A SUSTAINABLE MEDICAL CENTER IN TEXAS

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ABSTRACT

The purpose of this presentation is to demonstrate how one can successfully integrate many sustainable features into the construction and operation of a mid-sized medical clinic located in the hot/ humid piney woods of east Texas for a moderate increase over "normal" construction costs. Furthermore, the authors will point out that the application of "solar" design principals should entail more than the installation of solar collectors on a rooftop. The consuming public is sophisticated enough to see beyond the obvious, and perhaps dated, applications of solar design strategies - and welcomes the comfort and aesthetics that go along with an integrated approach to "Green" building.

The subject project, known as "The Texas Specialist Center", has enjoyed the predicted energy and green building results. It is a 6300 square foot stand alone clinic located in Lufkin, Texas for a client with multiple chemical sensitivities. "Green" features include passive solar design for heating and cooling, enhanced natural ventilation (including the use of natural "thermal siphons" within the building), "cool communities" site planning (to reduce the urban "heat island" effect), extensive use of daylighting and energy-efficient artificial lighting, photo-voltaics to provide security system & computer operations back-up, careful attention to material selections for low toxicity & high indoor air quality, use of regionally appropriate building materials and systems, an extensive rainwater collection system, as well as "xeriscape" landscaping principals. It was constructed in 1996 and has been under full operation for more than three years. Actual energy consumption data will be presented and the above "Green" design strategies will be elaborated upon.

This project was featured in the January/ February 1998 issue of <u>SOLAR TODAY</u>.

1. INTRODUCTION

Health is the number one concern at the Texas Specialist Center, which is not surprising when you consider that the Center is a doctors' office. What is surprising is the degree of attention the owners have given to not only creating a healthy place for their patients, but contributing to the health of the planet as well. If you were to visit this new orthopedic clinic outside of Lufkin, Texas, you would notice the beauty of the four-acre wooded setting and the spacious and sunny feel of the indoor space. What would be less apparent, however, is that the building itself conserves about $5000 worth of energy and many thousands of gallons of water each year, and that its indoor air quality is exceptionally good.

2. BUILDING FEATURES

2.1 Environmental sensitivity

The owners of the Texas Specialist Center, Dr. Jackson Wagnon and Betsy Wagnon, are an environmentally sensitive couple. They are sensitive not only to the impacts their personal and work lives have on the natural environment, but also to the impact that long-term exposure to toxins in the air can have on people who work in their building. So when the Wagnons decided to build their new clinic, their environmental sensitivities led them in search of a design that would minimize both indoor toxins and outdoor pollution while creating a pleasing environment for doctors, staff and patients. Their search led them to Barley & Pfeiffer Architects, an Austin, Texas, firm specializing in sustainable, energy-efficient design. This was a critically important step. For as the Wagnons can attest, while it may not be easy to find an architect with both the skills and enthusiasm for environmental design, it is essential if one wants to end up with a truly environmentally benign building.

2.2 Responsive Design

Barley and Pfeiffer were well suited in helping the Wagnons achieve their vision responding to their clients' design goals. The architects minimized energy loads to the building by thoroughly integrating site specific architectural planning, including passive & active solar energy technologies, with a highly efficient HVAC system. They designed a rainwater collection system for landscaping, saving thousands of gallons each year. They specified low-toxicity finishes throughout the clinic. And they created an aesthetically subtle building that does not call undue attention to its "solar" and "green" attributes.

Responding to their clients' goals demanded that the architects also be responsive to the local climate. In Lufkin this means dealing with heat and humidity first. Temperatures rise above 90°F (72°C) an average of 103 days per year. Humidity ranges between 50 and 90 percent. Cooling, including humidity control, is thus the largest climate-driven energy load and offers the greatest opportunity for demand reduction. Heating, on the other hand, requires little attention because temperatures rarely drop below freezing (only about 32 days per year). By far the largest energy user, even in this relatively small commercial building, is lighting. The architects thus concentrated their energy-related design efforts on reducing lighting and cooling loads.

