Analysis 3: Building Automotive Systems & Wireless Controls

About BAS Systems & Wireless Controls

Building Automotive Systems have become very common in commercial construction. BAS systems have the ability to limit water and electrical consumption by shutting off these systems when they aren't in use. With the use of motion sensors unoccupied rooms and hallways will no longer consume unnecessary energy.

Wireless controls can be used for virtually any on off switch. The way it works is with the press of the switch or possibly a key card swipe a small amount of energy transmits a signal to a receiver allowing wireless control. The use of wireless controls allows the owner to have full control of the entire building from one location.

Applications of BAS systems & Wireless Controls

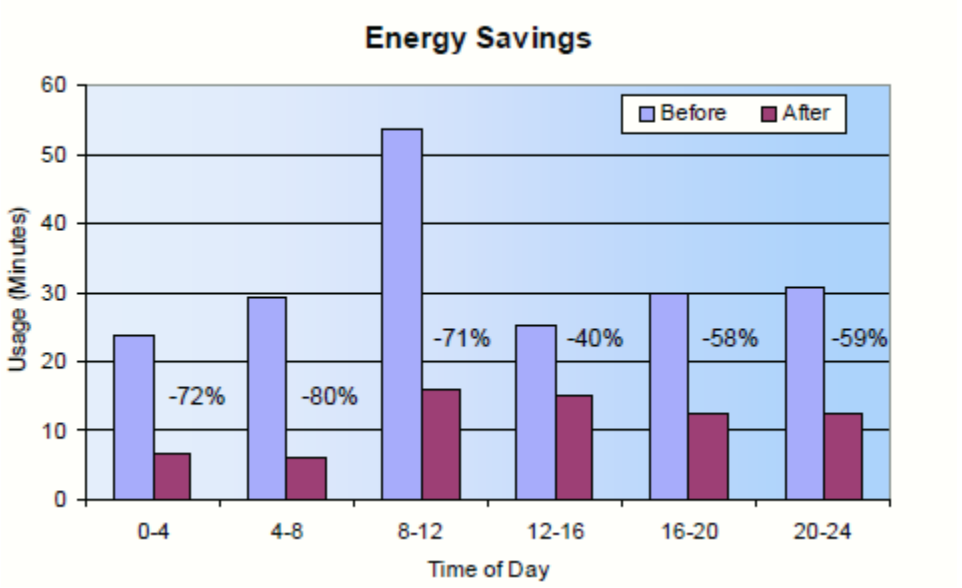
For this hotel project I intend to substitute all bathroom light switches with motion sensor/night light combination switches, and all the hotel HVAC units with upgraded units that can be controlled by occupancy sensors. In addition the second and third floor hallway lights will be scheduled to become motion censored between the hours of 11pm and 6am, to eliminate the need for lit hallways when they are unoccupied.

The BAS and Wireless products will be acquired from Prolighting, Lutron, and Watt Stoppers Inc. due to their experience with hotels and their fair pricing.

Bathroom Motion Sensor Nightlight Switch Analysis

In hotel units the most abused energy consumption comes from the bathroom lighting. A report by the Lawrence Berkeley National Laboratory said, it was estimated that 40% of hotel guests use the bathroom light as a nightlight. In addition, 75% of the fixtures energy usage occurs when the

fixture is on for more than two hours, usually overnight or during guest vacancy. The solution is to combine an appeal to the guests needs while reducing unnecessary energy consumption. This combination switch not only shuts the lighting system off when vacant it also serves as a nightlight for guests comfort. Surveys have been done to ensure that the nightlight on the switch is an acceptable substitute for leaving the bathroom light on. Below is a graph taken from the Lawrence Berkeley National Laboratory research which shows typical bathroom light use before and after the installation of the motion sensor nightlight switch.



The graph explains that typically, the bathroom fixtures are on for about (190min/day)/unit compared to (68min/day)/unit with the motion sensor nightlight switch. This is an energy savings of about 64% in each hotel bathroom unit. Now I must determine the difference in initial cost and the annual energy savings from this implementation on my particular project. Labor will not be compared nor will schedule time because the new switch has the same installation costs and rates as a typical light switch making it a negligible analysis.

Cost Analysis

The cost of the WN-100 Motion Sensor Nightlight switches are $38/each when bought in bulk and a typical switch runs about $16-20/each. So taking an average we can see that the new switches will cost about $20 more per unit. So with 49 new hotel units we can tell that the initial budget will be increased by about $980, which is hardly noticeable in a project of this magnitude.

Energy Efficiency Analysis: Electrical Breadth

To determine the energy savings from this implementation, the Holiday Inn Expresses lighting type and electricity cost must be used to get a result that's personal to this project. The lighting in each bathroom consists of three 100W incandescent light bulbs. The calculations below will explain the energy savings per year.

$$3(100W) * \left(\frac{190min}{\frac{60min}{hr}}\right) * \frac{365days}{year} = 346.8kWh/year$$

$$346.8kWh/year * \frac{\$0.13}{kWh} * 49units = \$2{,}210/year$$

Two 100W light bulbs running for (190min/day)/unit will use 346.8kWh/year. With the new switches implemented in all 49 units the owner will have a savings of $2,210/year which isn't much now, but will add up to be big savings as energy cost increases.

