

PROPOSED FINE ARTS PAVILION AT THE UNIVERSITY OF NEVADA, LAS VEGAS: THE BEAUTY OF GREEN DESIGN

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ABSTRACT

This article presents the completed schematic design of the Fine Arts Pavilion at the University of Nevada, Las Vegas (UNLV). The Fine Arts Pavilion was conceived as a research and demonstration facility where appropriate passive and active solar technologies for the United States Southwest could be tested and displayed. This pavilion would also be used to showcase student work from the School of Architecture and the Fine Arts College.

Among its strategies the pavilion counts the use of daylighting, external shading, a roofpond for passive heating and cooling, and direct gain for auxiliary heating. An off-grid PV installation, rainwater collection, and solar distillation were also considered for this facility.

INTRODUCTION

The main goal of this project is to demonstrate UNLV's strong commitment to sustainable development in the Southwest by promoting appropriate technological solutions. To that end, the Fine Arts Pavilion was designed using a collaborative process coordinated by the Natural Energies Advanced Technologies (NEAT) Lab. The framework adopted for this project implements as much as possible the principles for sustainable design published by Environmental Building News in its September of 1995 issue. These principles are listed as follows:

1. Save Energy
2. Recycle Buildings
3. Create Community
4. Reduce Material Use
5. Protect and Enhance the Site

6. Select Low-Impact Materials
7. Maximizing Longevity
8. Save Water
9. Make the Building Healthy
10. Minimize Construction and Demolition Waste
11. "Green Up" Your Business

The Fine Arts Pavilion's design team vigorously responded to each of the eleven principles. The following is a brief description of the project's regionally-appropriate design initiatives and resolution:

1. SAVE ENERGY

Information derived from climate data and site analyses became the driving design force behind the Fine Arts Pavilion. The building materials and the environmental control systems of the pavilion are direct responses to the climate and the site. For example, during the pre-design and schematic design phases solar access studies were conducted for each location where a solar system was proposed (e.g. ground-mounted solar stills, roofpond, etc.) to determine their viability and appropriateness. Figure 1 shows the analysis conducted at 12 feet above the ground to evaluate the feasibility of a roofpond system.

Figure 2 provides a summary of all the strategies ultimately employed to minimize energy expenditure using Las Vegas' abundant solar income to provide the majority of the pavilion's illumination, thermal, and electric power needs. To control the amount and quality of daylight coming into the pavilion, nanogel-filled double-glazed windows were chosen. The nanogel translucent aerogel is both insulative (R-value is 20 h ft² °F / Btu) and it possesses a light transmittance of 20%.

A daylight factor (DF) calculation (see Figure 5) shows that the interior illuminance produced by daylighting alone completely suppresses the need for electric lighting during business hours. Similarly, it was determined that 90 ft² of photovoltaic (PV) panels would be sufficient to provide 100% of the 376 ft² pavilion electrical needs.

Passive solar systems are the only means by which this building is heated and cooled. Both heating and cooling loads are reduced by a roofpond system. Preliminary thermal performance simulations indicate that the Solar Savings Fraction (SSF) for the entire year (cooling included) are roughly 84% using a 12" roofpond system (see Table 1).

The thermal performance of the pavilion will be improved by occasional forced-fan ventilation and a controlled solar exposure. According to the *cosine effect*, the amount of solar radiation gained by the southern glazing may be optimized by tilting the plane of the glazing relative to the radiation source—the sun (Moore 1993). Thus, the design team optimized the direct gain system of the south façade to collect heat during the heating season. In addition, a series of exterior shading devices were provided to block unwanted solar penetration during the cooling season.

2. RECYCLE BUILDINGS

The structure of the existing Alumni Pavilion (never completed) will be reused to minimize construction costs and raw material usage (see Figures 2, 3 and 4). Salvaged photovoltaic panels were also recuperated by the design team. These two measures will help reduce the cost of the

project and keep still-useful materials from unnecessarily going to the municipal landfill. The design team will make sure that eventually these PV panels return to their respective *technical metabolic cycle* (McDonough 2002) where they may be reused infinitely—effectively eliminating the PV panels as a waste item.