2.3 Thermal Efficiency

An important part of the strategy to reduce cooling loads was to design the building envelope (walls, windows, floor, ceiling) to work against radiant heat gain. A special low-toxicity (low in formaldehyde) blown-in fiberglass insulation was specified to achieve an R-13 in the walls and an R-30 in the ceiling. A tight sealing package to minimize uncontrolled air and humidity infiltration was also employed. A self-ventilating radiant barrier system in the roof was incorporated that keeps attic temperatures 35 to 45 degrees cooler in the summer than most buildings in this climate.

2.4 Lighting

The architects and owners estimate that more than two thirds of the ambient light needed in the 6300 square foot (585 m^2) clinic is provided by sunlight. This is about three times more "natural lighting" than is found in most doctors' offices with no passive solar daylighting design. The architects achieved this high degree of daylighting through the building's long, rectangular shape, its orientation and strategic window placement. Their primary design challenge was to maximize daylight entering the building year-round while minimizing solar heat gain in this climate during most of the year. The clinic is approximately 135 feet (41.1 m) long, 62 feet (18.9 m) wide on the west side, and 31 feet (9.4 m) wide on the east. The long elevations of the facility face north and south and account for more than 75 percent of the total window area. On the south side, sunlight enters through 510 square feet (47.4 m^2) of ground level and clerestory windows. In December and January, the sun's low-angled rays provide a moderate amount of passive heating. In May through September, when the sun is higher in the sky, heat gain is avoided by south-facing windows that are shaded by carefully sized roof overhangs that extend 3 feet (0.9 m) beyond the walls. During these generally hot months, scattered daylight enters the ground-level exam rooms indirectly, avoiding glare as well as heat gain.

The clerestory windows are the centerpiece of the daylighting strategy. Light reflected off the light colored roof and undersides of the overhangs enters the clerestory windows and bounces off the interior ceiling, causing the light to penetrate deeply into the central work space. In addition to the south-facing glass, daylight enters indirectly through 415 square feet (38.6 m^2) of north-facing windows, including clerestories, providing evenly distributed lighting. Window area on the east and west sides is 195 square feet (18.1m^2) and 85 square feet (7.9 m^2) respectively. By minimizing the glass on these east and west walls, glare and heat gain was avoided from bright morning and afternoon sunshine. The daylighting feature that stands out the most is a large south-east facing curved wall of glass, including operable awning windows, that greets visitors as they enter and gives a spacious and well-lit feel to the patient waiting area.

Compact fluorescents and T-8 fluorescent lamps supplement the daylighting. Because very high light levels are often needed for work in the clinic, the lighting controls are not connected to sensors that automatically adjust the lights to the amount of daylight present. The staff, however, is trained to manually adjust electric lighting levels to available daylight. In each exam room, there are two banks of lamps in the ceiling, controlled by separate switches so that occupants have the option of turning only one on. And because of the daylighting design, under most conditions one bank is all that is needed. In other areas of the building, office staff turn on only the lights that are needed to supplement the level of illumination from daylighting.

2.5 Staying Cool

Daylighting is also the first strategy for keeping things cool in the Wagnons' clinic. In general, by reducing the amount of electric lighting needed, and thus internal heat gain from lights, the daylighting design reduces cooling loads. In particular, minimizing west and east glass avoids external heat gain from low-angled direct sunlight.

To minimize heat gain while still optimizing the daylighting effect, the architects specified two different types of windows. On the north and south sides, where sunlight can be more easily controlled with overhangs, they used a clear low-e Argon-filled window with a shading coefficient of 0.73. For east and west windows, where the greatest concern was keeping out solar gain, the architects used tinted low-e windows with a shading coefficient of 0.43, which indicates that the glass cuts out more than half of the sun's rays. Both types of windows have high insulating values due to the Argon gas between the panes.