Payback

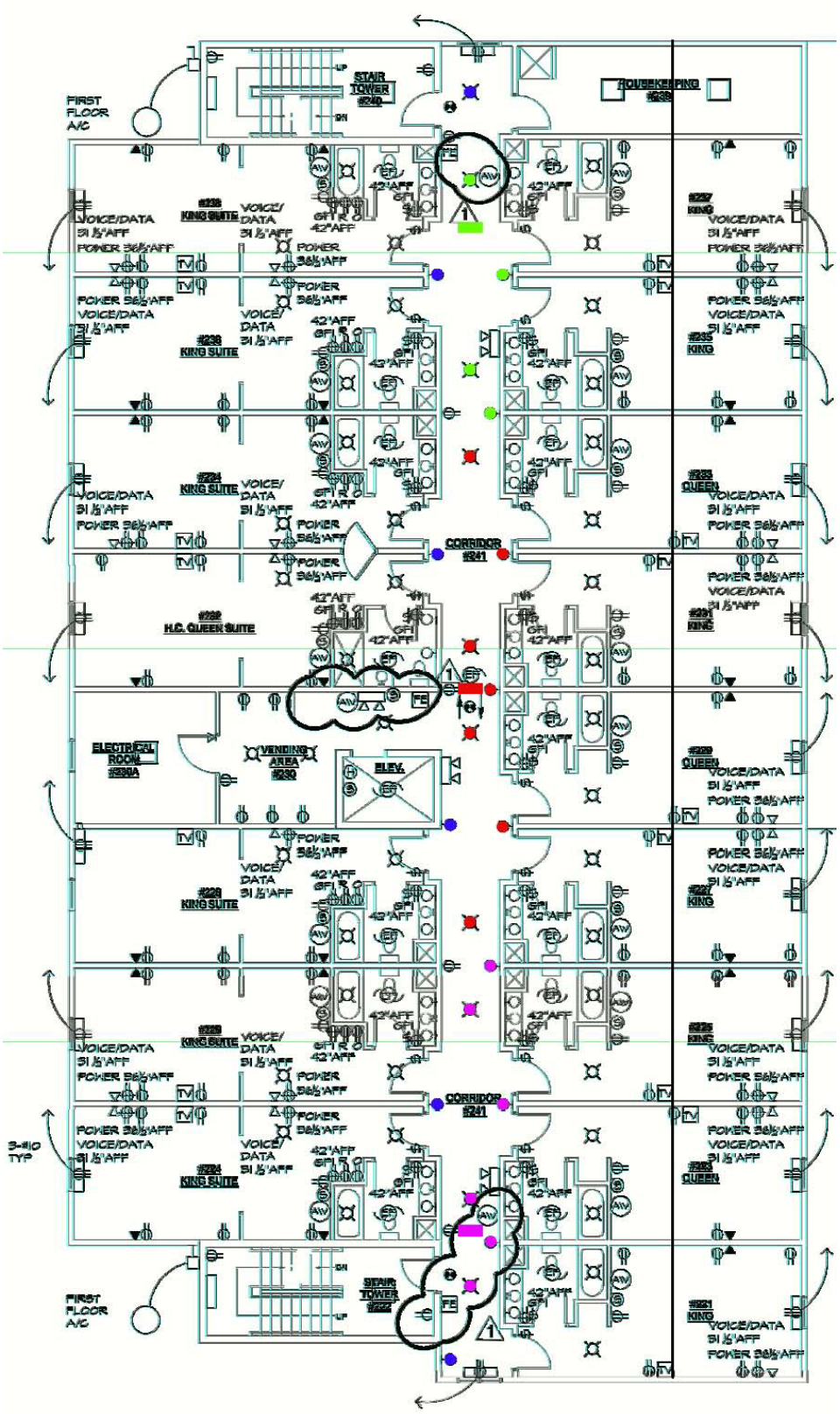
The initial cost increase is only $980, so with an average savings of $2,210/year we can see that the owner will be repaid for his investments in about .5 years. With that being said this investment is very practical. Also, the new switches reduce maintenance and operation cost by 33% due to increased length of light bulb life. However, this savings is a negligible amount.

Hallway Motion Sensor Analysis

In a typical hotel building hallway lights are left on at all times to allow guests to safely find their way through the building at anytime and to provide lighting in case of necessary emergency evacuation. However, these lights are useless outside of these few instances. Therefore, I believe the owner would benefit greatly by having these lights activated by motion sensors between the hours of 11PM and 6AM when most guests are sleeping. In order to do this, three RAB LOS2400H Smart Hallway Sensors will be installed on both the second and third floors. These sensors will control the entire hallway lighting except a few lights which will remain on continuously incase of severe emergencies.