3. CREATE COMMUNITY

The highly visible site of the pavilion opens the opportunity to create an iconographic piece that is both visually appealing and functional—a tangible pronunciation of what UNLV stands for, as well as an easily-identifiable symbol

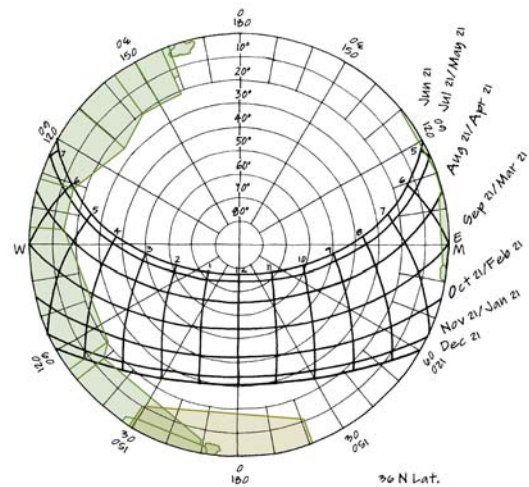


Fig. 1: Solar access study at 12 feet above the ground.

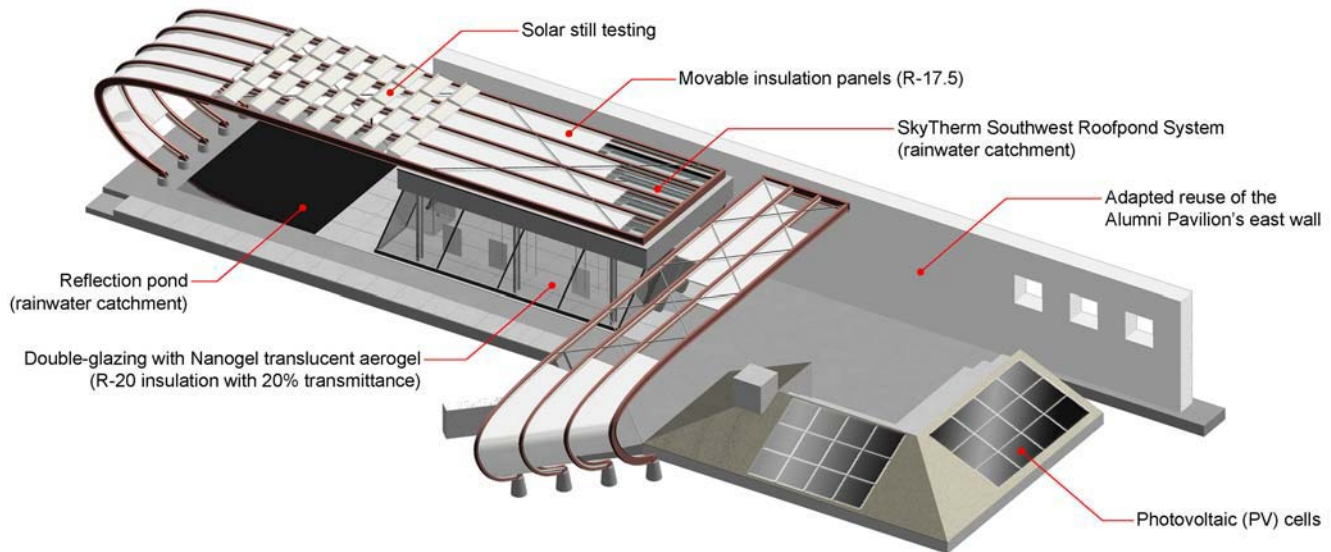


Fig. 2: Axonometric view of the Fine Arts Pavilion showing the solar systems used in the building



Fig. 3: View of existing Alumni Pavilion from parking lot



Fig. 4: Identical view including proposed Fine Arts Pavilion

that will give the university students a greater sense of identity.

At the community scale, the pavilion will be used to create a gathering place for UNLV students interested in presenting/performing their work to the community. As such, it will promote cultural and social exchanges.

TABLE 1: SIMULATED THERMAL PERFORMANCE AND SUBSEQUENT UTILITY SAVINGS BY MONTH

Month	SSF*	Utility Savings**	Indoor Temp. HI/LO
Jan	76%	\$35.57	68-76°F (20-24°C)
Feb	97%	\$36.38	68-76°F (20-24°C)
Mar	93%	\$26.34	68-76°F (20-24°C)
Apr	81.8%	\$17.91	72-80°F (22-27°C)
May	95.8%	\$9.42	72-80°F (22-27°C)
Jun	83.6%	\$15.49	72-80°F (22-27°C)
Jul	76.6%	\$21.46	72-80°F (22-27°C)
Aug	61.6%	\$14.53	72-80°F (22-27°C)
Sep	90%	\$13.03	72-80°F (22-27°C)
Oct	87%	\$17.57	72-80°F (22-27°C)
Nov	91.3%	\$35.00	72-80°F (22-27°C)
Dec	72.5%	\$32.37	68-76°F (20-24°C)
AVERAGE SSF*: 83.9			
TOTAL UTILITY SAVINGS**: \$275.07			

* conventional energy saved for heating and cooling

** assuming a constant utility rate of \$0.10 per kWh

4. REDUCE MATERIAL USE

In addition to salvaging used materials, the new materials chosen for this pavilion have high durability and whenever possible, low-embodied energy which translates into less material use over the entire life of the building.

