1.0 Introduction

1.1 Scope

This report represents the culmination of a student designer's five year professional education in the field of Architectural Engineering. The focus of this study lies in the design of an energy efficient mechanical system. However, other building systems have been affected by the design and they have been addressed and analyzed as well.

The building analyzed in this study is a 45,000 sf LA Fitness exercise facility located in Houston, Texas. Design documents for this building were obtained, studied, and critically analyzed over an eight month time period.

It should be noted that the findings of this report are specific to the initial constraints of building size, function, and location among other factors. It is not the intent of the designer to generalize the findings of this report to other building projects without a similar thorough analysis being conducted.

1.2 Design Objectives

The designer set out to achieve four goals over the course of the study. The three design goals to be achieved were energy conservation, cost reduction, and reduced emissions. The final goal that was set was to gain practical experience designing mechanical systems.

Energy conservation is absolutely critical. The United States Energy Information Administration's (EIA) most recent report shows that approximately 72% of the energy in the country goes to buildings as an end-user.

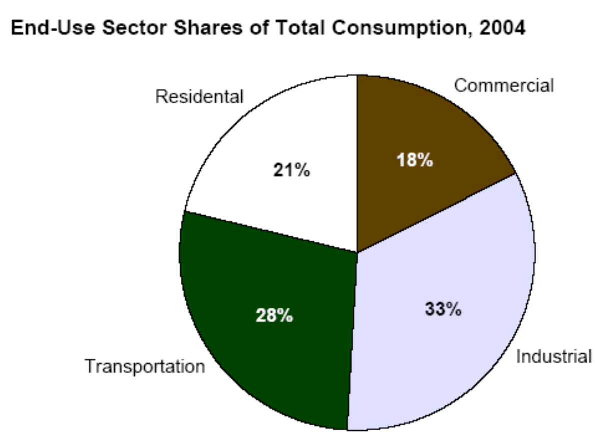

Figure 1.1 – 2004 EIA Reported Energy Consumption by Sector

With this fact in mind, finding and implementing more energy efficient systems should be a major focus of any good mechanical design. If the reduction of fossil fuel sources and the increase of energy consumption are not motivators to drive energy conservation, the resulting price increases will be.

Cost drives decisions. It is this simple unavoidable fact that keeps designers searching for lower cost design alternatives. An economic analysis is included for each of the systems being compared. An effort was made to lower the life cycle cost of the design. For many owners, first cost is the biggest factor. With this in mind, a special consideration was granted for systems with low first cost systems or attractive payback periods.

Another goal of the design is to make the building more environmentally friendly by the means of reducing harmful building emissions. Chemicals like CO_2, NO_x, and SO_x are harmful to the environment. These chemicals are responsible for air pollution and global warming among many other unpleasant topics. The final design will attempt to reduce building emissions.

The designer's final goal is to learn more about the practical application of conceptual design. It is the nature of classes to present a number of isolated concepts. Unfortunately, there is typically not enough time in a given course to focus on what it takes to fully integrate these conceptual designs into practical use. This analysis represents an opportunity to perform that integration.

1.3 Referenced Standards

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) publishes a number of standards for better building design. The standards used in this design are described below.

ASHRAE Standard 62.1 Addendum n

This is the standard that is used to regulate how much ventilation air is required for buildings. A thorough analysis of this standard for the building is included in Section 3.1 of this report.

ASHRAE Standard 90.1

This standard is published with the intent of providing minimum requirements for the energy-efficient design of buildings. The analysis provided contains specific discussions of Section 5 (Building Envelope) and a redesign for Section 9 (Lighting) of the standard.

1.4 Methodology

In any engineering analysis, there must be special attention devoted to the standards of measurement. It is the purpose of this section to discuss the metrics by which the design alternatives that will be presented will be weighed.

Energy Savings

The final design selected will have to be a more energy efficient design than the one proposed in the design documents. The alternatives presented will be analyzed for their performance over a one year time span via computer simulation on Trane's energy modeling program TRACE. The amount of energy necessary for one year of operation will be one of the selection criteria.

Emissions:

Related very closely to energy savings is the issue of emissions. LA Fitness is located in Texas which is not connected to the power grid for the rest of the United States. Texas energy production can be broken down into three categories: coal, natural gas, and nuclear. Shown below is a breakdown of the types of emissions produced from the energy being considered at the site.

Texas Grid lbm/year				
Fuel	**Particulates/kWh**	**SO_2/kWh**	**NO_x/kWh**	**CO_2/kWh**
Coal	4.51E-04	5.24E-03	3.04E-03	8.82E-01
Natural Gas	0	6.21E-06	1.17E-03	6.17E-01
Totals	4.51E-04	5.25E-03	4.21E-03	1.50E+00

Table 1.1 - Texas Emissions Rates/kWh

Reduced yearly emissions will also serve as a critical component of the final selection criteria.

Economics

The final contributing component to the selection criteria will be a cost analysis. The options that were selected will be analyzed on either the basis of first cost, life cycle cost, or payback period depending on which is most appropriate.