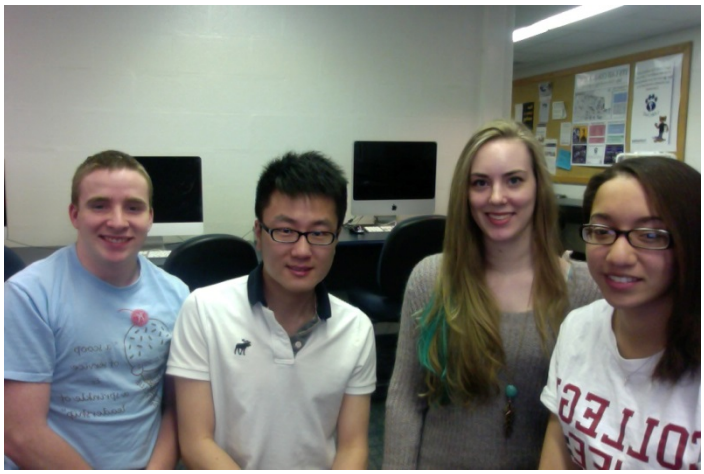
Sustainable Campus Project

EDSGN 100: Intro to Engineering Design

Section 16 Team 1



Sponsor: Siemens

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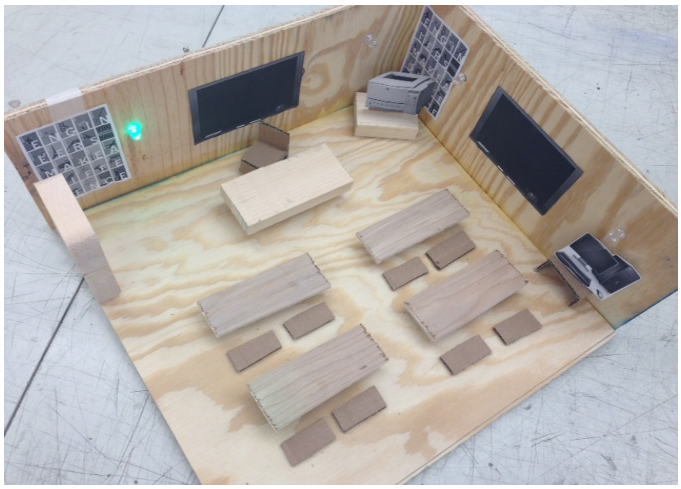

Spring 2013

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http://www.personal.psu.edu/dzg5206/s16t01_sp13_edsgn100.pdf

Abstract

In this report, there are several pages that describe the idea of an energy conservation school. This prototype was created as an energy-efficient classroom model. It mainly concentrated in electrical energy wasting within the scope of public places. More details about the design can be found on the following pages.

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Introduction

Electrical Energy wasting is a very common trouble that most families, firms, factories or any other public places are facing in nowadays. In those public places, there are always unnecessary electric appliances running, such as lights, fans, air conditions. Such a waste of energy seems inevitable. But in fact, it can.

"Lights Off" is a motion sensor that can distinguish motion direction, body shape of the object and it can count individuals. It can work individually or by group. Depend on the number of the doors in the target room. It counts "+1" when a person comes inside the room, and "-1" when a person left the room. As long as it gets "0", "Lights Off" will cut off the power supply for those unnecessary electric appliances, like lights. But it will still connect the power supply for these appliances that needs power all the time, such as computers or refrigerators.

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Description of Design Task

Problem Statement:

Penn State's University Park campus is a small city with little to none sustainability. Each year a great amount of electricity is used throughout campus. The cost of Penn State's electric bill alone is $17,409,222. It is imperative that a concept is designed to help lower the amount of electricity used throughout campus.

Mission Statement:

Using the research gathered on the concept of Sustainable Cities, the team will design a product that is energy efficient and will lower the amount of electricity used on campus.

