would switch over from an appliance model to another appliance model that uses Y kWh less per year, then the total saving would be X*Y kWh per year." Further study should be done to shed light on this aspect. This further study would be a market study that will total the number of higher efficiency appliances that are purchased instead of a lower efficiency counterpart from the use of the proposed website. This number can be translated into a carbon footprint reduction, stemming from the savings in electricity usage caused by the higher percentage of ENERGY STAR devices that are in use. The generated energy savings could then be compared to other popular energy conservation efforts to determine relative effectiveness of the proposed service. An indirect effect that can also be monitored is the shift in the percent of energy efficient appliances entering the market, and ideally link this increase to the usage of the website.

Future works related to assessing the impact of the selected concept on the refrigerator market and the amount of energy saved include:

- Detailed consumer behavior models for refrigerator purchase that include consumers' perception of future cost and its sensitivity to the purchase decision
- Database for currently available product with actual price data in market

The consumer model can be constructed through a series of consumer survey and analyzing previous consumer choice results and linking their sensitivity to price and other product attributes such as style, convenience features, brand, and capacity. The realistic database to test the consumer model can be compiled using a data aggregation procedure.


FINAL CONCEPT

After conducting validation and receiving feedback, many parts of the final design were similar to the alpha concept; however, there were a few notable changes that consumers requested that have been added into our prototype plan. Firstly, many of the consumers clearly expressed interest in being able to see the calculations that go behind the total cost of ownership values. For this, a mouse-over pop-up that will show the calculations was designed, as can be seen in figure 9. This tooltip will allow for the consumers to exactly see what factors are considered when calculating the true cost of ownership. It will also allow the users who are less versed with economics concepts to feel at ease and trust the calculation methods. Additional FAQ (frequently asked question) sections can also be included to allow users to understand why we are using the 12-year model and how we are calculating electricity usage over those 12 years.

Figure 9: The proposed home page of our site shows the mouse over tool-tip that helps our customers understand how the 12YC is calculated.

The product list page is almost identical to the one from our alpha design, since our ethnographic research showed that the number of filters provided was more than sufficient. One addition we made, generated by the target audience surveys, was to include a customer review section to the products. This way, consumers can also factor in these reviews when making their purchase decision, on top of the financial analysis that is provided. Word of mouth is an important driving factor for consumers when making a choice and adding this will make the website more appealing. This feature has also been added into the final concept as seen in Figure 10 below.
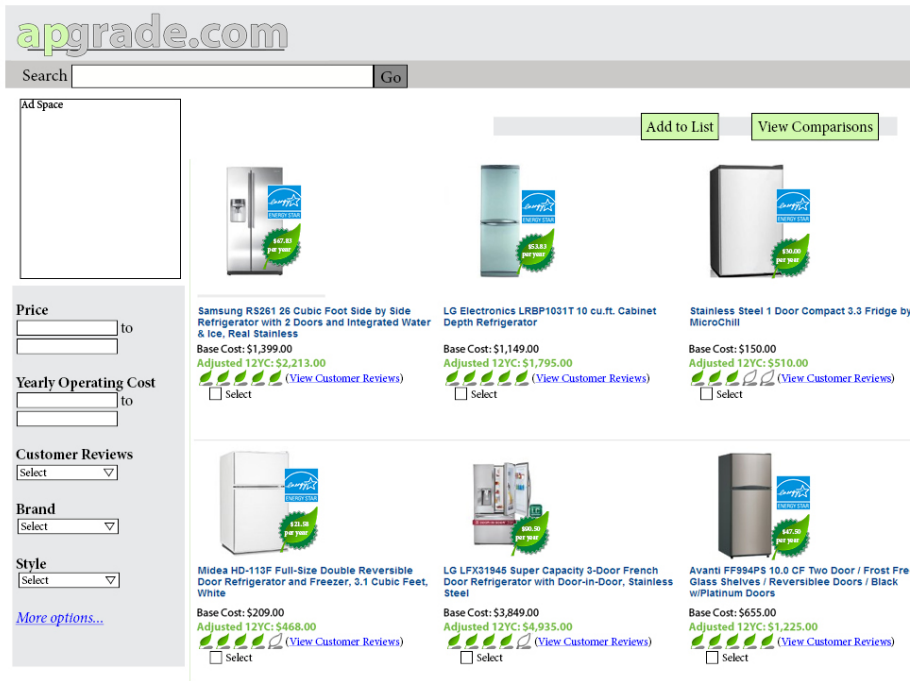
Figure 10: Product list page, showing the customer reviews that can be accessed by the user.

Our feedback also revealed the need for a more intuitive method of describing the true cost of ownership, possibly in a graphical form. A page that can show the true cost of ownership or net present value costs in a graphical form was designed to allow the customers to see the rate of cost increase throughout the predicted use period. This also ties into another customer request, which was to be able to see the total cost of ownership over a varied number of years. Figure 12 shows the new concept for this page of the website that a customer can access during their search process, while Figure 11 shows the old comparison page with the specifications in its entirety. Figure 13 shows the product picture, description, associated financial information, such as yearly operating cost, 12 year cost, and payback period, and availability at different retailers. The table will show which retailers offer the product and at what price, as well as the tax and shipping information, delivery and old appliance take away options, and the total price. Both these pages will be provided in the final product.
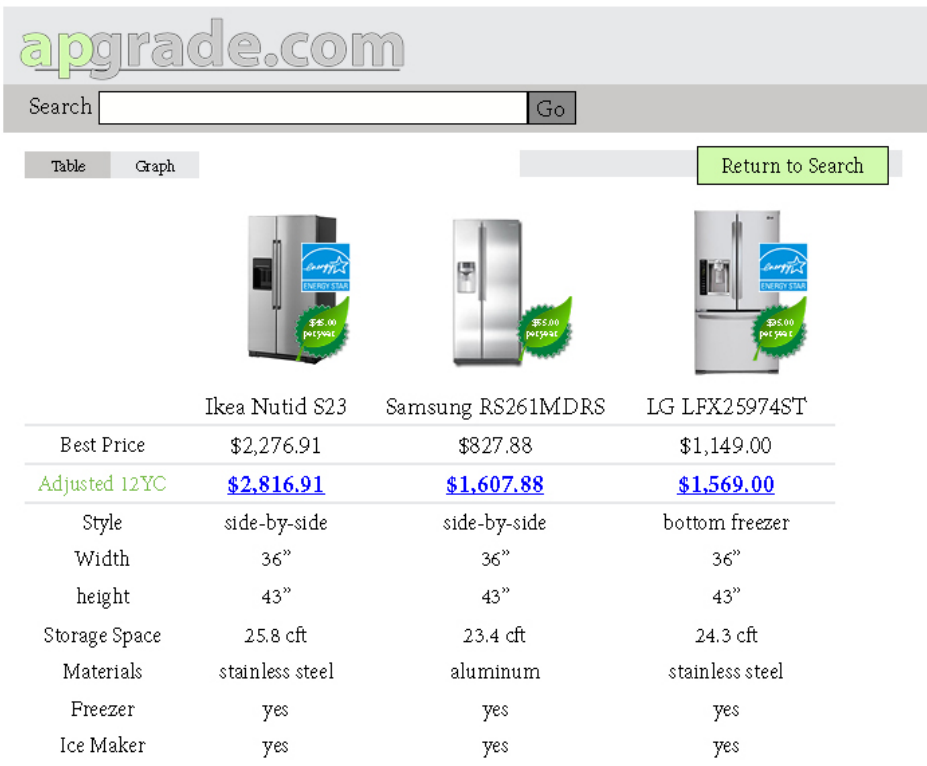
Figure 11: Comparison page that shows all the specifications of the products selected
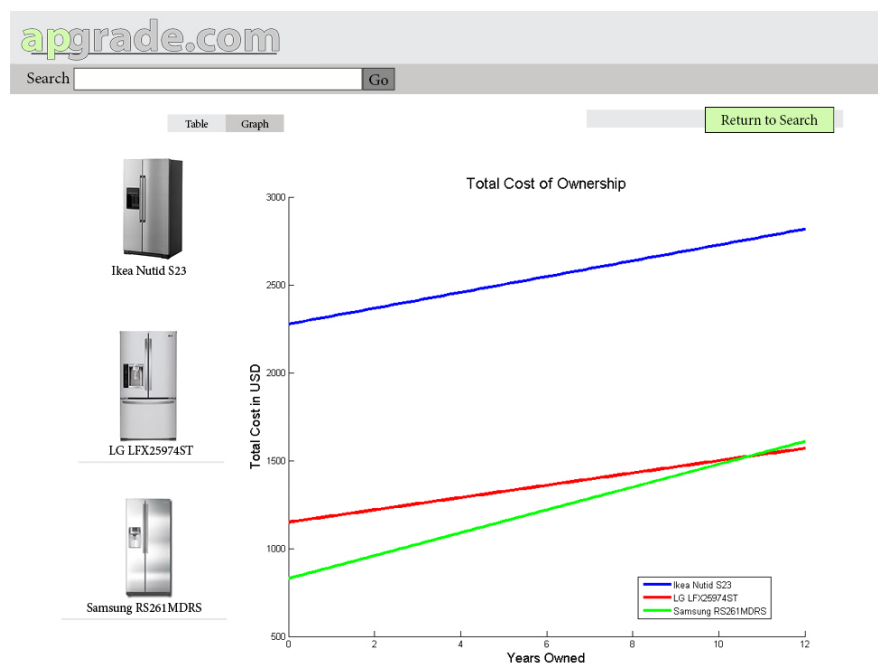

Figure 12: Alternate comparison page that shows the Total Cost over time.

