Lighting and HVAC Modifications
Riverbend 1 Office Building
Fort Worth, Texas

Reduction in the Costs of Operation through Energy Management and Efficiency

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Introduction

Will replacing old and inefficient lighting and HVAC systems impact a building's overall Cost of Ownership, Operation, and Energy Efficiency?

- **A path for an Integrated Energy Strategy.**

  Energy is one of the top five operating costs for most businesses. Whether the building is a large or small consumer of energy, it's imperative owner's implement an energy management strategy. Programs are employed to reduce operating expenses, which, in turn, increases net operating income (NOI) and asset value. Major capital allocation decisions are based on financial metrics like return on investment (ROI) and net present value (NPV).

- **Steps on the Path.**

  The journey begins by evaluating the systems consuming the most energy on a daily basis - lighting and environmental systems. Then develop an action plan to manage the assets required for modifications and understanding the Return on Investment - ROI.

This Case Study investigates the Owner's concerns with the effects of the old lighting and HVAC Systems on the overall monthly utility costs, the overall Cost of Operation and Ownership, overall comfort in the building, and security.

Introduction

Opened in the mid-1980s as one of two planned buildings, Riverbend 1 Office Building has two floors, approximately 15, 000 SF each. The second building was not constructed.

A simple, inexpensive general lighting design:

- Interior Suspended Ceilings - 2'x4' recessed florescent 4-bulb fixtures for the interior and HID recessed can-lights for the lobby ceiling - Figure 1.
- Exterior building lighting - 8" recessed soffit fixtures with metal halide bulbs;
  - Parking lot lighting - Pole lights with high-pressure sodium fixtures.

A simple, inexpensive HVAC System:

- Two Roof-Top Unit (RTU) air handlers, one for each floor. Each 50 tons capacity.
- Floor air distribution - an approximate total of 41 Fan Powered Variable Air Volume (FPVAV) and 4 VAV air terminal units (ATUs).
- Each ATU is controlled with an individual thermostat. No system controls or Building Automation System (BAS).

With the exception of new RTUs replaced in 2012 with a new roof membrane, the current owners purchased the building in 2015 with all the original systems and equipment.

Figure 1 – Florescent Light

Figure 2– Old VAV ATU

Goal and Objectives

Problem

- The owners group first building, it was important to understand the overall existing condition of all aspects of the operating
- An extensive survey report issued to the owners focused in the following four topics:
  - Topic One - The building's energy efficiency and management.
  - Topic Two - The building's deferred maintenance.
  - Topic Three - The overall site (grounds) deferred maintenance.
  - Topic Four - Tenant services.
- Topic One is the subject of this case study.

Project Goals

- Goal One - Reduce the building's overall consumption of electrical lighting energy.
- Goal Two - Reduce the building's overall consumption of electrical service energy.
- Goal Three - Reduce the overall energy consumption of the Heating, Ventilation and Air Condoning System (HVAC).
- Goal Four - Implement an overall Operation Energy Management Program.

Objectives

- Implement an energy efficient lighting system, phasing plan, and budget.
- Implement an HVAC Modification Plan with a BAS, phasing plan and budget.
- Conduct the work in a manner minimizing disruption of the tenant's business operations.

Parameters

❑ Phase Implementation

- ❍ Lighting
  - ❖ Phase 1 - Fall of 2015 - Installation of new site parking lot lighting.
  - ❖ Phase 2 - Spring of 2016 - Installation of the new building perimeter soffit lighting and close abandoned openings.
  - ❖ Phase 3 - Spring through Summer of 2016 - Installation of new recessed ceiling light fixtures and bulbs.
- ❍ HVAC System
  - ❖ Phase 1 - Summer 2017 - Installation of the building HVAC Control System (BAS) with global controllers.
  - ❖ Phase 2 - Summer 2019 - First of three phase on the second floor to replace 24 ATUs.
    - ✻ Summer of 2020 - Eight ATUs remain to install. No ATUs installed on the ground floor.

❑ Project Conditions

- ❍ Lighting
  - ❖ Phase 1 and Phase 2 - General coordination with the building manager.
  - ❖ Phase 3 - When work began, the building was 90% occupied. Inside installations were scheduled on weekends and after hours. Clean-up required at the end of every work session.
- ❍ HVAC System
  - ❖ Work in the occupied suits was conducted on weekends and after hours. The remaining units were installed in vacant suites during tenant transitions.
  - ❖ Controllers installed on the old ATUs during HVAC Phase 1, were removed and reinstalled on the new ATUs.

Parameters

❑ Project Materials

- Lighting Systems
  - Phase 1 - New LED fixtures replaced existing Metal Halide fixtures and the addition of three new poles - Figure 3.
    - Nine 200 watt fixtures on poles.
  - Phase 2 - New LED fixtures replaced the Incandescent and Metal Halide fixtures for the building perimeter fixtures.
    - Sixteen ten (10) watt fixtures
  - Phase 3 - New LED fixtures replaced the 2'x4' four bulb florescent fixtures for the building fixtures.
    - Two hundred twenty (40) watt fixtures.
- HVAC Systems
  - Phase 1 - New Building Automated System (BAS)
    - RTUs - Augment the manufacturer’s controls.
    - Removed the old pneumatic system from each ATU and install digital remote control system.
  - Phase 2 - Replace the old, broken, and outdated ATUs with new, energy efficient systems with digital controls.
    - Modifications to the existing duct-board ductwork and replace the old supply and return air grilles.