In addition, this project was designed with modularity in mind so that commercial, standardized materials are used in full pieces. This approach reduces the quantity of new materials used and also minimizes construction waste.

The only exception made to this principle during the design of the pavilion was the curved steel members that support the track ways for the movable insulation and external shading devices. The curves—which are all identical—are designed to allow the maximum amount of track way with the minimum amount of building footprint. The tracks have a specific length requirement to fulfill their purpose and a curve provided that length without expanding the pavilion’s usage of the site.

5. PROTECT AND ENHANCE THE SITE

The site is a brown-field that was left underdeveloped despite the fact that it connects the city bus stop at the south end of campus with the rest of the university (see Figures 6 and 7). The Fine Arts Pavilion will engage the heavy pedestrian traffic that circulates through the site by presenting student artwork, demonstrating appropriate building technologies, and promoting and demonstrating xeriscaping landscape techniques for the United States Southwest.

Given the site’s location and constraints the state of its biological systems is very weak. However, because of its heavy pedestrian traffic and high visibility the site presents what McHarg (1992) calls *the solution of maximum social utility*, which provides the maximum social benefits with the least social costs (these include human health, economic, and environmental factors). In this case, the social values introduced to the site by the pavilion dramatically outweigh the social costs incurred.

6. SELECT LOW-IMPACT MATERIALS

A life-cycle analysis is being conducted to guarantee that low impact materials are used in this project. For example, the pavilion's new concrete components will use Flyash (a byproduct from coal combustion processes) to substitute over a third of the Portland cement the concrete would otherwise require.

However, the most effective low-impact material used in the pavilion is the 2,812-gallons of water that constitute the roofpond, which serves as the source of heating and cooling for this building. Instead of using mechanical HVAC systems to condition the interior environment, the Fine Arts Pavilion utilizes the inherent thermal properties of water to condition its space. Water has an extremely low embodied energy compared to other mechanical conditioning alternatives, it's nontoxic, it naturally-occurs, it's abundant, can be quickly recycled, it brings a unique fire-safety feature to the pavilion, and it's the life-source for all species that survive on this planet—there couldn't be a better green building material.

7. MAXIMIZE LONGEVITY

Though this building features a number of systems that will be modified during the research process, therefore causing it to adapt and evolve over time, the design team is confident that the pavilion will become a vibrant component of the UNLV campus for many years to come. The ultimate goal of the design team is for the Fine Arts Pavilion to reduce life-cycle impacts by a *factor of 20* when compared to similar projects in the United States Southwest.

To achieve this *factor of 20* project goal the pavilion uses materials such as steel, flyash concrete, and glass that have very long life-spans, are resilient, and are available in standardized sizes/modules (which fosters adaptation, disassembly, and reuse). Though some of the materials possess a high embodied energy, these choices were heavily guided by the idea of maximizing social utility. For example, the fenestration system with its modular steel louvers could be easily disassembled and reconfigured should circumstances necessitate such a change. Further, some components such as the roofpond system for heating and cooling can be removed and replaced easily should needs change or a better solution be conceived.

8. SAVE WATER

Southern Nevada receives an average of 4 inches of rain per year. The region also experiences extended periods of drought that are accentuated by a larger consumption of

