Name: Daniel J. Overbey
Affiliation: Ball State University
College of Architecture
Muncie, IN 47306
Degree program: Architecture
Mailing Address: 2500 E. Mockingbird Dr.
Clinton, IN 47842
Phone Number: (765) 376-4616
Email address: djoverbey@bsu.edu

SBSE Sponsored Student Poster Contest

Abstract

Description of the design and passive/alternative focus presented
The design shown in these boards contains material from a low-income, single family, detached housing prototype designed at Ball State University's Muncie Urban Design Studio. The building was designed for the Greater Muncie, Indiana Habitat for Humanity affiliate and has a floor area of 832 ft^2. This particular housing prototype (one of eight) specifically explored alternative heating and cooling strategies that would benefit both the homeowner and the environment; while also possessing the capacity to become economically comparable to conventional HVAC systems. The prototype is also 100% ADA compliant.

The results of a climate analysis of Muncie, Indiana suggested that passive solar heating and cooling strategies may have great potential in the application to the prototype. Therefore, a variation to Harold R. Hay's Skytherm™ system of Natural Air-Conditioning (also know as a *roofpond*) coupled with a solar direct gain (DG) strategy was integrated into the prototype to hopefully provide 100% passive heating and cooling. Computer simulations using *RP_Performance* indicated that only an 88.7% annual solar savings fraction could be attained with the prototype's current design. During extreme winter conditions, two to three small electric heaters, slated to operate 5% of the day (about 1 hour), would be necessary for auxiliary heat.

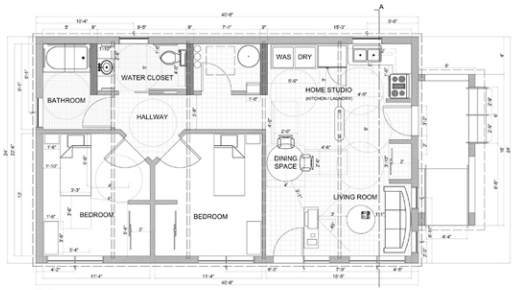
Principles and concepts conveyed
The Natural Air-Conditioning System (NACS) is founded on the premise that water possesses roughly three-times the thermal storage capabilities of concrete. The system exhibits a passive (radiant heat transfer), pollution-free approach to heating and cooling. This variation of the roofpond is specifically designed for the harsh Muncie climate. To facilitate economic feasibility, the natural air-conditioning system (NACS) is almost completely composed of mass-produced components (such as insulated garage doors and residential skylights). The presentation contains graphics that illustrate the major components of the system as well as the system's functions during the heating and cooling seasons.

The significance of the approach in architectural design
The NACS does not compromise the appearance of the home. The interior space of the prototype is unaffected. The building's envelope and overall aesthetic may essentially remain unchanged. The system has great potential for reducing initial, life-cycle, and monthly utility costs because it combines the solar collector, storage, dissipator and heat exchanger into a single component—sealed bags of water. This system fosters healthier indoor air-quality by avoiding the health risks bound to conventional HVAC systems; and eliminating carpet in favor of a more thermally-massive floor finish (such as tile-floor or exposed colored concrete). Roofpond case studies have been recognized for their unique, inherent fire-safety attributes (which is of particular interest to a disabled homeowner). Experimental research suggests that this passive approach to solar heating and cooling may shave over $300 off of the low-income homeowner's utility bills every year—potentially improving the homeowner's financial disposition and possibly serving as a stimulant for micro-economic development. This is in addition to the enormous potential reduction in energy consumption from nonrenewable resources.

Information that people will take away from your presentation
At the heart of this presentation is one central message: by harnessing our planet's abundance of solar income and the natural, thermally-massive qualities of such materials as water, architecture can once again become integral with natural environmental influences and conventional HVAC systems may be eliminated.

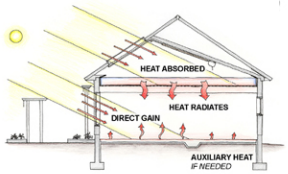
Naturally Air-Conditioned Low-Income Housing Prototype

- Elimination of conventional HVAC system
- Use of water as a thermally-massive building material
- Healthier indoor air-quality and unique fire safety feature
- Naturally adjusts to changing climate for superior comfort
- Substantial utility savings passed to homeowner