Figure 3 – New Pole and Lights

Figure 4 – New 2’x2’ LED Fixtures

Parameters

❑ Project Criteria

- ❍ The building, situated on the North bank of Mosier Lake, a reservoir for storm water and ski lake, experiences micro heating and cooling differences associate with a water body.
  - ❖ The East side is shaded by trees as tall as the building.
  - ❖ The South side is exposed to the lake.
  - ❖ The West side is affected by the lake and exposed to the concrete parking lot.
  - ❖ The North side is affected by landscape surfaces and affected by the concrete parking lot.
- ❍ The majority of the building’s facade is a single glaze bronze glass curtain wall.
- ❍ Upgrading the HVAC system required redesigning the equipment (ATUs) sizes for the various site condition effects on the building's exterior glass walls.
  - ❖ During the Fall, Winter, and Spring months, the Westside experiences heat gain due to the low sun angles. Portions of the building exposed to the parking lot require cooling, while the Eastside, shaded by the trees, and minimal direct sun, require heating.

Figure 5 – Front of Riverbend 1

Figure 6 – New FPVAV ATU

Solutions

- **Lighting**
  - An estimated Return on Investment (ROI) demonstrated a pay-back of two years. Ten weeks into the replacement phase, the Owner's monthly electric bill showed a reduction of approximately **$15,000.00.** The overall ROI balanced in five months.

LIGHTING PERFORMANCE COMPARISON

PHASE	DESCRIPTION	FIXTURE DESCRIPTION	WATTS PER BULB	QUANTITY	LUMENS PER WATT	KELVIN TEMPERATURE	CRI	LIFE SPAN HOURS	PERCENTAGE EFFICIENCY
1	New site parking lot lighting	**LED - New**	**200**	**9**	**132**	**4000**	**74**	**100,000**	**95-98**
		Metal Halide - Old	250	9	82	3000	65	7,500	55[1]
2	Perimeter Soffit Lights	**LED - New**	**10**	**16**	**146**	**5000**	**84**	**100,000**	**74**
		Metal Halide - Old	100	16	85	3000	75	10,000	55[1]
3	2'x2' Interior Ceiling Lights	**LED - New**	**40**	**180**	**146**	**4000**	**90**	**50,000**	**90-95**
	2'x4' Interior Ceiling Lights (4 per fixture)	Florescent - Old	4x32=128	200	92	3000	75	10,000	55[1]

Notes
1. Approximately 55% efficiency after one year, diminishing each subsequent year.

Solutions

- **HVAC Systems**
  - Phase 1 - New Building Automated System (BAS)
    - Tenant comfort levels were barely attainable season to season because the RTU fans were set manually.
    - The new Building Automation System (BAS) provides digital control over fans and additional electrical energy savings. The fan operations now moved into a demand mode according to temperature and set-points for the air-static levels.
    - The BAS is a powerful tool for building managers to utilize to make changes to their HVAC systems. Optimization of the HVAC system is automated by personnel off-site.
  - Phase 2 - Replace the Air Terminal Units (ATUs).
    - Original to the building's construction, all the ATU's had various operation levels from not-at-all to operate without controlling the intake air damper. The supplemental heat strips, for many units, did not work or were missing. The units with working heat strips had no control of the internal fan. Heating was accomplished by diverting warm air from the building's interior zones to the exterior zones.
    - Replacement phases were establishes by grouping ATUs to related suites always completing the suite before the next sub-group of a phase. Each floor comprised three groups. Each group divided into three to five ATUs.
    - Comfort levels of the suites with new systems improved over several days. Initial savings of electrical energy moderated during the first winter because the supplemental electric heat strips warming previously cold areas.

Solution - Observations

❑ Lighting

- Pros and Cons abound any product and depending on those espousing the information, bias can skew either position. LED lights have more pros than cons and depending on the specific use, the cons diminish.
- The savings of electrical energy was almost 60%.
- Greatly improved is the overall quality of light in and outside the building.
- A second benefit is the small amount of heat generated by the fixtures thus reducing the overall cooling load. For this project this project the LED change reduced lighting heat load approximately 70%.

❑ HVAC

- Comfort - Improved balanced air flow and temperature control provided even heating and cooling along the perimeter glass curtain walls (exterior zones) controlling temperature drift into the interior zones. Also of benefit is the improved overall humidity control across the zones.
- Air Flow - The BAS controllers for each ATU operate the damper and vary the speed internal fan motors (during the heating seasons) ensuring air flow at the perfect level throughout the suite. Varying the fan speed increases the static pressures in the ducts, resulting in appropriate volume of air at each register.
    - ❖ Along with better air flow, varying the fan speeds help operation at energy efficient levels. This action creates the concept of an ‘Economizer Cycle” allowing ATU internal fans to run year round, filtering the air constantly without a major jump in the power bills. This ideas also mixes the air from the exterior zones with the air of the interior zones reducing the zone’s additional heating and cooling energy. Better air flow means more comfortable temperatures in every room, which helps keep the air healthier as well.

Summary

Will replacing old and inefficient lighting and HVAC systems impact a building's overall Cost of Ownership, Operation, and Energy Efficiency?

- YES

- Buildings Owners and Managers association International (BOMA)
  - **BEEP (BOMA Energy Efficiency Program)**
    - Educates its members to understand how **energy** is generated and used in their buildings, how to recognize the potential impact of **energy efficiency on the building's financial and environmental performance**, and "what's important" to financial decision-makers.
  - **BOMA's 360 Performance Program**
    - **Building operations and management**
    - Training and education
    - **Environmental/sustainability**
    - Life safety, security and risk management
    - **Energy**
    - Tenant relations/community involvement
  - BOMA has two programs to educate its members the importance of these concepts and values.