Finally, the final decision page of our product is again similar to that of the alpha design. Once the user decides which retailer they would like to purchase from, they will click on the retailer link and be redirected to the actual retailer website for purchasing. Our feedback show that potential users greatly appreciate being able to see shipping costs from different retailers. We will be looking into including different options of warranty and how the cost differs between retailer to retailer in future designs.

Figure 13: Product detail page with shipping and tax information factored into the price.

The design team also had a benefit of interacting with Mr. Keith Cooley, the CEO of Principia, LLC. Principia specializes in services that focus on "clean economy" products. After hearing the pitch for the proposed service, he suggested a unique service that would allow customers to input their existing appliance into the system, so that they can compare their current energy expenditure with future costs, further encouraging them to purchase the more energy efficient appliance, since it will garner them larger monthly savings. This is an idea that is proposed as a future work in a subsequent section.

BUSINESS PLAN

Company Description
The proposed company is in the business of providing a service to assist the purchasing process of major household appliances. Currently, there are multiple retail websites that sell home appliances, including Best Buy, Home Depot, Sears, and Walmart. Each retailer has different prices, sales, delivery options, warranties and a host of other purchasing options. On top of which, customers encounter ENERGY STAR certified and non-ENERGY STAR certified appliances, the former boasting higher efficiency ratings and lower energy costs. Currently, to understand these electricity costs and power consumption, a consumer has to physically visit the retail store to read the stickers on the appliances, or search deep within the specifications on the website to view these figures. Since home appliances are expensive and there are a number of suitable products available, customers are usually very price sensitive and want to

maximize value while minimizing cost. It was observed that there is a need for comparing offerings across retailers, as well as for greater understanding into yearly operating cost and total ownership cost.

To meet these market needs, the proposed website, Apgrade.com, aims to provide two primary services for consumer shopping for home appliances. First, it provides one convenient location to shop and compare prices and options for appliances by aggregating data from a number of the manufacturers and retailers into one website. Second, the website highlights and emphasizes the yearly operating cost and total cost of ownership to educate consumers on the long-term benefits of buying a more energy efficient appliance.

Target customer is someone who is slightly frugal in spending, either by nature or financial constraints, and therefore intensely researches each purchase to maximize his value and minimize his expense. The target customer is willing to spend time visiting multiple stores or websites to compare products and offerings to make sure his purchase will get him the best overall package, including price, delivery, taxes, warranty, and etc. The target customer also understands the long-term benefits associated with the purchase, and is willing to spend a higher amount up front to receive net savings later on. Finally, the target customer is environmentally conscious and pays attention to power consumption and his environmental footprint. It does not have to be someone who is intensely environmentally conscious, but one who has a desire to reduce his energy consumption, either for the environmental impact or to reduce his energy bills.

Market Analysis
Within the US, the major household appliance manufacturing market is about $15.5 billion and is expected to grow by 2.8% between 2013 and 2018 [12]. For online large kitchen appliance sales specifically, the market size is $4.9 billion and is expected to grow 2.7% between 2013 and 2018 [13]. This includes over 13.7 million washers and dryers, 8 million refrigerators, and 6 million dishwashers [3,4]. There are several direct competitors in the space such as Google Shopping and PriceGrabber.com, both of which compare prices and options across multiple retailers. Indirect competitors would be the retailers website, such as BestBuy.com, Sears.com, or HomeDepot.com, which list the appliances they carry and related information. Our competitive advantage lies in the emphasis on yearly operating cost and total cost of ownership. Our price comparison is similar to Google or PriceGrabber, but neither of the competitors highlights yearly operating costs or total cost of ownership. Based on ethnographic research it is expected that the consumer will value such information because it will provide them with a more detailed view of how much they are spending and which appliance will be the cheapest or most efficient.

Weaknesses lie in our available capital, brand name, and product development stage. Google Shopping has much more access to capital to develop algorithms and website layouts, whereas the proposed business is limited to small loans or venture capital funding. In addition, Google has the brand name recognition and an already loyal customer base to market its product to. PriceGrabber and Google are also several years old and may have a more refined product than the proposed business will be at this stage. This will give them the advantage in ease of use and interface intuitiveness. PriceGrabber is also later in the development stage than the proposed business, and its website includes other products beyond appliances, such as TV, furniture, and yard equipment. The current weakness is that the proposed website only includes appliances, but for the future, Apgrade.com would expand to offering more product types.

The proposed website is marketed free to consumers because, with so many other competitors, no evidence of willingness to pay for more convenience and information in purchasing appliances was found. Revenues will be generated from advertisements and redirecting traffic to retail websites. To determine the price point for each consumer that is redirected, competitors such as Google, PriceGrabber, and Kayak.com will be benchmarked to have a broad understanding of willingness to pay. Based on the benchmarking, the dollar amount each consumer is worth to the retailer website will be determined. For

example, if 1/1,000 visitors of the retailer's website ends up making a purchase with a $100 profit on average, then each visitor is worth $0.10 to the retailer. Apgrade.com will price the redirection cost based on what would generate a profit, but also in a range where the net benefit to the retailer will result in overall profit as well. In the previous example, the price point could be $0.05 per redirect, giving the retailer a $0.05 potential profit and creating the willingness to pay.

There are low barriers to entry into this market. Initial capital expenditure to build the website is relatively low, and there are no significant regulations to comply with. The largest barrier is building the relationship with manufacturers to obtain product listings and specifications, as well as a relationship with retailers to verify willingness to pay and possibly cooperation to supply price listings. However, these barriers are not considered significant risks toward the development of the project.

Product Description
From the customer's perspective, Apgrade.com provides a one-stop shopping location to view all available appliances and associated prices on the market. It also allows customers to view what the total cost of ownership will be for a product. The webpages highlight yearly operating cost and total cost over multiple years, so that the consumers can make a smarter financial decision that will provide benefit in a given set time period. By aggregating all of these data in one place, Apgrade.com fulfills the need of consumers to reduce their time visiting multiple retail stores or websites. Instead of driving to multiple stores, or visiting multiple websites, they can use Apgrade.com and see all of the products and prices available. This is advantageous because such retailers as Best Buy or Sears may only sell certain manufacturing brands and thus only carry those brands in their stores and on their websites. Apgrade.com will carry all of the major manufacturing brands available and thus fulfill the desire of the target customer to be informed on all possible options. To fulfill the need of the customer to receive the best "package" deal, not only will the website show prices across retailers, but also taxes, shipping options, delivery, old appliance removal, and warranty options. By having all of these data in one easy location, the customers can easily weigh price and purchasing options to make sure they are receiving the best "package" deal. Since the target customer values their time, both of these features are meant to save the customers' time and increase their shopping efficiency. Finally, since the target customers are environmentally conscious of their energy expenditure, Apgrade.com will highlight appliance energy consumption data and yearly operating costs. These data points will inform the customers of the energy efficiency and expense associated with the appliance and allow them to choose appliances that will satisfy their need to reduce their carbon footprint and energy bill. This last environmental feature is an advantage Apgrade.com holds over the competition, as no other website highlights these data and places them in such an easy to read manner.

Apgrade.com is currently in the pre-prototype stage. A prototype website has not been built yet, but is in the stage of validating the ideas of back-ends, user interfaces, and features. The life cycle of website industry is in the mature phase. Website commerce has been around for a long time and there are several competitors, all of which have little product differentiation. A mature industry means, there must be distinguishable differentiating attributes that create competitive advantages to be a successful business. The differentiating attributes are yearly operating cost and total ownership cost displaying features.

In order to validate our approach our earlier ethnographical survey had requested potential users to describe the value they see in the tools that we are providing through our website. There was almost a unanimous agreement that being able to see the lifetime ownership cost of an appliance when making a purchasing decision was very valuable. For example, Mr. Bhaskar said "I will definitely use a website that provides NPV and lifetime ownership cost. I see value in such a tool provided it is simple and unbiased." His only disclaimer was that he would like to be able to see the derivation of lifetime ownership cost based on our mathematical model, something we are implementing into the final concept (See appendix 11). Mr. Ramkumar, another potential user said that "If the comparisons are fairly accurate

and not biased, then I would use that website" (Appendix 11). This positive customer response clearly shows that our website is one that people would welcome, as long as we focus on ensuring that we stay unbiased and honest with the numbers we are showing.

Market Penetration Strategy
Apgrade.com will target consumers actively searching for new home appliances, possibly who have just bought a home or condo, or are replacing a broken one. Typical new homeowners are young professionals or new families, but the consumers looking to replace an appliance are any homeowners. These two types of target audiences are most likely to be the first adopters of Apgrade.com. After establishing the initial stage of website development, the target consumers will expand to include homeowners looking to upgrade their existing appliance for more features or to increase energy efficiency. After the expansion of product offerings into other types of household appliances, Apgrade.com will start targeting consumers shopping for TVs, consumer electronics, vacuum cleaners, and other common household items. See the Financial Plan section for a breakdown of profitability and expected costs.