Design Layout

The RAB LOS2400H Smart Hallway Sensors have a 16' x 80' maximum viewing range and can control 2400 Watts of lighting per sensor. Since the length of the hallway is 123' we must evenly separate the sensors to gain full coverage. Starting with the one sensor in the center of the hallway, and offsetting the other two sensors 46' on either side we can ensure full coverage. The reason I am using three sensors and not two is because walls and other objects can decrease viewing range, so to be safe an additional sensor was used. Also the reason the side sensors are closer to the end of the hallways than they are to the center sensor is because their viewing path is also decreased by the end of the hallways. The sensors will be ceiling mounted at 8'-8" to try and gain the greatest viewing range. Below is a layout of the motion sensors. The blue circle lights indicate those which will be left on continuously for emergency purposes. The rest of the lights will be color coded to match the sensors that trigger them. Sensors are designated by colored rectangles.


FIRST FLOOR A/C
STAIR TOWER #240
HOUSEKEEPING #238
#238 KING SUITE
#237 KING
#236 KING SUITE
#235 KING
#234 KING SUITE
#233 QUEEN
CORRIDOR #241
#232 H.C. QUEEN SUITE
#231 KING
ELECTRICAL ROOM #230A
VENDING AREA #230
ELEV.
#229 QUEEN
#228 KING SUITE
#227 KING
#226 KING SUITE
#225 KING
#224 KING SUITE
#223 QUEEN
CORRIDOR #241
3-#10 TYP
STAIR TOWER #222
#221 KING
VOICE/DATA 3/4"AFF
POWER 36"AFF
42"AFF GFI

	Bulb Quantity/Floor	Bulb Type
Green Sensor 1	4	100W Incandescent
Red Sensor 2	7	100W Incandescent
Magenta Sensor 3	6	100W Incandescent
Continuous Blue	6	100W Incandescent

Cost Analysis

Each sensor costs $139 for a total cost of $834 for all 6 sensors. Since relays and sensors are all in one in this product installation cost is low. Also the system is wireless which also keeps installation cost down. Since it will only take about 30min to install each unit, a total of 3hrs. We can assume that at a standard electrician rate of $60/hr the labor will cost about $180. This makes the total initial cost $1,014 for products and installation.

Energy Efficiency Analysis: Electrical Breadth

For this analysis I am going to assume that between the hours of 11PM and 6AM, a maximum of 1 hour of operation will be necessary for hallway lighting with the implementation of the motion sensors. This leaves us with 6hrs of energy savings. The calculations below explain the annual energy consumption before and after the motion sensor implementation.

Before
23(100W) * (2 Floors) * (24hrs) * (365 days) = 40,296 kWh/year

After
[6(100W) * (2 Floors) * (24hrs) * (365 days)] + [17(100W) * (2 Floors) * (18hrs) * (365 days)] = 32,850 kWh/year

With the motion sensors the owner will be able to save 7,446 kWh/year, which is a cost savings of $968 annually.

Payback

With an initial cost of $1,014 and an annual savings of $968 we can see that the owner shall make up for his investment in just over 1 year. Again this is not great deal of savings but it is still practical and it is always good to reduce energy consumption in a sustainable era.

Motion Sensor Package Terminal Air Conditioner Analysis

In the background section under the building system summary it is noted that each hotel unit will have a 9000 BTU Amana PTAC unit for individual heating and cooling. For an additional $60/unit the owner can substitute this unit for the DigiSmart version of the same unit. The difference here is that a wireless occupancy sensor can be connected to the heater to return the room to set temperature when the room is vacant. The occupancy sensors run about$109/unit. Using this upgraded PTAC system typically results in a 35% reduction in heating and cooling loads. Specs for these two products can be seen in Appendix D Figure 1.

Cost Analysis

The budget will initially increase $169/room to make this change in HVAC systems. Therefore, the total cost of implementing the new system is $8,291. Labor is negligible because the DigiSmart system is installed the same as the original system and the occupancy sensors are wireless running off 2 AAA batteries which makes their installation extremely simple and quick.

Energy Efficiency Analysis: Mechanical Breadth

With the help of the PTAC energy calculator I was able to determine that for my location in south Jersey the typical 9000 BTU PTAC unit will use approximately 4,400 kWh/year. The occupancy sensor 9000 BTU PTAC unit will use approximately 3,000 kWh/year. The calculations below explain the annual energy consumption for both units and the overall annual cost.

Original PTAC Unit
(4,400 kWh/year) * (49 units) = 215,600 kWh/year

(215,600 kWh/year) * ($0.13/kWh) = $28,028/year

DigiSmart PTAC Unit
(3,000 kWh/year) * (49 units) = 147,000 kWh/year

(147,000 kWh/year) * ($0.13/kWh) = $19,110/year

The substitution in HVAC units resulted in an $8,918/year savings. In addition we can see that the new system is about 32% more efficient than the original.

Payback

The initial cost increase was $8,291 and the savings per year was $8,918. We can see that the payback period for the implementation of motion sensor PTAC units is just less than 1 year, making this a practical move by the owner.