Design Specifications:

- Fit in the guidelines of sustainability
- Cost and energy efficient
- Lower's the campus's electric bill
- Easy to implement throughout the campus

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Design Process/Approach- Design Matrix

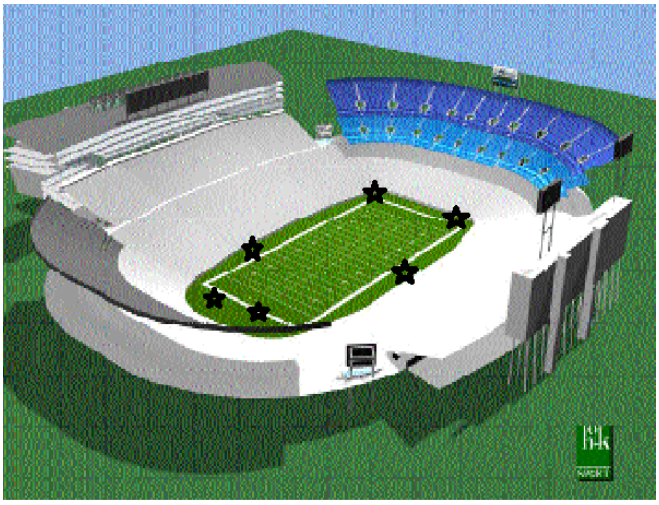
Project Management

Table 1: Gantt Chart

Task	3/11/2013	3/18/2013	3/25/2013	4/1/2013	4/8/2013	4/10/2013	4/15/2013	4/17/2013
Brainstorming								
Customer Needs Assesment								
Research								
Concept Selection								
Working Drawings								
Prototype								
Presentation								
Final Finishes								

Concept Generation – Brainstorming

1) Use sound to power the campus.



Place microphones at stars, convert soundwaves to energy

FIG. 1 Microphones in Beaver Stadium

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2) Begin a recycling program to take care of the large amount of water that is used on campus.

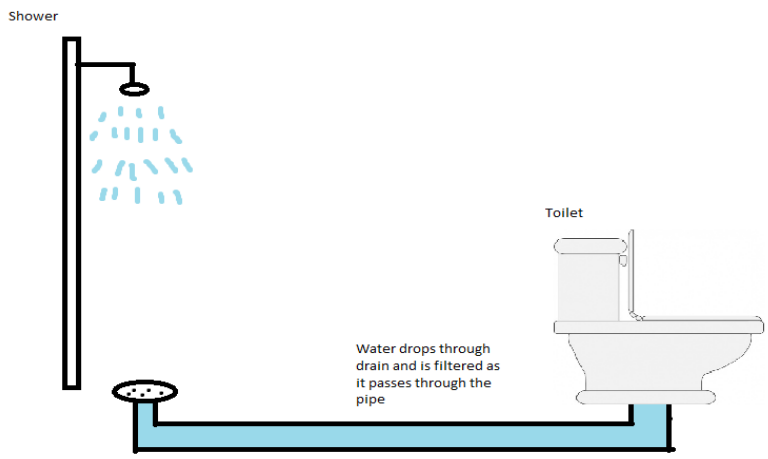

FIG. 2: Water Recycling

3) Change CATA bus's which currently use natural gas to a renewable form of energy.

4) Develop a program to change the university waste into energy.

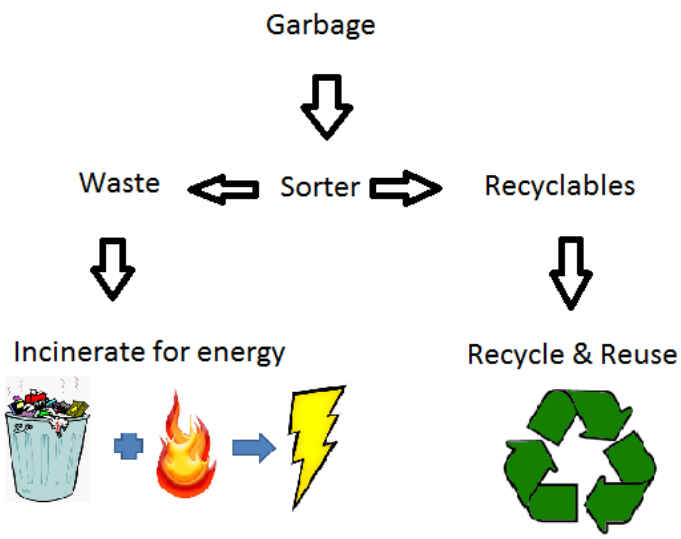

FIG. 3: Waste to Energy

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5) Encourage recycling through putting point values on recycling. These points would be counted by the recycling bins after a student id was swiped his or her PSU ID card in the bin and then dropped their recyclables in. After obtaining a certain amount of points, the students would receive some sort of inexpensive university supplied prize.

