

Design Issues

ECE 480 DESIGN TEAM 5

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The idea behind the Whirlpool Corporation Proximity Detection project is to reach all the customers with a futuristic design concept and improve their user experiences. This will be provided by utilizing the standby mode feature on Whirlpool home appliances for a power consumption less than one Watt. This design will present two different sensing systems for low-end and high-end appliances, while maintaining complete functionality of the appliances. To achieve this power efficiency demand, Design Team 5 selected various sensors to detect user presence in front of the appliance or in the same room as the appliance. While focusing on the energy efficiency issue, Design Team 5 also considered other design specifications that will be very significant for the product's lifespan. This paper discusses how the product design of Design Team 5 is sensitive to project lifecycle management (PLM), environmental issues, and universal design principles. The project lifecycle management phase will be explained starting from the project idea formulation and ending with the recycling of the product. Environmental issues are another criterion that is critical to this project. The purpose of this design is to build more environmentally friendly appliances by saving energy. Environmental issues will address how the operating detection system will contribute Whirlpool's eco-friendly production. As the third benchmark, universal design principles were specifically followed to give this sensing technology the flexibility to improve itself by integrating with other technologies. With this project, it is important how the design and development process has been conducted considering these three design issues aspects.

The project lifecycle refers to the series of stages that a project must go through in order to successfully achieve its goals or objectives. Proper management of a project's lifecycle is essential for its success. The stages of the product lifecycle include the design phase, production phase, distribution phase, consumption phase, and the retirement phase. Regardless of scope or complexity, every project goes through these stages, and Design Team 5's project is no exception. The project will last a few short months. However, with the average lifespan of home appliances being anywhere from ten to twenty years, for the Whirlpool Corporation this project

has important implications for years to come. Each stage of the development of a user proximity sensor for a Whirlpool appliance line has many issues that must be considered.

Some of the common issues that a team will encounter during the design phase of a project include delivery time, cost, and energy efficiency. Due to the nature of the project, Design Team 5 has paid close attention to cost and energy efficiency of the final product. The inflexible delivery date of Design Day has also been of utmost concern. Early on, a Gantt chart was made in order to keep the project on schedule. A common issue in the design phase is over-engineering of the product. This problem was experienced early on when attempting to design for all possibilities which led to a delay in final design choices. This delay caused Design Team 5 to miss some deadlines and thus the Gantt chart had to be revised. In order to meet the deadline with a successful project, Design Team 5 will have to strictly follow the updated Gantt chart.

The issues encountered during the production phase of a project include items such as production cost and quality. For Design Team 5, robustness of the final design has been identified as one of the top concerns of the corporate sponsor. Moving into the production phase, an area of improvement will be to test the design in “less than ideal” conditions. For example, sensors may function differently at different temperatures; this must be considered to make sure there are no adverse affects to the functionality of the overall design.

Issues in the distribution phase of a project consist of transportation cost and time, inventory, and sales network. These issues have not been taken into consideration because the designed product will be used within Whirlpool’s existing appliances. Because of this, many of the considerations of transportation and cost have already been taken into account by the company and should not be affected by the addition of the sensors.

Issues that must be considered for the consumption phase include maintenance, customer-training, upgrade options, and product lifetime. The

ultimate goal of the project is to improve energy efficiency while not affecting the customer experience. Therefore, before the final project is handed over, it must be made sure that a failure in the user sensing system will not result in a loss of functionality of the appliance. It is also expected that the life of the sensing unit will function throughout the lifespan of the appliance in which it is housed.

As the final stage of the project, retirement phase issues include recycling and reuse, product lifetime, and upgrade options. An area of improvement in this field would be more consideration about upgrade options for the sensor design as appliances are retired and are replaced by new technology. As concern about the environment increases, the retirement phase of a product have become an extremely important aspect of the overall design.

The drive to lower energy consumption and protect the environment has become a growing priority in consumers' minds. The main aspect of this project is to comply with the anticipated venture between the Environmental Protection Agency and the U.S. Department of Energy's ENERGY STAR requiring that home appliances must enter a standby mode and consume one watt of power or less. This has led Design Team 5 to integrate sensors for human proximity detection both in the same room as the Whirlpool appliance as well as directly in front of it. With the forthcoming developments of the so-called "smart" grid and "smart" homes, the end design presented will integrate neatly into a more intelligent, energy efficient future.

In 1992, ENERGY STAR was introduced as a voluntary labeling program to promote energy efficient products. It was a joint venture created by the U.S. Environmental Protection Agency and the U.S. Department of Energy. Corporations must follow strict energy efficiency guidelines in order to market their products as ENERGY STAR approved. As of October 30, 2009, ENERGY STAR has established that a display less than thirty inches diagonal, as possibly found on a high end refrigerator, must consume one Watt of power or less in OFF mode. This standard is anticipated to spread to the standby mode of home appliances. This will lower household energy costs as well as reduce green house gases. Indeed, if all displays

sold in the U.S. meet the new specification, the energy savings each year would be approximately \$1 billion and it would prevent the green house gas emissions equivalent to about fifteen million vehicles.