Another cooling strategy makes use of the high ceilings and clerestory windows. Besides their important role in daylighting, the operable clerestory windows assist with natural ventilation and cooling during the spring and fall seasons when the temperatures humidity ratio is conducive. (Something the owners report they enjoy between 10% and 20% of the days of the year!) Gentle prevailing breezes enter through low-placed operable windows in the lobby and offices and help dispel warm air up with them through the high clerestories. Ceiling fans in the common areas also promote air circulation and ventilation, reducing the need for air conditioning.

At times when the temperatures get too warm for open windows, a cooling tower-assisted air conditioning system meets cooling needs more than twice as efficiently as conventional systems. In the cooling towers, freon-filled coils are cooled from the outside as water is sprinkled over them and air passes through. This dramatically increases the efficiency of the light commercial-type conventional air conditioner. As temperatures rise into the 90s and lOOs, the system performs even better compared to conventional units.

2.6 Photovoltaic System

The clinic includes a 1.5 kilowatt photovoltaic array, primarily to provide electricity in the event of a power outage. The photovoltaic system can provide enough energy to keep it functioning with its essential electrical needs met for about 24 hours. The system cost about 10% less than a conventional un-interruptable power supply (UPS) system, which would have otherwise been required. But unlike a conventional UPS system, photovoltaics has the added benefit of supplementing the power supplied by the local utility on an ongoing basis, not just when the power goes out.

3. ENERGY PERFORMANCE

The integrated combination of photovoltaics, daylighting, passive solar gain, natural ventilation, and high-efficiency cooling equipment results in a significant reduction in energy use. Using software developed in the offices of L.M. Holder Ill, Inc. of Austin, Texas, the architects predicted an estimated overall 43 percent savings over a reference building of conventional design. The vast majority of the savings is in energy used for lighting and cooling. The lighting loads for both the reference case and the Wagnon clinic are high relative to other small commercial buildings because higher lighting levels are required by medical facilities than other office spaces.

While “doctor's bill" is a term most people don't like to hear, the Wagnons are pretty happy with theirs. In keeping with the architects' performance calculations, the Wagnons report that they are paying energy bills of about half of what they paid in their former office on a per-square-foot basis. Their annual gas and electric bill now totals about $7,000. The architects estimate that the total energy bill for a same size conventionally designed medical clinic in east Texas would be close to $12,000 per year. This indicates an estimated savings for the Wagnons of about $5,000. The Wagnons see the money they save on energy as money in their pocket. The way they see it, their orthopedic center cost about the same to build as comparable-quality medical clinics. According to the architects' research, on a per-square-foot basis, the Wagnons construction price tag falls right in the middle of a wide range. Comparing the construction cost with a reference case is difficult because of the many widely variable factors that impact cost.

In order to achieve their energy and environmental goals, the Wagnons were willing to put a moderate premium on architectural fees. The Texas Specialist Center, with its site specific planning, high ceilings and clerestory windows, probably cost more to build than a low-profile, uninteresting clinic of the same size. However, it also cost less than many clinics with high ceilings and other purely aesthetically-motivated design features that contribute nothing to energy conservation -- and which usually leave energy saving strategies up to the mechanical engineer to attempt incorporating at the last minute, if at all.

4.0 CONCLUSION

The Texas Specialist center is an example of what can be achieved when an environmentally and fiscally concerned client values expertise in sustainable and energy-efficient design. Jackson and Betsy Wagnon took the initiative to look into doing things differently, for the sake of their own health and that of their environment. And they will be the first to acknowledge they've been richly rewarded.

They also proved that environmentally responsible "Sustainable" architecture can be successfully integrated into the mainstream of the American building industry.

4.1 Energy

A summation of how the Texas Specialist Center stacks up is as follows:

43 percent overall reduction in total energy load.
42 percent reduction in electrical use for lighting.
65 percent reduction in electrical use for cooling.

4.2 Affordability

The construction cost of $885,000 falls in the middle of the range of costs for medical clinics of comparable quality and size. The Wagnons will save about $5000 per year on energy bills.