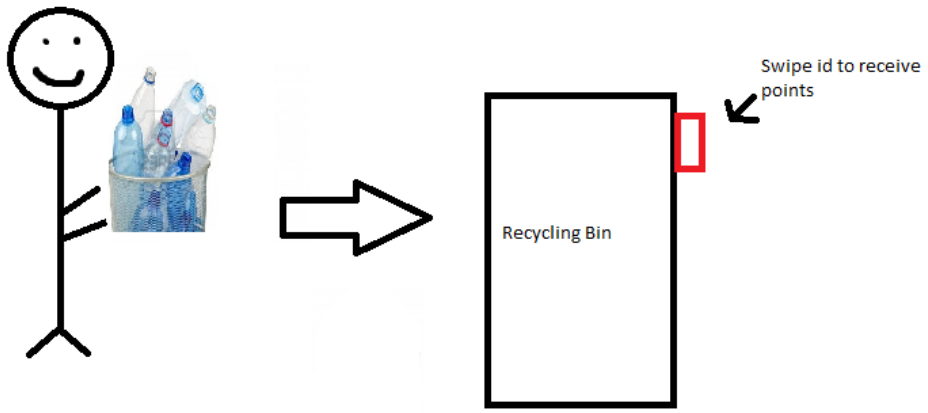

FIG. 4: Earn points for recycling

6) Sophisticated motion sensors that will accurately count how many people are in the classroom and thus turn on the lights and other electrical things as people enter the room. When the counter reaches zero, as people leave the room, the lights will turn off along with all other devices deemed unnecessary to be on when no one is in the classroom.

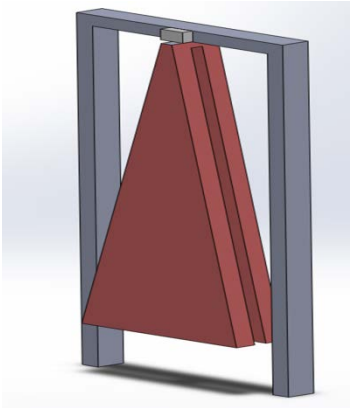

FIG. 5: Motion Sensor

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Design Idea/Concept Selection – Design Matrix

To determine which project idea was the best Team 1 chose to analyze the factors of cost, efficiency, need, public health and safety, environmental impact, ease of manufacture, and feasibility. These seven factors were determined to be those of the most value and contained the most difference between the ideas.

Table 2: Design Matrix

Factor	Sound Power	Water Recycling	CATA Power	Waste Energy	Recycling Points	Power Saver
Cost	-	0	0	-	0	0
Efficiency	+	+	0	+	0	+
Need	0	0	-	0	0	0
Public Health/ Saftey	0	0	+	0	0	0
Environemntal impact	0	0	+	0	+	+
Ease of Manufacture	-	-	0	-	0	+
Feasability	-	0	-	-	+	+
total -	-3	-1	-2	-3	-1	0
total +	2	1	2	1	2	4
Total	1	0	0	-2	1	4
Rank	5	2	2	6	5	1

Table 3 Weighted Design Matrix

Factor Weight	Factor	Sound Power	Water Recycling	CATA Power	Waste Energy	Recycling Points	Power Saver
0.2	Cost	2	3	3	2	3	3
0.05	Efficiency	4	4	3	4	3	4
0.2	Need	3	3	2	3	3	3
0.05	Public Health/ Saftey	3	3	4	3	3	3
0.05	Environemntal impact	3	3	4	3	4	4
0.05	Ease of Manufacture	2	2	3	2	3	4
0.3	Feasability	2	3	2	2	4	4
	Total	2.2	2.7	2.3	2.2	3.05	3.15
	Rank	5	3	4	5	2	1

Description of the Best Design Selected

The design that we have chosen involves sophisticated motion sensors that will accurately count how many people are in the classroom and thus turn on the lights and other electrical components as people enter the room. When the counter reaches zero, as people leave the room, the lights will turn off along with all other devices deemed unnecessary to be on when no one is in the classroom. These motion sensors will be placed in classrooms all over campus. They will eliminate a part of PSU's power bill, which is currently completely wasted.