Communication Strategy
To reach the target customers several communication methods were considered. First, working with Search Engine Optimization engineers is planned to make sure Apgrade.com is showing up on major web search engines when consumers use home appliance related search words. There will be online and in-print advertisements on home appliance and furnishing related websites and magazines. One major advertisement strategy is to utilize Google AdWords to place targeted advertisements within search results. In addition to these techniques, social media, as well as passing out flyers and brochures to shoppers going in/out of retail stores, will be utilized to develop and spread out brand name. Using this strategy it is expected to successfully reach out to the target customers and generate website traffic.

Channels of Distribution
The distribution method of service is primarily Apgrade.com, since it is a standalone product and independent of manufacturers or retailers. Eventually a smartphone and tablet application would need to be developed to complement the website as another channel of distribution.

Growth Strategy
The growth strategy mainly involves adding more products to the product database and branching out from only home appliances to other types of household products. Popular items such as vacuum cleaners, grills, lawn mowers, snow blowers, toasters, and more would be included to utilize Apgrade.com's total cost of ownership feature. After this growth, other types of products which consumers routinely compare prices regardless of whether they have operating cost or not. By this time Apgrade.com will have established a brand name recognition and become known as a website for convenient shopping. This will enable the website to utilize the retailer comparison features to offer price comparison for all types of products, which will still provide value to the consumer and fulfill a need. The last types of products that are planned to be included are such things as cameras, computers, furniture, and sporting goods.

Financial Plan
An initial investment of $100,000 will be needed to develop the website, buy the domain name, and conduct focus groups and surveys to validate and finalize the website layout. This will come in the form of a loan or venture capital funding. Once the website goes live, expenses will include cost of revenues, renting server space, website maintenance, website updates, brand marketing, online marketing fees, general and administration, wages, rent, and utilities. A breakdown of the income and expenses over the first three years for the best and worst cases scenario can be found in Appendix 15. These expenses and "expense as a percentage of revenue" are modeled after Kayak.com's "expenses as a percent of revenues" found on its annual report. Since Apgrade.com provides a similar service with a similar business model, it would be appropriate to model the expenses percentages after Kayak.com's, adjusted for a smaller start

up business. As suggested by the financial statement breakdown, marketing is the major expense in order to bring traffic to the website and provide revenue. $10,000 per year is allocated for website development and updates, and $2,000 and $3,000 are set aside for rented server space and technical maintenance, respectively. In order to keep the wages low, very few part time employees will be employed. As the business grows larger, it is expected that Cost of Revenues, Brand Marketing, and General and Administrative (G&A) expenses will decrease as a percent of revenue due to increases in efficiency, scale, and reduced need to continue intense brand marketing once the brand has been established.

In an estimated $4.9 billion market where each consumer spends approximately $1,000 on an appliance, there are 4.9 million online consumers. If Apgrade.com captures 5% of that web traffic, and be able to generate $1 revenue per redirect, $245,000 revenue will be generated during the first year in the best-case scenario. The $1 per redirect was based on Kayak.com's $0.50-$2.00 per redirect [18]. Over the next three years, it is estimated that the market size as well as the percentage captured by the website would increase from 5% to 13% under the best-case scenario. In the best-case scenario, the business will start generating a positive income by the end of second year and the break-even point, including the $100,000 loan, will be achieved by year three. In the worst-case scenario, where the website only captures 1% in the first year and grows to 5% of the web traffic, the business would not generate positive income until the end of third year. For this worst-case scenario, it will take much longer to pay back the initial $100,000 investment. Figure 14 shows per year net income for the best-case and worst-case scenarios. The detailed best and worst-case scenario financial statements can be found in Appendix 15.
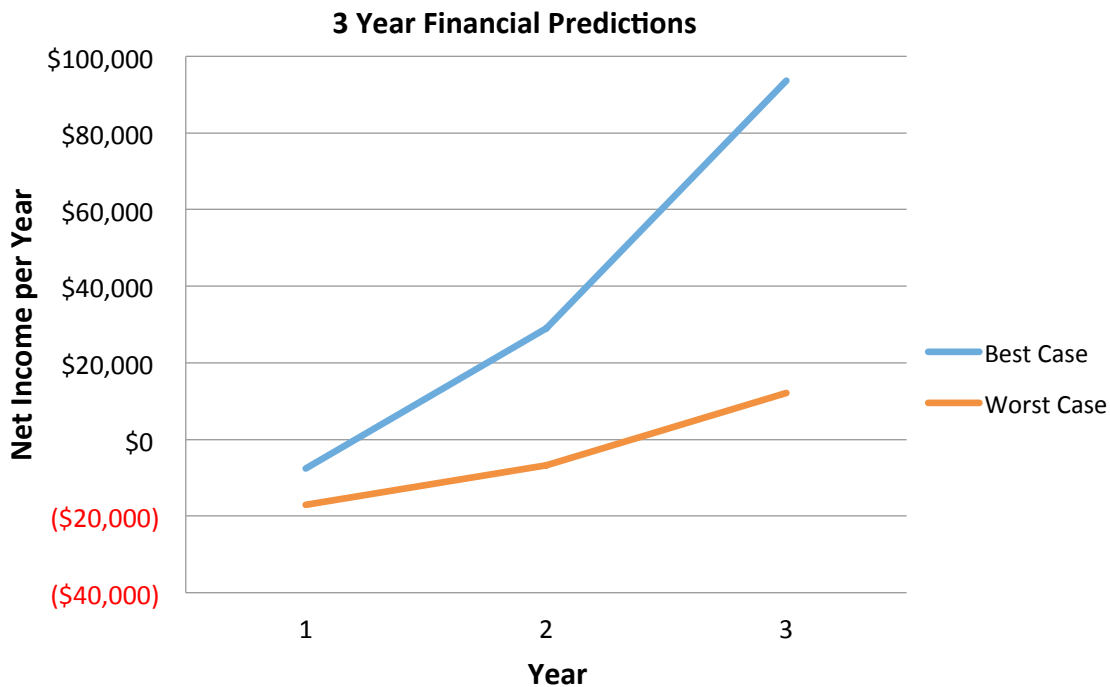

**Figure 14: Financial projection graph showing best and worst case scenario**

ADDITIONAL REFLECTIONS

Consistency with Sustainable Design
Apgrade.com meets the criteria for sustainable design because it successfully addresses all three aspects of sustainable design: social, environmental, and economic benefit. Apgrade.com is consistent with

providing social benefits because it increases awareness of linking new appliances purchase with the total ownership cost over the lifetime of product. Without such awareness, the consumers would most likely focus on the initial purchase price rather than its long-term cost of operation. The service will also educate the user on all available products on the market place and does not constrain their shopping choices and prices to a specific retailer or manufacturer. This increases buyer power, which works to the consumer's advantage, and results in a better purchase for the consumer.

It is also consistent with providing environmental benefits as energy consumption and emissions associated with use phase would be lower with intended consequences of the users choosing more efficient appliances over inefficient ones. Life cycle assessment done by Boustani et al. supports use phase energy consumption is much greater than raw materials and manufacturing phases energy consumption for refrigerator, dishwasher, and clothe washer as shown on Figure 15 below. Considering the previously done study, Apgrade.com would likely be considered a sustainable design when the design promotes the purchase and manufacture of more efficient products with intended consequences. This in turn would reshape the household appliance market toward more a sustainable industry.
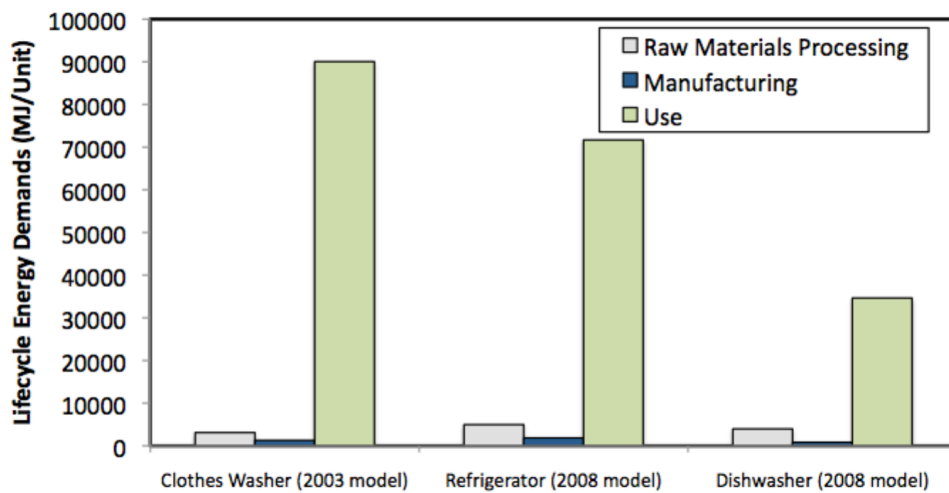
Figure 15. Life cycle assessment of new appliances [15]

Lastly, Apgrade.com is consistent with providing economic benefits since the users would be able to choose products with the lowest ownership cost when making their new appliance purchase decision. With the help from the design, the users don't have to spend much time comparing different products available on market as it effectively aggregates pertinent information that can be used to help make purchase decision. This will provide economic benefit to the consumer directly, as well as potential economic benefit to manufacturers and retailers because consumers will be purchasing more efficient appliances that are generally higher priced. As a profitable venture, Apgrade.com will provide economic benefit by providing returns to the shareholders and salaries for the employees.

Unintended Consequences
It is yet to be seen if Apgrade.com achieves actual eco-efficiency. After surveying products available in retailers, it has been found that, while there is a list of products that are more energy efficient than similarly equipped products and would pay back the price difference over lifetime, there are also other products that would not likely pay back the price difference with added energy efficiency. Such lists are shown on Appendix 16 and Table 6. This market reality induced information may trap users into making purchase decision of less efficient products over more efficient ones based on lower total ownership cost.

