THESIS

SUNSHADE HOUSE:
A FRAMEWORK IS ERECTED OVER A LARGE PART OF THE SITE. THIS ESTABLISHES THE PRIMARY AND SECONDARY GRIDS. THE FRAMEWORK, WHICH ALSO PROVIDES SUPPORT FOR THE WALLS, ROOF, AND DECK, PRIMARILY PROVIDES SEVERAL DIFFERENT LAYERS OF SHADING DEVICES. THESE LAYERS OF SHADING INCLUDE SEASONALLY OPERABLE BARS OF SEMI-TRANSLUCENT PV PANELS, OPERABLE FABRIC AWNINGS, AND FIXED WOODEN ROOFS. THESE SHADING DEVICES ARE ARRANGED TO PROVIDE VARIOUS LEVELS OF SHADE THROUGHOUT THE DAY AND THE YEAR. THERE ARE ALSO NON-SHADED AREAS IN BOTH THE DECK BELOW AND THE FRAMEWORK ABOVE LEFT OPEN TO ALLOW FOR A LAP POOL, VEGETABLE GARDEN, AND MATURE TREES.

THE HOUSE:
THE HOUSE IS DESIGNED ON THE GRID SYSTEM ESTABLISHED BY THE STRUCTURAL FRAMEWORK. A SOLID BOX AND A GLASS BOX ARE EXPLODED TO OPPOSITE CORNERS. THIS ALLOWS FOR NATURAL LIGHT, VIEWS, VENTILATION, AND PRIVACY TO ALL AREAS WITHIN THE HOUSE.
The roof plan shows the layers of shading: The region at the top of the plan has opaque, fixed shading of the house and carport roofs. On top of the roofs are the elements of solar collection: the evacuated tubes and the solar panels. The next region down has operable fabric awnings that can be moved at different times of the day and year. Finally, there is a region of shade trees at the bottom of the plan that shade the southwest façade in the summer, and allow sunlight to it in the winter.
The roof plan shows the layers of shading: The region at the top of the plan has opaque, fixed shading of the house and carport roofs. On top of the roofs are the elements of solar collection: the evacuated tubes and the solar panels. The next region down has operable fabric awnings that can be moved at different times of the day and year. Finally, there is a region of shade trees at the bottom of the plan that shade the southwest façade in the summer, and allow sunlight to it in the winter.
01 Axon of Functional Kitchen/Mechanical Unit
UT Solar Decathlon 2009
“Sunshade House”
University of Tennessee, Knoxville
Arc 572 I Spring 2008

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kit of parts appliances energy balance
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02 Neighborhood Units

01 Stacked Units

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01 Capillary Tube Mats Radiant Cooling

02 Radiant Flooring

03 Solar Panels

04 Evacuated Tubes
Material and Equipment Sources:
• Windows, glass doors, sliding doors: Kawneer
• Radiant Heat Flooring: Warmboard
• Radiant Cool Mats: KaRo Capillary Tubes Mats
• Roof Membrane: Sarnafil Peel and Stick Membrane
• Solar Panels: Sunpower 220 Panels
• Evacuated Tubes: Sunmaxx 20
• Evacuated Tubes Rack: Sunmaxx Solar Rack
• Fabric Awning: Nysan Custom Motorized Roller Shade
• Low-E Glass: PPG Industries SolarBan 70XL Glass
Knoxville, TN:
- Latitude 36 degrees N
- Longitude 84 degrees W
- Elevation 949 feet

01 Sundial, 36 degrees Latitude

02 Sunpath Diagram, 36 degrees Latitude

03 Shading Angles, Outdoor Rooms, Knoxville, TN
Knoxville, TN:
- Latitude 36 degrees N
- Longitude 84 degrees W
- Elevation 949 feet
Preliminary investigation showing that my building in Knoxville, TN is out of balance.
Later investigation showing that my heat gains and losses from all elements are balanced (on typical days).
Later investigation showing that my heat gains and losses in winter and summer are balanced on typical days, but that I am loosing heat in the winter on the extreme days, and gaining heat in the summer on the extreme days.

Winter/Summer Extreme Days:
- Total Heating Load of -198,365 Btu; heating peak of -20,095
- Total Cooling Load of 153,267 Btu; cooling peak of 25,854 Btu/hr
01 Water Supply and Usage:

Assumptions:
• Knoxville, TN, 0.5% available monthly precipitation, 50 g/cd for 2 occupants, conservative water usage, 30 day dry period

Data:
• 23,375 gal/yr required yield from catchment, 1,652 calculated catchment area
• Cistern Volume = 314.2 ft cubed (2,350 gallons)
• Stored in cistern located underneath the house footprint
**Assumptions:**
- Solar Rating of Knoxville, TN = Good
- 13,242.8 kWh/person/year in USA = Assumed Average Electric Rate: $0.0759 kWh (Residential Rate)

**Data:**
- Estimated System Cost = $99,000
- Estimated Net Cost = $97,000
- Increase in Property Value = $17,020
- Return on Investment (including increase in property value) = 496%
- Years to Break Even = 34 years
- Greenhouse Gas Saved = 269 tons

**Estimated System Cost**
- Assumed Installation cost: $99,000
- Assumed Annual Electric Rate: $0.0759/kWh (Residential Rate)
- Estimated Net Cost: $97,000
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