It is the overall goal of Design Team 5 to create a flexible application for home use that is environmentally friendly. By utilizing low power sensors, Design Team 5 has developed a method for human proximity detection that meets and may exceed the forthcoming ENERGY STAR standard. Essentially, with in-room devices such as a passive infrared sensor or an ultrasonic sensor, the homeowner can reduce greenhouse gases by allowing the sensor to control the appliance. If the user is not in the kitchen the sensor will not detect user presence and thus will direct the appliance to utilize a standby mode whereby the appliance will consume one Watt of power or less. Current appliances do not utilize a standby mode that consumes one Watt or less and thus displays and user interfaces increase the appliance energy consumption by two to five Watt-hours. Indeed it has been shown that a typical home in the United States requires close to fifty Watts of standby power. To drive appliance user interfaces down to one watt or less would significantly reduce this number. Take into account that there are roughly one hundred million homes in the United States; the standby consumption is equivalent to approximately five Gigawatts of power. Considering that the majority of America's energy comes from coal and natural gas, whereby the CO₂ emission for energy generation is about .9 kg CO₂/kWh and .5 kg CO₂/kWh, respectively, the cost of standby power is extraordinary.

It is inherent to Design Team 5 to not only create a robust and flexible option for reducing energy consumption, but also to be mindful of the future of America's households and energy needs. It is anticipated that the world's energy demands are expected to rise by about 60% by 2030. With the advent of smart homes that will put the homeowner in direct control of the power consumed by appliances in the house and the impending rise of worldwide energy consumption, the design proposed by Design Team 5 is ideal for future markets. It has the capability of being integrated into communication networks between appliances and will significantly

reduce power consumption by using a low-cost, low-power sensing method.

Although it is uncertain how the world will generate the majority of its energy in the future, it is clear the proposed design will contribute to the reduction of greenhouse gases and lead the way in creating an autonomous smart home.

Universal design principles have become increasingly important in the development of Whirlpool products. A key element in the design and selection of our proximity sensors was to ensure that they could be used to detect any person that appeared in the vicinity of the appliances. Along with this, the design also needed to be compatible with Whirlpool's appliances that were specifically intended for disabled persons. The project design has achieved both of these objectives. By using a passive infrared sensor combined with either an infrared or ultrasonic sensor, depending on the appliance, the ability to detect a person of any size while still filtering out almost all false alarms has been achieved. The sensors must be integrated with Whirlpool's proprietary software in order to allow the sensors to work with all Whirlpool products with minimal assimilation. The design limitations will be equal to the limitations of the appliance. Every person that is able to use the appliance will be able to use it with the sensors integrated with it.

A previous capstone project at Michigan State University worked with Whirlpool Corporation to develop appliances that could be used by people with sight limitations. The issue with the products was that blind people were unable to see the labels of buttons they were pressing, and they were also unable to see the LEDs that were lit up to indicate which mode the appliance was currently running. The appliances currently implemented with the sensors are also hindered with these restrictions. The solution of this previous project was to develop an audio source that announced which button the user was pressing so that he/she did not have to rely on the LEDs or the button labels. Combining this previous project with ours could enhance both projects for the blind by using universal design principles. After integrating the software of both projects, a small piece of initialization code that announces the current mode of the appliance as the user walks up to use the appliance can be added. This way the user do not have to press any buttons to

check the current mode, and the user interaction will be easier and more convenient.

Design Team 5 successfully met both universal design principles. The sensors will detect anybody who is in the same room as Whirlpool appliances, whether they are disabled or not. In this way, Design Team 5 will not cause any Whirlpool appliances to lose quality in universal accessibility. The sensors are also capable of being integrated with any Whirlpool appliance whether it is designed specifically for the disabled or not. By accomplishing this, the Design Team 5 design could potentially improve some Whirlpool appliances designed for the disabled by adding accessibility options to the product software that initiates when the person is about to use the appliance.

Although the most important aspect of a product is whether or not it accomplishes the task it is designated to perform, the design and implementation of the proximity detection system is performed by taking into account all three of the discussed design issues. Product lifecycle management will determine how much the product will be embraced by the consumers and how long its lifespan will be. It needs to ensure the integration of the product is feasible with the future. As mentioned, Whirlpool has been working on improving home appliances to make them more environmentally friendly for over thirty years. The intended use of this system needs to appeal to the entire scope of the customer profile. By investigating the universal compatibility of this proximity detection technology it is fair to say that this system will enhance any customer's experience. By integrating with other existing Whirlpool projects, it will elevate the product accessibility level. The design and development of this project fulfilled these three design issues and as Design Team 5 proceeds to the final stage of the project, the design can still be improved to deal with these issues.

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