One example of intended consequence where the actual eco-efficiency is achieved is choosing GE GTH18GBDWW (more efficient) over Frigidaire FFTR1814LW (less efficient). They are both top freezer type and have similar capacity as shown on Table 5. The GE product is more expensive by $70, but the 12 year cost of ownership is lower by about $68. Using the project design, the consumers would likely choose the GE over the Frigidaire to lower total ownership cost achieving eco-efficiency. On the other hand, there is an unintended consequence where Whirlpool WRS325FDAW is chosen over Samsung RS265TDRS based on the lower total ownership cost even though the Samsung uses 40 kWh per year less than the Whirlpool. Because the initial price difference is too big ($160), it cannot be paid back over the lifetime of refrigerator. The consumers would likely choose the Whirlpool over the Samsung and fail to achieve eco-efficiency.

Table 5. Examples of intended and unintended consequences of project design use

Case	Make	Model	Volume (cu. ft.)	Energy (kWh/yr)	Price ($)	12 yr TCO ($)	Type
1 (Intended)	Frigidaire	FFTR1814LW	18.2	479	529.99	1219.75	Top Freezer
	GE	GTH18GBDWW	18.1	383	599.99	1151.51	Top Freezer
2 (Unintended)	Whirlpool	WRS325FDAW	25.4	544	1099.99	1883.35	Side-by-side
	Samsung	RS265TDRS	25.5	502	1259.99	1982.87	Side-by-side

Another type of unintended consequence of the project design is possible rebound effect. Appliances such as refrigerators may be exempt from such consequence, as they are run 24 hours a day. However it is expected that the users would have more likelihood of using other types of energy intense appliances such as clothe washer, dryer, dishwasher, and TV more often if they were to have more efficient products. Taking washer and dryer as an example, the users may increase their operating frequency as they cost less per run. Similar to the rebound effect seen in relation from vehicle fuel efficiency to vehicle miles traveled, this rebound effect would negate the efficiency gains in household appliances.

Design Critique

Strengths
Apgrade.com provides cost of ownership and yearly operation cost to the users. Such feature has not been offered by any other websites available in market and this is the design's competitive advantage. It also provides retailer information such as the shipping/delivery, taxes, and warranty for price comparison. This comprehensive flow of information coupled with easy to use and intuitive web interface enables the users to spend less time on browsing products available in market and make purchase decisions. Overall, the appliance consumers get the best package deal of time and money when using our design.

Weaknesses
Currently, Apgrade.com includes only the major household appliances such as refrigerators, washers, dryers, dishwashers, stoves, and ovens. There are other price comparison websites such as PriceGrabber.com and Google Shopping that feature many more products, and thus might be more attractive to consumers. For example, if a consumer already uses Google Shopping for all other products, they are more likely to use Google Shopping for appliances, rather than switch to a unique website that only contains appliances. In addition to the product selection deficiency, features of Apgrade.com are reproducible by big name websites and retailers such as Google, Best Buy, and Home Depot without

much effort. If a bigger company were to implement similar features as Apgrade.com, consumers may switch back to the websites they were using before Apgrade.com. To combat this we must make our features so intuitive and easy to understand that users have no reason to switch back to other websites. We must make sure to create tangible value so that there is a switching cost associated with the consumer switching websites. Along with reproducibility, the proposed business does not have easy access to capital when compared to the established companies; therefore implementation of design ideas into a competitive website is challenging. Cooperation with the retailers in the beginning stage and the users validation on website interface preference are additional uncertainties. The cooperation with the retailers directly influences the income stream as the website will base operation on revenue per redirection. At this point we are unsure of the retailers willingness to pay and if the amount will be high enough to sustain a business. All the weaknesses presented in this section should be well addressed following the recommendations made in the subsequent section.

Recommendations

Short-term recommendation
The immediate short-term goal is development of a working prototype to gauge users' reaction to layouts and usefulness of service. A significant amount of initial investment should be allocated to conduct focus group surveys and interviews. The focus group should effectively represent the target persona. Based on feedbacks from the potential users, the design team can further improve the user interface and website functionality. All aspects of the prototype should be thoroughly tested and researched to make sure each feature is intuitive and fulfills a need of the consumer. Research through focus groups and studies should test such things as what filters to include, what graphs are portrayed, how products are arranged on the website, what information is more highly valued than others and how it should be portrayed, and what additional features users would like to see. This additional research is crucial to finalizing our prototype and creating a website that creates value for our user and captures their loyalty.

In addition to the prototype, communication with the retailers and the manufacturers should be initiated. The negotiation results will affect the revenue stream of business and some of the product functions in website back-end. If the retailers are unwilling to provide retail data such as price, shipping/delivery, and warranty, the website back-end should be implemented with web scraping features to build the retailer database. Additional research should also be performed on the technical side to make sure our website can handle the traffic demand and web scraping functions. The website should be stress tested for different scenarios, such as if a retailer tries to hide their product price, to make sure our technical support staff can handle unforeseen events and continue the smooth operation of our website. Similar steps should be taken when negotiating with the manufacturers on periodic update on product specification database.

Long-term recommendation
For long term recommendations, we recommended to expand beyond the six major household appliances. The candidates for expansion are any consumer products that consumers a significant amount of energy so that we can implement our total cost of ownership features and provide similar competitive advantage over other shopping websites. Examples of products that fit this niche and that we expect to include after appliances are toasters, lawn mowers, snow blowers, grills, vacuum cleaners, and televisions.

Over the long term, additional differentiating features that can outperform competitors should be developed in order to maintain our competitive advantage. One of such features is an interface where the users can input their current appliance (model number, year, type, and etc.) and usage data that can then be used to compare the customer's current operation cost per year versus the cost per year for a new product purchase. Our website could then display product recommendations and net present value based on energy expense savings and payback period to determine whether the appliance upgrade would be a

good investment. There are currently no other websites that have this net present value feature. Additionally, the website can provide users with additional discounts on purchase price at pre-negotiated rates with retailers and/or profit sharing associated with the purchase transaction. Lowering purchase price for the users when using the website would ensure establishing consistent website traffic to further increase market share and income. One more feature could display the historical purchase price data along with the current purchase price, similar to the feature on airline fare websites, to help the users when making purchase decisions. Lastly, we would recommend adding a feature that compares the user's appliance expenses to nearby neighbor's expenses. During our ethnography research one subject mentioned that the gas company sends information on how his energy consumption relates to his neighbors. They mentioned that this was helpful information and would encourage energy use reduction if they realized they were using more energy than their neighbors. Since users who are looking to upgrade appliances may entering appliance model numbers, usage data, and location so electricity expense can be calculated, we will collect and save this data into a large database. After we have amassed a large database, if a user inputs his appliance information, a graph could show how his expenses compare to people who have used the website and are within a similar geographic location or area code. If the user notices that his energy expenses are vastly higher than the majority of people nearby, then he might be more inclined to purchase more energy efficient appliances. These are some long term recommendations we would like to see included on Apgrade.com.

ACKNOWLEDGEMENT

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APPENDIX 1: TEAM INTRODUCTION

Devin Miller

Devin Miller is a second year graduate student in Robotics and Autonomous Vehicles. He received Bachelor's degrees from Eastern Michigan University in both physics and mathematics and has previous experience in computer science, astrophysics, statistical analysis, and robotics from internships and research opportunities at NASA and the University of Michigan. His interest in sustainable design stems from a functionality perspective, Given that the Earth on its current trajectory will consume itself, the only real solution is to endeavor to change course through implementation of sustainable practices. Devin brings an in-depth knowledge of technology and computer science, and a desire to effect real, measurable change.

David Odell
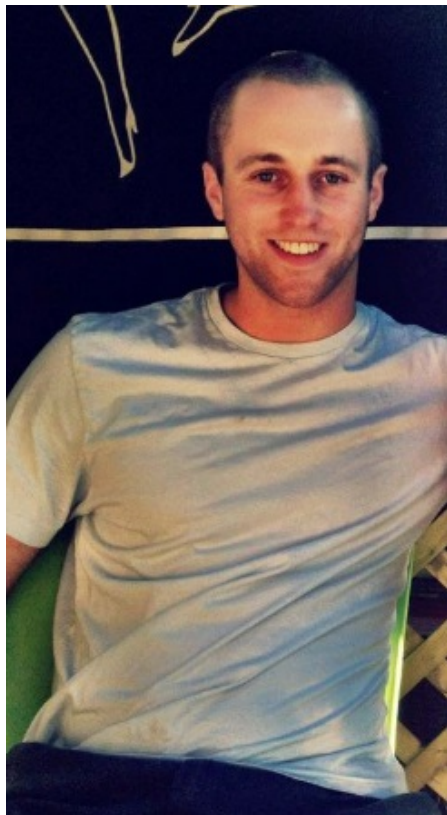
David Odell received his Bachelor's in Mechanical Engineering from the University of Michigan in 2012, where he is currently pursuing his Master's in Mechanical Engineering and will graduate in December of 2013. He has done several internships, including working at Toyota, Chrysler, Pratt & Whitney, and PricewaterhouseCoopers. He plans to pursue a career in management consulting working on business strategy. David's hobbies include fitness, discovering new music, cooking, and following the start-up and automotive industry. He grew up in a small suburb outside of Boston, Massachusetts, and remains an avid Boston sports fan.