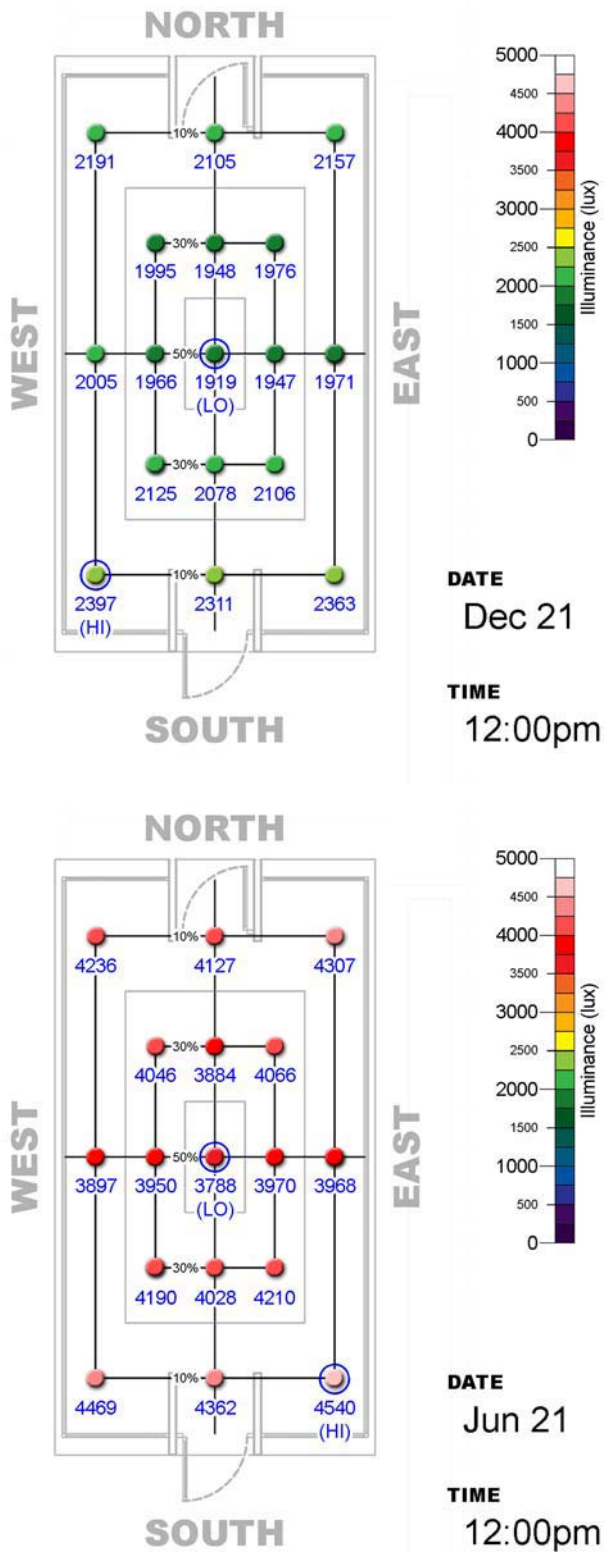


Fig. 5: Daylight analysis (IESNA Lumen Method)

water during the cooling season. Thus, the design team strongly believes that a rainwater collection system is appropriate for virtually any type of structure built in this region. As designed, the Fine Arts Pavilion is a stand-alone structure separated from the adjacent Paul B. Sogg Architecture Building. Though it would technically serve as a gallery and/or office space, the pavilion doesn't have any plumbing fixtures (i.e. water closet, lavatory, etc.). The 376 ft² roofpond and the 225 ft² reflective pond will collect rainwater for use in solar distillation research. The water will be stored in an underground 41 ft³ cistern. Solar distillation takes advantage of Las Vegas' abundant solar radiation to distill previously contaminated water. This is yet another example of an appropriate response to the region's climate.

8.1. Potentials for Water Conservation and Recycling

The design team conducted an in-depth analysis to determine the potential for water conservation and recycling within a building the size of this pavilion. With an area of 376 ft², this space could support two offices. Therefore, a scenario consisting of one water closet, one sink, and one water fountain was proposed to explore water conservation and reuse. The base case assumed that each worker flushed the toilet three times per day (including weekends), with typical usage of the sink and water fountain. After all appropriate conservation measures were taken for each water fixture (e.g. the replacement of a conventional flush-tank toilet with a low-consumption flushometer tank, which uses only 1.5 gal. per flush) the results obtained were:

- Annual water usage: 2,597 gal.
- Annual rainwater collection: 749 gal.
- Annual gray water reused in W.C.: 1,963 gal.
- Collection of gray and rainwater: 2,712 gal.
- Potential net gain stored in cistern: 115 gal.

This analysis indicates that if water conservation strategies were to be employed, gray water and rain water after distillation could potentially satisfy the water requirements of two workers in this 376 ft² structure.

9. MAKE THE BUILDING HEALTHY

The design team has addressed the chemical sensitivity of building users by specifying building materials that possess zero-toxicity and/or emissions. The concise material palette composing the pavilion's interior space—light- and heavy-gauge steel, glass, and travertine tiles—emit no volatile air-contaminants and can be easily cleaned and maintained to avoid dust collection (oftentimes caused by HVAC systems). Figure 8 shows the interior of the pavilion.