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Prototype/ Model

Scale: 1”:3’

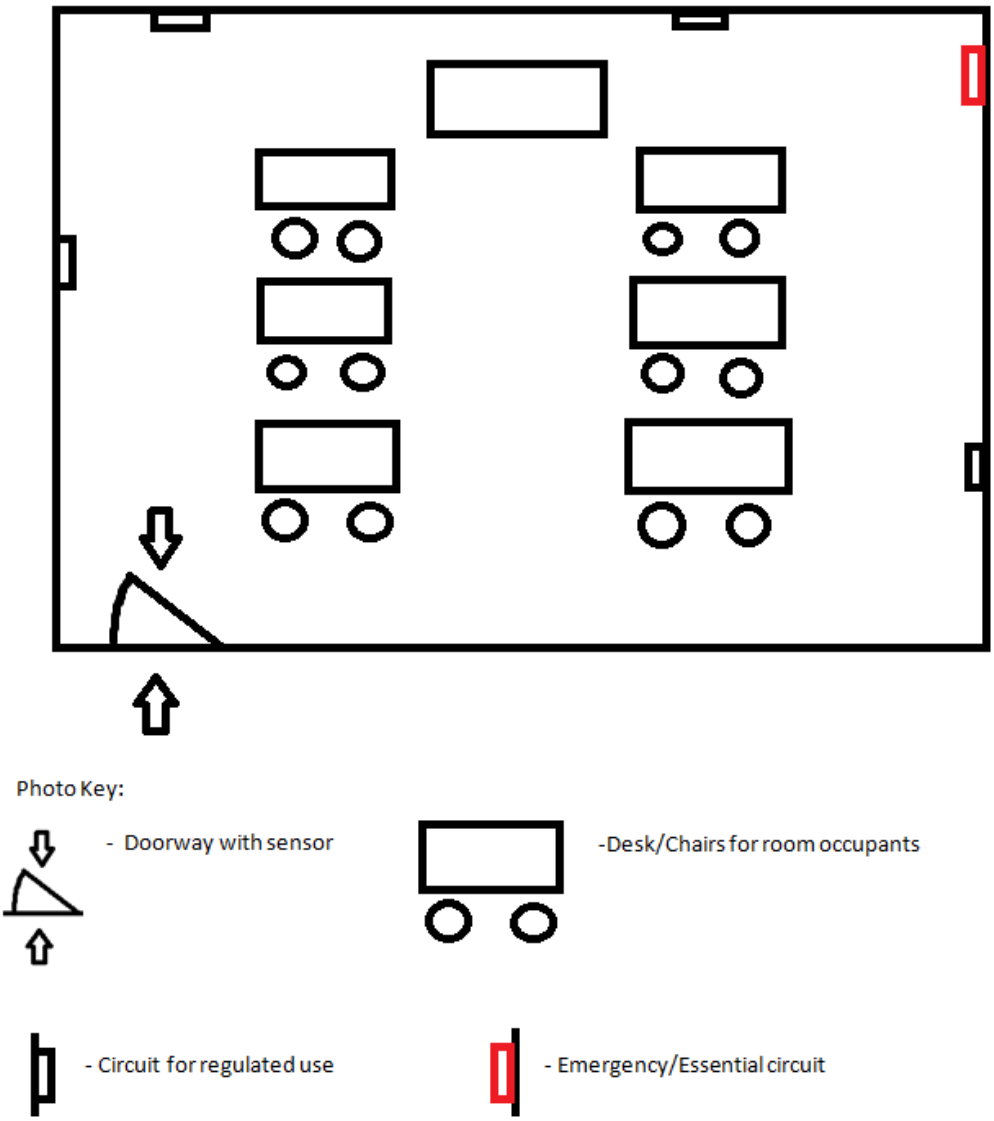

FIG. 5: Image of Sample Classroom

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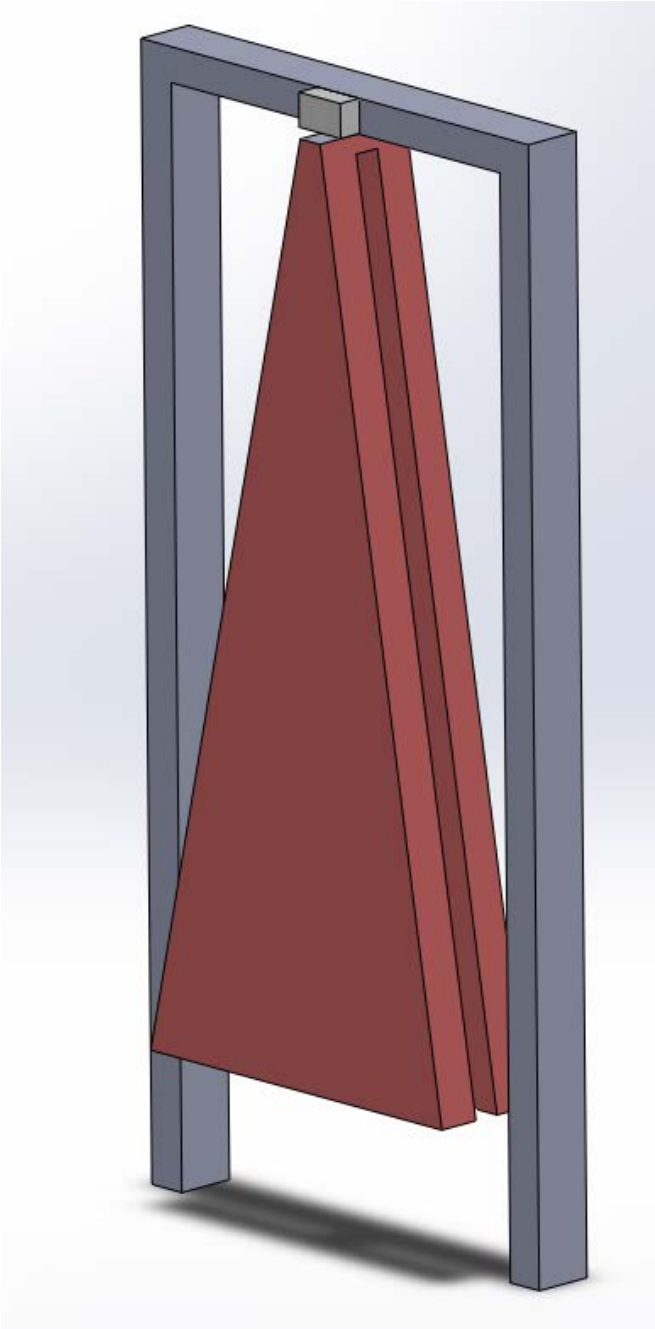
FIG. 6: Image of Sample Sensor



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Engineering Analysis including cost analysis

Working Mechanism:

The occupancy counter relies on several key components, however an integral part of the system is the sensor chosen for each doorway. For this case, a multi-beam sensor is used in order to detect three dimensions. This allows the sensor to determine how many people are passing through the doorway, as well as the direction they are travelling in. The sensor is also able to determine if the object passing through the doorway is in fact human. This data is then processed and submitted to a program integrated throughout campus, which calculates and records the occupancy of each room. However, machines do have hiccups and thus an override function is available in order for a supervisor to remotely set the occupancy of a problematic room.

Cost Analysis:

Most of the cost of this project comes with the initial material purchase and installation. The cost of each sensor is between $15 and $20; however a bulk deal could possibly be made due to the extremely large amount of sensors needed for Penn State's 100+ buildings. Installation can be completed quickly, and the sensors require very little maintenance over time if any. After installation is complete, the only cost would be the miniscule cost of electricity per sensor and any wage paid to a supervisor monitoring the rooms.

The cost of this system could be reduced by using lower grade sensors; however this would result in many more glitches in rooms and could therefore lead to need of additional supervisors. This would counteract the savings of using cheaper sensors and therefore is an inefficient alternative. Money could also be saved by eliminating supervisors and instead creating an automated telephone line that students/faculty could call if there is a problem in a room. This reduces the cost over time greatly, but compromises the satisfaction of the room's occupants.

The best way to test alternatives of this system would be to begin by installing the system into a small number of rooms on campus and testing each method. Only then could accurate measurements of costs and savings could be made.

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Summary and conclusions

In conclusion, the final design was chosen because it was energy efficient, affordable, and simple to implement throughout campus. When choosing which design to use, an important factor was that it would be affordable for the university to invest in. Also, the design needed to fit in the guidelines of sustainability. The team thus decided to go with the “Lights Off” design because it best fit these specifications.

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Attachment of the PowerPoint Presentation Slides

PowerPoint

Attachment of the tri-fold brochure

Brochure

Acknowledgements

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