His interest in sustainability involves applying "Blue Ocean Strategy" to create products that promote sustainability and create new markets. This is directly applicable to our project because our website focuses on encouraging users to buy more sustainable appliances by showing net present value prices and payback. This website also creates a new market, since it would be the only website within the kitchen appliance industry that aggregates data from several retailers and emphasizes energy conservation. Through David's experience in design engineering and management consulting, he will bring a unique perspective toward the development of the project and the distinctive features that will set it apart from the competition and attract consumers.

Deokkyun Yoon

Deokkyun received his BS and MS degrees in mechanical engineering from the University of Michigan in 2009 and 2010 respectively. After graduation, he had worked at Korea Institute of Machinery and Materials as a staff research engineer in the area of design and control of flexible electronics manufacturing equipment. He returned to the University of Michigan in Fall 2013 to pursue Ph.D degree in mechanical engineering. His interest in sustainability involves improving the energy efficiency of consumer goods and manufacturing equipment. He has experience working in the area of optimal design and design solicitation from users for his senior design project. He hopes to contribute his design experience from both inside and outside the school to developing the new product/service for sustainability.

Raghavsrinivas Ramkumar

Raghavsrinivas Ramkumar (Raghav for short) completed his BS degree from University of Michigan in Mechanical Engineering with two minors in Mathematics and Electrical engineering. He joined the Robotics and Autonomous Vehicles Masters program at UM in Jan 2013 and is in his second semester of the program. He's born in India, but lived all his life in Singapore. His interest in sustainability stems from projects involving creating sustainable prosthetics and sustainable robotic systems. He has done research for 2 years under Dr. Brent Gillespie in his Haptix laboratory and hopes to be able to contribute the skills he has garnered in the two years to this project.

APPENDIX 4: SAMPLE IMAGE OF BEST BUY ONLINE CATALOG

BEST BUY

PRODUCTS | SERVICES | SHOPS & DEALS | GIFTS

Narrow Your Results

1 - 15 of 179   1 2 3 4 5 ··· ›   View: 15 per page

Compare up to 4 items   [ ] [ ] [ ] [ ] **COMPARE**   Sort by: Best Selling

Current Offers
- ☐ On Sale (166)
- ☐ Free Shipping Eligible (178)
- ☐ Special Offers (177)
- ☐ Clearance & More (6)

Brand
- ☐ Samsung (46)
- ☐ LG (34)
- ☐ Whirlpool (32)
- ☐ KitchenAid (26)
- ☐ GE (23)
- ☐ Electrolux (11)
- ☐ Frigidaire (6)
- ☐ Bosch (1)

Price
- ☐ $1250 - $1499.99 (20)
- ☐ $1500 - $1999.99 (62)
- ☐ $2000 - $2499.99 (47)
- ☐ $2500 - $2999.99 (30)
- ☐ $3000 and Up (20)

Refrigerator Features
- ☐ ENERGY STAR Certified (156)
- ☐ LED Lighting (127)
- ☐ Thru-the-Door Water Dispenser (102)
- ☐ Thru-the-Door Ice Dispenser (97)
- ☐ Counter Depth (26)
- ☐ Magnetic Doors (5)

Condition
- ☐ New (177)

Customer Reviews
- ☐ Top-Rated (40)
- ☐ 5 Stars (22)
- ☐ 4 or More Stars (119)
- ☐ 3 or More Stars (145)
- ☐ 2 or More Stars (147)
- ☐ 1 or More Stars (151)

Capacity Range (cu. Ft.)
- ☐ 15 - 19.9 (28)
- ☐ 20 - 23.9 (29)
- ☐ 24 - 25.9 (49)
- ☐ 26 and Up (72)

Depth
- ☐ 28 - 28-9/10" (2)
- ☐ 29 - 29-9/10" (4)

All Items (179) | Best Buy Items (177) | Marketplace Seller Items (2)

Samsung - Clearance 28.5 Cu. Ft. French Door Refrigerator with Thru-the-Door Ice and Water - Stainless-Steel

Model: RFG297HDRS   SKU: 2146814

ENERGY STAR Certified
Electronic external controls; LED lighting; Twin Cooling Plus system; spill-proof, tempered-glass shelves; 2 humidity-controlled crisper drawers; gallon-size door storage

Customer Reviews: ★★★★½ 4.5 of 5 (186 reviews)

Check Shipping & Availability ›

☐ Compare

$1,799.99
Original Price: $2,799.99 ›
You Save: $1,000.00
- 10% Off Geek Squad Protection: See How
- Free Delivery Major Appliances $429 & Up
- Get 5% Back in Rewards: See How

Add to Cart

LG - 24.7 Cu. Ft. French Door Refrigerator with Thru-the-Door Ice and Water - Stainless-Steel

Model: LFX25974ST   SKU: 2869309

ENERGY STAR Certified
Smart Cooling system; Spill Protector glass shelves; full-width, temperature-controlled drawer; 2 humidity-controlled crispers; 2 gallon door bins

Customer Reviews: ★★★★½ 4.4 of 5 (87 reviews)

Check Shipping & Availability ›

☐ Compare

Sale: $1,499.99

Reg. Price: $2,299.99
You Save: $800.00
- 10% Off Geek Squad Protection: See How
- Free Delivery Major Appliances $429 & Up
- Get 5% Back in Rewards: See How

Add to Cart

Samsung - Clearance 28.0 Cu. Ft. French Door Refrigerator - Stainless-Steel

Model: RF4287HARS   SKU: 9790988

ENERGY STAR Certified
External digital display and controls; Twin Cooling Plus temperature management system; 2 humidity-controlled crispers; 5 tempered-glass shelves; FlexZone drawer; ice and water dispenser

Customer Reviews: ★★★★½ 4.5 of 5 (443 reviews)

Check Shipping & Availability ›

☐ Compare

$2,199.99
Original Price: $3,199.99 ›
You Save: $1,000.00
- 10% Off Geek Squad Protection: See How
- Free Delivery Major Appliances $429 & Up
- Get 5% Back in Rewards: See How

Add to Cart

LG - 30.5 Cu. Ft. Door In Door French Door Refrigerator with Ice and Water Dispenser - Stainless-Steel

Model: LFX31945ST   SKU: 4964402

ENERGY STAR Certified
Digital temperature controls; 4 Spill Protector tempered-glass shelves; 2 humidity-controlled crispers; Glide N' Serve drawer; 3 freezer drawers

Customer Reviews: ★★★★★ 4.7 of 5 (176 reviews)

Check Shipping & Availability ›

☐ Compare

Sale:

See price in cart >

Reg. Price: $3,499.99
- 10% Off Geek Squad Protection: See How
- Free Delivery Major Appliances $429 & Up
- Get 5% Back in Rewards: See How

APPENDIX 5: PURCHASE BEHAVIORS AND ATTITUDES

Washers and Dryers - US - June 2012 - Purchase Behaviors and Attitudes					
Figure 58: Purchase behaviors and attitudes, by washer dryer ownership, March 2012					
	All	Purchased new less than two years ago	Purchased new about two to five years ago	Purchased new about six to 10 years ago	Purchased new more than 10 years ago
Base: internet users aged 18+ whose household purchased a washer and/or dryer	1,495	475	497	338	185
	%	%	%	%	%
I knew what I wanted and spent little or no time doing research	29	28	26	33	35
I visited multiple stores in person	28	29	32	24	21
I did research online before visiting stores	28	38	29	22	10
I waited for a sale to get the best deal	27	30	28	26	22
I bought using a finance offer to spread out or delay payment	11	14	11	11	8
I have trouble remembering the details of my most recent purchase of a washer or dryer	11	5	7	15	26
I participated in a state/federal rebate program for energy-efficient machines	7	10	7	5	2
I found it difficult to sort through the different options and features available	6	7	6	5	2
I was not involved in the purchase	5	4	5	6	8
While shopping I used a mobile device (phone, tablet, etc.) to compare prices at other stores/online retailers	4	8	4	1	1
I looked at products in the store but purchased online	3	6	3	1	2
None of the above	6	4	6	8	9

APPENDIX 6: SALE OF APPLIANCES BY MAJOR RETAILERS

 * washers, dryers, refrigerators, freezers, dishwashers, ranges, cooktops, wall ovens, microwave ovens, room air conditioners and dehumidifiers

Washers and Dryers - US - June 2012 - Retail Channels						
Figure 29: Sales of major appliances* at top 100 retailers, 2009 and 2010						
	2009 appliance sales	**Share**	**2010 appliance sales**	**Share**	**Change in sales 2009-10**	**Change in share 2009-10**
	$billion	%	$billion	%	%	**% point**
Sears	7.19	31.2	7.51	30.9	4.5	**-0.3**
Lowe's	4.9	21.3	5.37	22.1	9.6	**0.8**
Home Depot	3.37	14.6	3.54	14.6	5	-
Best Buy	1.71	7.4	1.76	6.9	2.9	**-0.5**
Walmart	0.67	2.9	0.72	3	7.5	**0.1**
All others	5.18	22.5	5.49	22.6	6	**0.1**
Total	23.02	100	24.3	100	5.6	-

APPENDIX 7: REASONS FOR NEW PURCHASE

Figure A:

Washers and Dryers - US - June 2012 - Main Reason for Most Recent Purchase							
Figure 46: Main reason for most recent purchase, by household income, March							
	All	<$25K	$25K-49.9K	$50K-74.9K	$75K-99.9K	$100K-149.9K	$150K+
Base: internet users aged 18+ whose household has purchased a washer and/or dryer	1,495	182	313	313	237	328	122
	%	%	%	%	%	%	%
Our/my previous one broke down	51	49	52	53	49	51	48
Because we/I were/was moving	12	5	11	13	15	13	12
This was a first-time purchase	10	14	10	11	8	10	11
To save money on energy costs	7	9	7	5	8	8	10
To get new features we/I didn't have	6	4	5	5	8	5	9
To conserve water	3	4	3	4	2	1	2
To get a larger product	3	4	4	1	3	2	2
Because we/I were/was remodeling	2	1	1	2	3	3	3
For aesthetic reasons	1	3	1	2	1	1	1
We/I had a child or are/am expecting one	1	1	0	1	0	1	1
To get a smaller product	0	0	1	1	0	1	0
Other	4	5	5	4	4	3	1

Figure B:

Washers and Dryers - US - June 2012 - Main Reason for Most Recent					
Figure 47: Main reason for most recent purchase, by when washer/dryer					
	All	Purchased new less than two years ago	Purchased new about two to five years ago	Purchased new about six to 10 years ago	Purchased new more than 10 years ago
Base: internet users aged 18+ whose household has purchased a washer and/or dryer	1,495	475	497	338	185
	%	%	%	%	%
Our/my previous one broke down	51	49	53	50	51
Because we/I were/was moving	12	8	11	21	8
This was a first-time purchase	10	7	9	10	24
To save money on energy costs	7	10	8	3	6
To get new features we/I didn't have	6	6	7	5	2
To conserve water	3	5	2	1	1
To get a larger product	3	2	3	3	2
Because we/I were/was remodeling	2	3	3	1	1
For aesthetic reasons	1	3	0	0	1
We/I had a child or are/am expecting one	1	1	1	0	0
To get a smaller product	0	1	0	0	0
Other	4	4	3	5	5

APPENDIX 8: IMPORTANCE OF PRODUCT ATTRIBUTES

Washers and Dryers - US - June 2012 - Importance of Product				
Figure 48: Importance of product attributes, March 2012				
	Very important	Somewhat important	Not very important	Not at all important
	%	%	%	%
Reliability	84	14	1	1
Price	71	26	2	1
Energy-efficiency rating	58	35	6	1
Clothing capacity	57	37	5	1
Amount of water used	52	38	8	2
Noise and vibration level	45	42	10	2
Length of warranty	44	44	10	2
Overall size of machine/s	43	46	10	2
Configuration, (front-loading, top-loading, etc.)	40	43	14	3
Automatic settings and controls	39	47	12	2
Length of wash and dry cycles	36	46	16	3
Brand name	26	49	21	4
Style/design	21	44	29	6

APPENDIX 9: SPECIAL FEATURE INTEREST RANKINGS

Attitudes Toward Energy Savings - US - May 2011 - Interest in Energy Efficient Figure 36: Interest in purchasing energy efficient products, Dec. 2010	Very interested	Somewhat interested	Not very interested	Not at all interested
	%	%	%	%
Light bulbs or lighting fixtures	57	32	5	5
Major appliances, such as a refrigerator or clothes dryer	51	35	7	7
Air conditioners	49	32	8	10
Heaters	47	33	10	10
Televisions or computer monitors	46	40	7	7
Cars/trucks	44	37	10	9
Windows, roofing, or other building supplies	43	35	10	12
Small appliances, such as a toaster or iron	40	40	12	8
Portable electronics, such as cell phones or notebook computers	38	38	13	10
Lawn and garden equipment	28	35	19	19
Power tools	27	34	21	18

APPENDIX 10: INTEREST IN PURCHASING ENERGY EFFICIENT PRODUCTS

Attitudes Toward Energy Savings - US - May 2011 - Interest in Energy Efficient				
Figure 36: Interest in purchasing energy efficient products, Dec. 2010				
	Very interested	Somewhat interested	Not very interested	Not at all interested
	%	%	%	%
Light bulbs or lighting fixtures	57	32	5	5
Major appliances, such as a refrigerator or clothes dryer	51	35	7	7
Air conditioners	49	32	8	10
Heaters	47	33	10	10
Televisions or computer monitors	46	40	7	7
Cars/trucks	44	37	10	9
Windows, roofing, or other building supplies	43	35	10	12
Small appliances, such as a toaster or iron	40	40	12	8
Portable electronics, such as cell phones or notebook computers	38	38	13	10
Lawn and garden equipment	28	35	19	19
Power tools	27	34	21	18

APPENDIX 11: SAMPLE SURVEYS FOR CUSTOMER BEHAVIOR

Survey 1

This survey is designed to help us understand consumer buying habits for household appliances. This survey is purely for academics and will not be released to any third party. When selecting an answer for a multiple choice question, please clearly indicate your selection via clear marking, e.g. highlighting. Thank you very much for your time

What is your age? (Select an applicable range)

1. 18 to 24
2. 25 to 34
3. 35 to 44
4. 45 to 54
5. 55 to 64
6. 65 to 74
7. 75 or older

How comfortable are you with using the internet?

1. Very comfortable, I use it on a daily basis
2. Somewhat comfortable, I can use most functions but certain things confuse me
3. Not very comfortable, many tasks seem too complicated
4. Not comfortable at all I prefer to not use it
5. Other: (Please Specify)

How often do you shop online?

1. Extremely often, I shop online for almost all my purchases
2. Quite often, Many of my purchases are made online, but I do go to storefronts
3. Moderately often, I shop online every now and then
4. Slightly often, I rarely use online stores
5. Never

Name some sites you use for online shopping:

http://www.courts.com.sg ; http://www.mustafa.com.sg ;
For other products and services, I visit following sites:
http://www.fabindia.com/ ; http://www.dell.com.sg/ ; http://www.booking.com/ (For hotels) ;
http://www.farecompare.com/ (For airline)
Normally, I start with google.com for search and then use link to supplier / aggregator website.

When shopping online, do you check many sites for the same product before making a decision?

1. Yes
2. No

Would you trust an aggregator site? (Aggregator sites are sites that compile data on products across the internet to give you a full selection, like Google Shopping)

1. Yes
2. No, please explain why:

When was the last time you had to purchase an appliance?

Four months ago. (I purchased a new TV.)

Why did you purchase this appliance?

1. First time buying this appliance
2. Replacing a broken appliance
3. Upgrading an appliance
4. Other: (Please Specify)

The new TV offered new generation technology (SMART TV). Previous TV was still in working condition and well within its expected life span.

(Note : If above reason fits in your definition of 'Upgrading an appliance', then please consider my answer as 3 instead of 4)

Where did you buy this new appliance?

1. At a store
2. Online
3. Other: (Please Specify)

At an IT expo.

Before buying this product did visit multiple stores/websites for comparison?

1. Yes
2. No

When you are shopping for appliances what are top 5 things you look for? Please rank them in order. Suggestions include Reliability, Functionality, Price, Size Energy Effectiveness, etc.

1. Reliability (Brand)
2. Energy Effectiveness
3. Functionality including safety mechanism
4. Total Cost of Ownership
5. Ease of use / maintenance e.g. cleaning

Consider the following two appliances (this is a fictional case, with two refrigerators of similar quality):

Refrigerator X	**Refrigerator Y**
Price @ Best Buy: $1400	Price @Best Buy: $1480

Which refrigerator would you buy? Why?

Will not make decision only on this much information. The reason is that information is not sufficient * to evaluate/guess following:
a) whether the difference in brand value/features/functions of brand Y vis-à-vis brand X will justify $80 premium (which is about 6%).
b) whether brand X is good enough for my needs to avoid paying extra $80 for some frills that I may not need.
* Even when assuming that 'Best Buy' is the only option (or best channel) to buy the Refrigerator.

Now consider this case:

Refrigerator X	**Refrigerator Y**
Price @ Best Buy: $1380	Price @ Best Buy: $1440
Price @ Sears: $1420	Price @ Sears: $1520
Average Price: $1400	Average Price: $1480
Cost per month: $18	Cost per month: $11
Average life: 15yrs	Average life: 15yrs
Total cost incurred: $1670	Total cost incurred: $1645

Which refrigerator would you buy? Is the additional information provided important to you? Does lifetime ownership cost seem relevant to your decision? Please explain why.

I shall buy Refrigerator Y from Best Buy. Additional information is important to me. Lifetime ownership cost is relevant in my decision. For me, some of the considerations for 'lifetime ownership cost' should include a) electricity consumption, b) need of maintenance, c) resale value for potential replacement during its active life due to technology / lifestyle change and d) utility to others in case appliance is donated. In above example, my decision will be based on replacement after 8-10 years even though average life of refrigerator is 15 years.

Would you use a website that provides you net present value calculations and lifetime ownership costs to purchase appliances? Do you see the value in such a tool? Would it sway you away from other websites? How would you like to see such a tool implemented? Please explain in a short paragraph.