Fig. 6: View of existing Alumni Pavilion, facing south



Fig. 7: View of proposed Fine Arts Pavilion, facing south



Fig. 8: Interior view of the proposed Fine Arts Pavilion

10. MINIMIZE CONSTRUCTION AND DEMOLITION WASTE

As mentioned above, the utilization of standardized building construction materials will help to reduce construction and demolition waste. Figure 9 shows a construction detail of the pavilion. Every component of the pavilion (with the exception of products damaged during demolition) could be potentially reused indefinitely as a result of their modularity and resilience. Building assemblies have also been designed to allow configuration changes (or dismantling and reuse of components).

11. “GREEN UP” YOUR BUSINESS

As part of its mission, the Natural Energies Advanced Technologies (NEAT) Lab at UNLV is charged with research and demonstration of appropriate technologies for the United States Southwest. The authors of this article fully agree with Aitken (2005) that it is not too late to stabilize climate change and successfully transition to

renewable energy technologies. However, Aitken makes it clear that decisive leadership should step-up now. The NEAT Lab argues that innately bound to this transition is a need for a much greater understanding of dynamic natural systems and how humans can destroy them, sustain them, or regenerate them.

Such a crusade must usher in a societal paradigm shift. The entire industry, including the clients, must equally value these goals and understand the implications of everything we design. Motloch (2000) very effectively summarizes our current global scenario:

"The global landscape is at a turning point from an equilibrium to a dissipative state characterized by breakdown of global life-support systems. Although the human-dominated technosphere is experiencing what seems to be increased organization, output, and better quality of life, this incomplete view is at the heart of our dilemma. Global society must turn from its reductive thinking to an integrative thought pattern, from Cartesian to systems science, and from anthropocentric (human-centered) to metabolic (life-cycle) thinking."

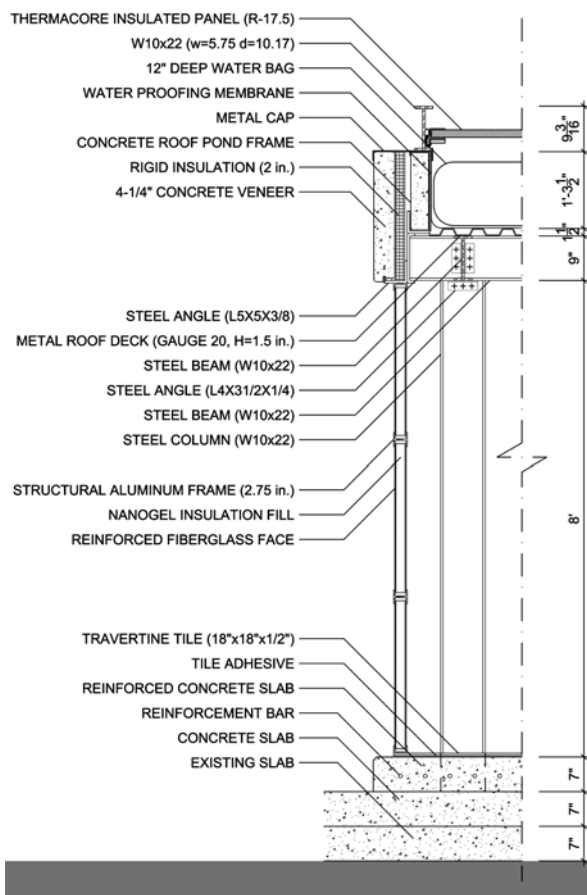


Fig. 9: Wall section of Fine Arts Pavilion

12. STATUS OF THE PROJECT

The source of funding for the Fine Arts Pavilion has changed resulting in a delay of its construction. The new funding scheme will include fundraising and therefore a greater pool of individuals who will hopefully share the ideas put forward by the Natural Energies Advanced Technologies Laboratory.

13. REFERENCES

- (1) Aitken, D. W., "The Renewable Energy Transition: Can It Really Happen?." *Solar Today*. No. 1, vol. 19 (2005): 16-19
- (2) McDonough, W. and Braungart, M. *Cradle-To-Cradle: Remaking the Way We Make Things*. North Point Press, 2002
- (3) McHarg, I. L., *Design With Nature: 25th Anniversary Edition*. John Wiley & Sons, 1992
- (4) Moore, F. *Environmental Control Systems: Heating Cooling Lighting*. McGraw-Hill, Inc., 1993
- (5) Motloch, J. L., "An Ecology of Design." *Introduction to Landscape Design, Second Edition*. John Wiley & Sons, 2000
- (6) Stein, B. and Reynolds, J. S., *Mechanical and Electrical Equipment for Buildings: Ninth Edition*. John Wiley & Sons, 2000