4.3 Jobs and Economy

Dollars not spent on energy are expended elsewhere in the state economy, creating more jobs than if the same dollars were spent on conventional energy consumption.

4.4 Health and Productivity

Natural lighting in the clinic has a positive physiological and mental impact on the staff and may result in increased productivity. The doctors also feel that the natural lighting contributes to a more pleasant experience for patients. The use of low-toxicity materials inside the building reduces the risk of negative impacts on human health from long term exposure to toxins in the air.

4.5 Environment

The large reduction in electricity consumption reduces the negative impacts of coal-fired power plants in Texas, reducing land degradation and human health problems associated with coal production and air pollution. Recovering rainwater for irrigation, using recycled building materials (such as the galvalume roof -- made from recycled steel), and utilizing native plantings are among a few of the strategies employed to conserve resources.

4.6 Project Description

Project Type: Orthopedic medical clinic

Owner: Jackson and Betsy Wagnon

Architect: BARLEY & PFEIFFER ARCHITECTS

Design Team: Alan Barley AIA, Peter Pfeiffer AIA & Edgar Farrera

Contractor: L. Richardson and Sons

Location: Lufkin, Texas

Size: 1 story, 6300 square feet (585 m^2)

Cost: $885,000 (not including unusual costs associated with site work, landscaping, change orders and rainwater collection system)

Date Completed: Fall, 1996

Heating Degree Days: 1930

Cooling Degree Days: 2650

ENERGY PERFORMANCE

The chart below provides a comparison of projected building energy loads for the Texas Specialist Center (TSC) and a simulated reference case. Figures for water heating and office equipment are assumed identical. The figures for the TSC are roughly verified by actual energy use in the first year of occupancy (which was an unusual year because some construction was still occurring and additional doctors and staff were added during the year).

	Reference	Tx. Specialist Center	Percent Reduction
Lighting	34,500 Btu/ft²/yr (392 million joules/m²/yr)	20,000 Btu/ft²/yr (227 million joules/m²/yr)	42 percent
Cooling	19,700 Btu/ft²/yr (224 million joules/m²/yr)	6800 Btu/ft²/yr (77 million joules/m²/yr)	65 percent
Office Equipment	12,000 Btu/ft²/yr (136 million joules/m²/yr)	12,000 Btu/ ft²/yr (136 million joules/m²/yr)	0 percent
Space Heating	6800 Btu/ft²/yr (77 million joules/m²/yr)	2500 Btu/ft²/yr (28 million joules/m²/yr)	63 percent
Water Heating	1000 Btu/ft²/yr (11 million joules/m²/yr)	1000 Btu/ft²/yr (11 million joules/m²/yr)	0 percent
Total	74,000 Btu/ft²/yr (840 million joules/m²/yr)	42,300 Btu/ft²/yr (480 million joules/m²/yr)	43 percent

AUXILIARY HVAC SYSTEM

Four-zone, light commercial grade DX-type air-conditioners assisted by twin cooling towers. Heating system is hydronic with a gas-fired boiler. Digital programmable thermostats.

DAYLIGHTING FEATURES

- High aspect ratio (E/W axis twice as long as N/S)
- 925 square feet (85.9 m²) of glazing on S & N sides combined, including clerestories
- 280 square feet (26 m²) of windows on E & W
- Open floor plan and interior clerestory windows
- Multi-stage manually adjusted lighting controls

ENERGY EFFICIENCY FEATURES

- R-22 - R-30 ceiling low toxicity insulation
- R-13 low toxicity fiberglass wall insulation
- Fluorescent T8 and compact lamps
- Efficient cooling system, approx. EER of 17.0.