Yes definitely I will use a website that provides NPV and lifetime ownership cost.
 I see value in such tool provided it is simple and unbiased. (I should be able to understand how tool derives ' lifetime ownership cost' based on the model / criteria / parameters used by the tool.)
Not sure about exact meaning of question related to 'swaying away from other websites'. But, I shall use both the tool and other traditional websites depending on my needs.
The tool could be an application running on mobile devices/tablets (example: iphone, ipad or Android based devices). The tool may be a website. For example something similar to say farecompare.com.
I would like the tool to be implemented in manner that it uses its own model that uses default criteria (i.e. parameters) with appropriate weights to perform analysis and provides user flexibility* to expand. The tool should explain these default parameters in simple terms (without using technology or finance jargon). The explanation could be in form of text, graphics, illustration or even analogy.
* Flexibility : The tool should let user perform some analysis by allowing them to change weight and/or values of parameters in meaningful range. Considering the case of refrigerator in previous question the tool should ask "For how many years would you use it" The applicable range could be say 1 year to 17 years with default as 15 years. (Please note that some of the loan calculators provide such flexibility)
The tool should also allow users to define their own parameters   (with its associated weights).
Also the tool should have some non finance related criteria. Example : Whether the company producing appliance has child labor policy, environment policy, disposal policy etc.
If the tool is aggregating information, it should let me select the service provider. Example: Tool will allow user to Select upto say 5 retail chains / manufacturers/brands etc.

THANK YOU FOR YOUR TIME!

Survey 2

This survey is designed to help us understand consumer buying habits for household appliances. This survey is purely for academics and will not be released to any third party. When selecting an answer for a multiple choice question, please clearly indicate your selection via clear marking, e.g. highlighting. Thank you very much for your time

---

What is your age? (Select an applicable range)

    8.   18 to 24
    9.   25 to 34
    10. 35 to 44
    11. 45 to 54
    12. 55 to 64
    13. 65 to 74
    14. 75 or older

How comfortable are you with using the internet?

    6.   Very comfortable, I use it on a daily basis
    7.   Somewhat comfortable, I can use most functions but certain things confuse me
    8.   Not very comfortable, many tasks seem too complicated
    9.   Not comfortable at all I prefer to not use it
    10. Other: (Please Specify)

How often do you shop online?

    6.   Extremely often, I shop online for almost all my purchases
    7.   Quite often, Many of my purchases are made online, but I do go to storefronts
    8.   Moderately often, I shop online every now and then
    9.   Slightly often, I rarely use online stores
    10. Never

Name some sites you use for online shopping:

Amazon, eBay, Alibaba Courts.com.sg – for price comparison purposes

When shopping online, do you check many sites for the same product before making a decision?

3. **Yes**
4. No

Would you trust an aggregator site? (Aggregator sites are sites that compile data on products across the internet to give you a full selection, like Google Shopping)

3. **Yes**
4. No, please explain why:

When was the last time you had to purchase an appliance?

Had to buy an electric steam iron to replace a leaking steam iron – 2 months ago

Why did you purchase this appliance?

5. First time buying this appliance
6. **Replacing a broken appliance**
7. Upgrading an appliance
8. Other: (Please Specify)

Where did you buy this new appliance?

4. **At a store**
5. Online
6. Other: (Please Specify)

Before buying this product did visit multiple stores/websites for comparison?

3. Yes
4. **No**

When you are shopping for appliances what are top 5 things you look for? Please rank them in order. Suggestions include Reliability, Functionality, Price, Size Energy Effectiveness, etc.

6. Features - Functionality
7. Reliability
8. Energy consumption
9. Price
10. Warranty / Serviceability

Consider the following two appliances (this is a fictional case, with two refrigerators of similar quality):

Refrigerator X	Refrigerator Y
Price @ Best Buy: $1400	Price @Best Buy: $1480

Which refrigerator would you buy? Why?

Refrigerator X. If the features are same, then X is cheap.

Now consider this case:

Refrigerator X	Refrigerator Y
Price @ Best Buy: $1380	Price @ Best Buy: $1440
Price @ Sears: $1420	Price @ Sears: $1520
Average Price: $1400	Average Price: $1480
Cost per month: $18	Cost per month: $11
Average life: 15yrs	Average life: 15yrs
Total cost incurred: $1670	Total cost incurred: $1645

Which refrigerator would you buy? Is the additional information provided important to you? Does lifetime ownership cost seem relevant to your decision? Please explain why.

Refrigerator Y.
The lifetime ownership cost and energy saving for the environment is important to me.

Would you use a website that provides you net present value calculations and lifetime ownership costs to purchase appliances? Do you see the value in such a tool? Would it sway you away from other websites? How would you like to see such a tool implemented? Please explain in a short paragraph.

Yes. If the comparisons are fairly accurate and not biased, then I would use that website.
This would be my primary site to check for any appliance decision, rather than looking at product site.
It should be possible to choose products from various manufacturers and do online comparison. The website maintenance team would collect such info from manufacturers and make the details available. The website could be a pay per use for the analysis purposes. Alternatively, an online store could be accessed from this website and a commission could be obtained from the manufacturers for buying through this website

THANK YOU FOR YOUR TIME!

APPENDIX 12: INTERVIEW 1

INTERVIEWER: David Odell
INTERVIEWEE: David's Parents

Q: What is your process for buying household appliances?

A: First browsed prices and selection online from several retailers then went to retail store where we have bought appliances in the past. We preferred too look at local retailers to support local economy and because they often came with local service in case it broke. Other considerations were if free delivery was included, or financing options.

Q: How often do you change appliances around the house? Give some examples.

A: Every 5-10 years. We only replace it if it breaks or if we were to move and we couldn't take it with us like a stove.

Q: What do you look for? Name your top 3 priorities.

A: Style and dimensions were the main priority. Style is important especially for kitchen appliances. We had preexisting dimensions because we were remodeling our kitchen and only had a certain amount of space. We wanted to maximize dimensions to store the most amount of food, hence shop less. Energy efficiency was third because we actively wanted to save energy and money.

Q: Do you ever consider operating costs or the net present value of your purchase?

A: We considered energy efficiency but only looked at energy star rating and what we had read about which types of appliances were most energy efficient (top-freezer vs bottom freezer). Did not look at power consumption or yearly operating costs. Did not think to compare current appliance with new purchase

Q: Would you be keener on buying more energy efficient products if you knew the net present value and the payback time?

A: Yes, if we saw a listing of which appliances led to more savings that would definitely influence our decision, but only if it fit our style and dimensions.

Q: Any other important information relating to appliance purchasing you would like to let us know?

A: Yes, whether the company would take the other appliance was a major consideration in which retailer we chose. We chose Sears, which took away the appliance to be refurbished or recycled properly. Some companies won't take the device or will only take it if it isn't broken. Also, we think energy conservation would be promoted if there were some feedback to how our energy usage compares to our neighbors. This is something the gas company currently does. If we found that our energy usage was significantly higher than others then we may take action to reduce energy consumption.

APPENDIX 13: INTERVIEW 2

INTERVIEWER: Raghavsrinivas Ramkumar
INTERVIEWEE: Ramkumar Govindarajan

Q: What is your process for buying house hold appliances?

A: When I need to change appliances around the house, I spend a long time looking at different shops and catalogues before making my decision.

Q: How often do you change appliances around the house? Give some examples.

A: I mostly change appliances when they break and the cost of repair becomes too high. Certain appliances break with more regularity. For example, we only just changed the fridge in the house, after about 10 years of using it, but we've changed microwaves twice in the same time. Sometimes things also become outdated and I change appliances when newer technologies come out.

Q: What do you look for? Name your top 3 priorities.

A: Cost is definitely the most important. I then look for reliability, by reading reviews of the product. I finally look for technologies used or look and style.

Q: Do you ever consider operating costs or the net present value of your purchase?

A: No, not really, because estimating numbers on how much something would cost per month would be difficult. The numbers are not easy to find.

Q: Would you be more keen on buying more energy efficient products if you knew the net present value and the payback time?

A: Certainly. That would be great because I've always wanted to buy more green appliances but the costs of these appliances are always a huge deterrent.

APPENDIX 14: VALIDATION SURVEY

This survey is designed to help us understand how we as a team should modify our alpha design to propose a final design. This survey is purely for academics and will not be released to any third party. When selecting an answer for a multiple choice question, please clearly indicate your selection via clear marking, e.g. highlighting. Thank you very much for your time

Did you take part in another ethnographical survey?

1. Yes
2. No

Over the next few pages you will be looking at some pictures of our alpha design for our website. Please pay close attention to each picture and then answer the questions that follow:

<div align="center">

HOMEPAGE

</div>

PRODUCT SELECTION PAGE

apgrade.com

Search [   ] Go

Ad Space

Add to List   View Comparisons

Samsung RS261 26 Cubic Foot Side by Side Refrigerator with 2 Doors and Integrated Water & Ice, Real Stainless
Base Cost: $1,399.00
Adjusted 12YC: $2,213.00
☐ Select

LG Electronics LRBP1031T 10 cu.ft. Cabinet Depth Refrigerator
Base Cost: $1,149.00
Adjusted 12YC: $1,795.00
☐ Select

Stainless Steel 1 Door Compact 3.3 Fridge by MicroChill
Base Cost: $150.00
Adjusted 12YC: $510.00
☐ Select

Midea HD-113F Full-Size Double Reversible Door Refrigerator and Freezer, 3.1 Cubic Feet, White
Base Cost: $209.00
Adjusted 12YC: $468.00
☐ Select

LG LFX31945 Super Capacity 3-Door French Door Refrigerator with Door-in-Door, Stainless Steel
Base Cost: $3,849.00
Adjusted 12YC: $4,935.00
☐ Select

Avanti FF994PS 10.0 CF Two Door / Frost Free / Glass Shelves / Reversiblee Doors / Black w/Platinum Doors
Base Cost: $655.00
Adjusted 12YC: $1,225.00
☐ Select

Price
[   ] to
[   ]

Yearly Operating Cost
[   ] to
[   ]

Customer Reviews
[Select ▽]

Brand
[Select ▽]

Style
[Select ▽]

More options...