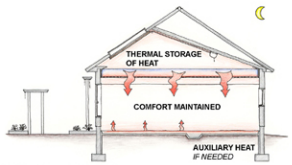


Plan

Interior Perspective of Living Room



Winter Day



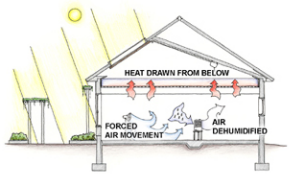
Winter Night

The impending energy and pollution crises necessitate the development of new and practical methods for heating and cooling buildings. Unfortunately, most "active" solar strategies involve collection at medium and high temperatures suitable for supplementing the heat required by conventional thermal control devices. However, the featured low-income housing prototype (approx. 1000 sq.ft.) developed for the Greater Muncie, Indiana Habitat for Humanity focuses on a passive (radiant heat transfer), pollution-free approach to heating and cooling. By harnessing our planet's abundance of solar income and the natural thermal quality of water (roughly three times as thermally massive as concrete per volume), conventional HVAC systems may be eliminated. Such as system has potential for reducing initial, life-cycle, and monthly utility costs because it combines the collector, storage, dissipator, and heat exchanger into one component—sealed bags of water. The Natural Air-Conditioning System is a variation of the "roofpond" strategy developed by Harold R. Hay. Evaluated since the late-1960's, roofponds have been proven to possess superior and balanced thermal performance. These systems have been recognized for improving indoor air-quality, holding unique fire safety attributes, and adjusting to climate changes to offer a distinctive level of indoor comfort.

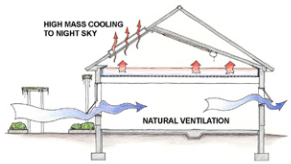
South Elevation

East Elevation

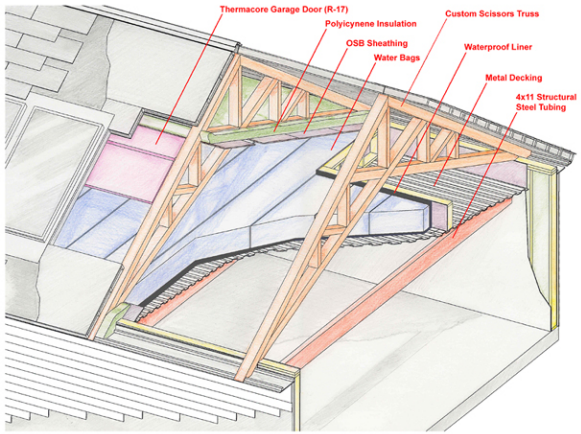
By harnessing our planet's abundance of solar income and the natural thermal quality of water, conventional HVAC systems may be eliminated.



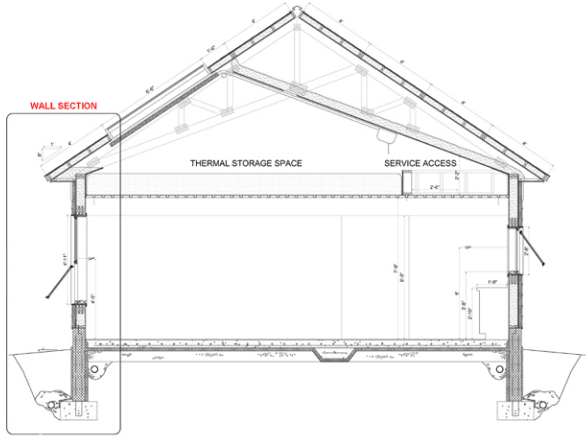
Summer Day



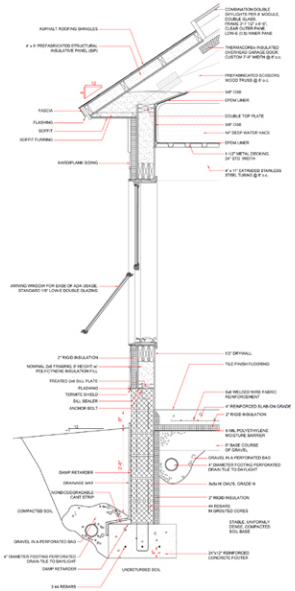
Summer Night



Components of the Natural Air-Conditioning System



Section A-A



Wall Section

How well does the Natural Air-Conditioning System work?

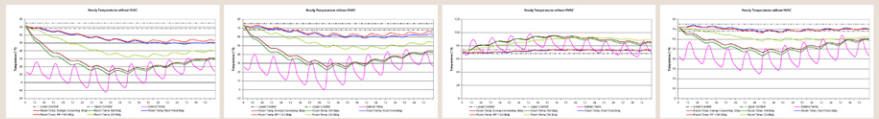
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Solar savings fraction	65.8%	71.9%	83.6%	96.9%	99.3%	100%	100%	100%	100%	99.0%	86.3%	68.5%
Indoor temp.	75-68°F	75-68°F	75-68°F	73-68°F	76-68°F	74-68°F	74-68°F	73-68°F	71-68°F	75-68°F	74-68°F	75-68°F
Utility savings*	$45.76	$46.60	$42.43	$30.79	$3.33	$18.30	$19.97	$19.97	$14.98	$23.30	$38.28	$42.43

TOTAL $346.14

* vs. electrical heating and cooling system; assume a constant electricity rate of $0.07per KWh and a (medium) heat capacity of 6 Btu/°F per ft2 of floor area

Simulated Thermal Performance of Prototype

WINTER: January SPRING: March SUMMER: July AUTUMN: October



STUDENT-DESIGNED HOUSING PROTOTYPE
PROPOSAL FOR THE GREATER MUNCIE, INDIANA HABITAT FOR HUMANITY