ENERGY COSTS

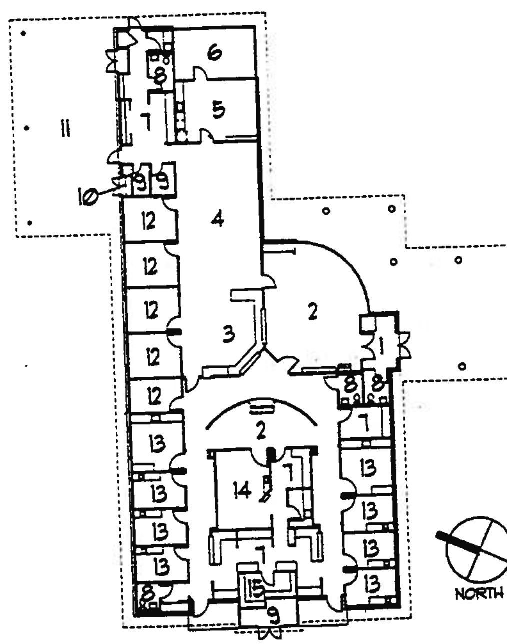
Total annual energy expenditure (gas and electric) is about $7000. Total cost of energy for the reference case would be about $12,000. Thus the Wagnons are saving about $5000 per year.

ENVIRONMENTAL/ HEALTH CARE ISSUES

- Continuous ventilation for air quality
- Daylighting (generous view-window area)
- Rainwater collection and storage for irrigation
- Landscaping with native plants
- Low-toxicity finish materials throughout

LEGEND:

1. ENTRY VESTIBULE
2. WAITING
3. CHECK-IN
4. WORKROOM
5. LOUNGE
6. SCREENED PORCH
7. STAFF AREA
8. TOILET
9. MECH./ELEC. ROOM
10. PHOTOVOLTAICS
11. CARPORT
12. OFFICE
13. EXAM ROOM
14. X-RAY
15. STORAGE
16. PATIENT DROP-OFF



FLOOR PLAN

Figure 1: South elevation of Texas Specialist Center. Note clerestory windows for daylighting & thermal siphoning. Light colored paving reduces site ambient temperatures. Photovoltaic panels are on upper roof.

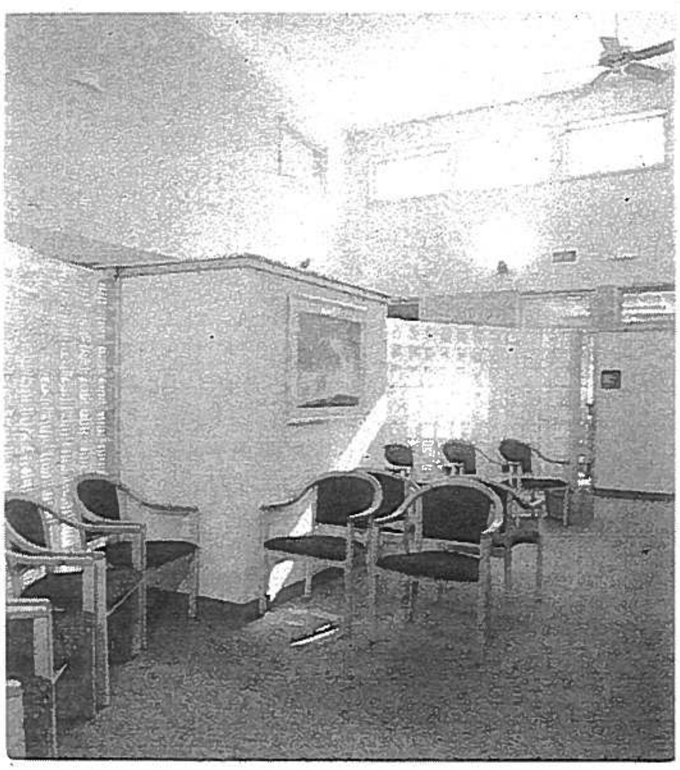


Figure 2: Clerestory windows daylight the building's core.

Figure 3: Southeast facing lobby receives ample reflected daylight. All electric lights are fluorescent.