PRODUCT COMPARISON PAGE

apgrade.com

Search [   ] Go

Table   Graph

Return to Search

	Ikea Nutid S23	Samsung RS261MDRS	LG LFX25974ST
Best Price	$2,276.91	$827.88	$1,149.00
Adjusted 12YC	**$2,816.91**	**$1,607.88**	**$1,569.00**
Style	side-by-side	side-by-side	bottom freezer
Width	36"	36"	36"
height	43"	43"	43"
Storage Space	25.8 cft	23.4 cft	24.3 cft
Materials	stainless steel	aluminum	stainless steel
Freezer	yes	yes	yes
Ice Maker	yes	yes	yes

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PRODUCT DETAILS PAGE

Were the pages easy to follow and understand? Was there something else you would have liked to see on any of the pages?

The pages were easy to follow and have the relevant information such as yearly electricity cost and 12year running expenses included to the cost price. Customer review could be added to the 'Product Details' page, so that one can see the feedback of the customers. You can add average rating of the customers, if they are inputting the rating using a five-star scale.

What are the filters you would like to see for any appliance that you were considering buying? How many filters seem adequate for you to make the best decision?

What are the options for 'Customer feedback' drop down menu? It would be interesting if some of the economic concepts, TCO and such are explained.

Were the numbers shown on the last figure useful? (Yearly electricity cost, 12 year price, shipping information from different retailers, etc.) Are there any other calculations you would like to see?

Yes. Time to delivery and mode of delivery by the retailers would be useful. Also the other services provided by retailers – Installation, old equipment disposal, etc are required.

Would you like a page dedicated to showing you how we arrived at these numbers? Would you like to see plots?

1. Yes
2. No
3. Other: (Please explain)

How many products would you like to be able to compare at the least?

SIX is more than enough.

Would you like a complaints forum/page?

1. Yes -- Forum page is a good option.
2. No

THANK YOU FOR YOUR TIME!

APPENDIX 15: ESTIMATED 3 YEAR FINANCIAL PLAN

Assumptions

Total Initial Investment	$100,000

Best Case Scenario

Annual Income Statement	Initial	Year 1	Year 2	Year 3
Sales	$0	$245,000	$510,000	$840,125
Cost of Revenues (10%-1%/yr)	$0	$24,500	$45,900	$67,210
Total	**0**	**$220,500**	**$464,100**	**$772,915**
Gross Margin		90%	91%	92%
Expenses				
Website	$80,000	$10,000	$10,000	$10,000
Server Space	$0	$2,000	$4,000	$6,000
Maintenance	$0	$3,000	$3,000	$3,000
Validation	$20,000	$0	$0	$0
Brand Marketing (30%-2%/yr)	$0	$73,500	$142,800	$218,433
Online Marketing Fees (25%)	$0	$61,250	$127,500	$210,031
G&A (9%-1%/yr)	$0	$22,050	$40,800	$58,809
Wages (20%)	$0	$49,000	$102,000	$168,025
Rent + Utilities	$0	$7,350	$5,000	$5,000
Total	**$100,000**	**$228,150**	**$435,100**	**$679,298**
Net Income	**($100,000)**	**($7,650)**	**$29,000**	**$93,618**
Cumulative Net Income	**($100,000)**	**($107,650)**	**($78,650)**	**$14,968**
Profit Margin		-3%	6%	11%

Worst Case Scenario

Annual Income Statement	Initial	Year 1	Year 2	Year 3
Sales	$0	$49,000	$153,000	$258,500
Cost of Revenues (10%-1%/yr)	$0	$4,900	$13,770	$20,680
Total	**0**	**$44,100**	**$139,230**	**$237,820**
Gross Margin		90%	91%	92%
Expenses				
Website	$100,000	$10,000	$10,000	$10,000
Server Space	$0	$2,000	$4,000	$6,000
Maintenance	$0	$3,000	$3,000	$3,000
Brand Marketing (30%-2%/yr)	$0	$14,700	$42,840	$67,210
Online Marketing Fees (25%)	$0	$12,250	$38,250	$64,625
G&A (9%-1%/yr)	$0	$4,410	$12,240	$18,095
Wages (20%)	$0	$9,800	$30,600	$51,700
Rent + Utilities	$0	$5,000	$5,000	$5,000
Total	**$100,000**	**$61,160**	**$145,930**	**$225,630**
Net Income	**($100,000)**	**($17,060)**	**($6,700)**	**$12,190**
Cumulative Net Income	**($100,000)**	**($117,060)**	**($123,760)**	**($111,570)**
Profit Margin		-35%	-4%	5%

APPENDIX 16: SELECTION OF REFRIGERATORS FROM BEST BUY

Regard to eco-efficiency: intended case 1, intended case 2, unintended case 1, unintended case 2 [14]

Intended consequence: efficient product is cheaper in long run
Unintended consequence: efficient product is still more expensive in long run

Make	Model	Volume (cu. ft.)	Energy (kWh/yr)	Price ($)	12 yr TCO ($)	Type
Frigidaire	FFTR1814LW	18.2	479	529.99	1219.75	Top Freezer
Frigidaire	FFTR1817LW	18.2	479	579.99	1269.75	Top Freezer
GE	GTH18GBDWW	18.1	383	599.99	1151.51	Top Freezer
Frigidaire	FFHT1817LS	18.2	383	729.99	1281.51	Top Freezer
Whirlpool	WRT311SFYW	21.3	519	799.99	1547.35	Top Freezer
Whirlpool	WRT371SZBF	21.1	364	999.99	1524.15	Top Freezer
Whirlpool	WRS325FDAW	25.4	544	1099.99	1883.35	Side-by-side
Samsung	RS265TDRS	25.5	502	1259.99	1982.87	Side-by-side

APPENDIX 17: ADDITIONAL PUGH CHARTS

Intuited:

Design Criteria	Weight	Current System: Energy Guide	Smartphone Application	Kiosk	Website w/ Redirection	Website w/ Pay Service	Browser Extension
User Friendly Interface	5	1	9	9	9	3	3
Minimal Learning Curve	4	1	-3	-3	-3	-3	-3
Ease of Cooperation with Manufacturers and Retailers	5	1	-1	-3	-1	-3	-1
Scalability of Service Offering	3	1	3	1	3	3	9
Profitability Potential	4	-1	1	1	3	3	1
Environmentally Sustainable	3	1	9	-1	9	9	9
Likelihood to Adopt by Consumers	3	1	1	1	3	3	1
Technical Difficulty	1	1	1	3	1	1	1
Amount of Information Conveyed	5	1	1	1	9	3	1
	Total	25	77	33	131	61	65

Environmental:

Design Criteria	Weight	Current System: Energy Guide	Smartphone Application	Kiosk	Website w/ Redirection	Website w/ Pay Service	Browser Extension
User Friendly Interface	1	1	3	9	3	3	3
Minimal Learning Curve	1	1	-3	-3	-3	-3	-3
Ease of Cooperation with Manufacturers and Retailers	1	1	-1	-3	-1	-3	-1
Scalability of Service Offering	1	1	3	1	3	3	9
Profitability Potential	1	-1	1	1	3	3	1
Environmentally Sustainable	5	1	9	-1	9	9	9
Likelihood to Adopt by Consumers	3	1	1	1	3	3	1
Technical Difficulty	1	1	1	3	1	1	1
Amount of Information Conveyed	4	1	1	1	9	3	1
	Total	16	56	10	96	70	62

Equal Weights:

Design Criteria	Weight	Current System: Energy Guide	Smartphone Application	Kiosk	Website w/ Redirection	Website w/ Pay Service	Browser Extension
User Friendly Interface	3	1	9	9	3	3	3
Minimal Learning Curve	3	1	-3	-3	-3	-3	-3
Ease of Cooperation with Manufacturers and Retailers	3	1	-1	-3	-1	-3	-1
Scalability of Service Offering	3	1	3	1	3	3	9
Profitability Potential	3	-1	1	1	3	3	1
Environmentally Sustainable	3	1	9	-1	9	9	9
Likelihood to Adopt by Consumers	3	1	1	1	3	3	1
Technical Difficulty	3	1	1	3	1	1	1
Amount of Information Conveyed	3	1	1	1	9	3	1
	Total	21	63	27	81	57	63

Business:

Design Criteria	Weight	Current System: Energy Guide	Smartphone Application	Kiosk	Website w/ Redirection	Website w/ Pay Service	Browser Extension
User Friendly Interface	1	1	9	9	9	3	3
Minimal Learning Curve	1	1	-3	-3	-3	-3	-3
Ease of Cooperation with Manufacturers and Retailers	3	1	-1	-3	-1	-3	-1
Scalability of Service Offering	4	1	3	1	3	3	9
Profitability Potential	5	-1	1	1	3	3	1
Environmentally Sustainable	1	1	3	-1	9	9	9
Likelihood to Adopt by Consumers	4	1	1	1	3	3	1
Technical Difficulty	1	1	1	3	1	1	1
Amount of Information Conveyed	1	1	1	1	9	3	1
	Total	11	29	13	61	43	53