



THE FACTS
ON PROTECTING
ART AND
ARTIFACTS

Museum collections face eight environmental issues that can threaten collections of all types. Here, we visit two California museums requiring special attention to humidification, chillers and piping, and enabling building staff to keep fighting the dangerous eight after the project is done.

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Designing a museum HVAC system requires a solid understanding of how to best maintain various conditioned space requirements consistent with known local microclimate variability and the preservation needs of the contents of the museum's collections.

Above all, when selecting among the various HVAC systems and operating control strategies available, HVAC designers must carefully consider their combined environmental impacts on valuable collection contents ranging from historical artifacts and irreplaceable rare books and documents, to artwork, specimens of natural history, and much more.

MUSEUM DESIGN CONSIDERATIONS

Eight indoor environmental design issues can threaten collections, thus requiring the attention of MEP engineers and their architect clients: light, rh, temperature, air quality, shock, vibration, pest/mold infestation, and potential MEP system failures.

1. Light damage can be particularly extensive should collection materials undergo permanent photochemical or photo-physical change from overexposure to light. While principally an architectural and operational control issue, protecting against overexposure from daylighting, eliminating UV light, and limiting illumination intensity and duration (exposure) are generally manageable.

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2. Relative humidity range is a well-known risk/control factor requiring careful design consideration and will be highlighted subsequently using an actual case history. Each collection material possesses a level of environmental moisture content (EMC) that contributes to optimum chemical, physical, or biological stability. Where the EMC level is being maintained either too high or too low, the rh is incorrect and needs to be promptly adjusted; otherwise degradation/damage can occur.

3. Temperature ranges for materials must also be controlled. Some polymers used in collections become brittle and are more subject to fracture at lower temperatures. Conversely, damaging chemical processes

are known to accelerate aging at higher temperatures. Recognizing that incorrect temperature at a given space air dewpoint can directly magnify incorrect rh range conditions for important collection materials (e.g., paper and photography), the mechanical engineer must pay careful attention when selecting the HVAC system type, as well as temperature and rh control strategies.

4. Air quality design issues must address both outdoor-generated (via ventilation and infiltration) and indoor-generated gaseous and particulate pollutants. Care in the selection of both gaseous and particulate filtration, including provision for monitoring instrumentation, is essential, along with provision for maintaining adequate

positive indoor pressurization to minimize adverse effects of excessive infiltration.

5/6. Shock and/or vibration (from handling, shipping, operating of mechanical systems, or adjacent surface traffic) can result in long-term damage to sensitive collections. HVAC design considerations are generally limited to: vibration through ductwork, piping, or inadequate isolation of rotating equipment (transmitted to works hung on adjacent walls, etc.), or poor air distribution resulting in active air drafts in contact with collection materials.

7. Pest and/or mold infestation involving insects (consuming collections for food — a housekeeping item) or mold, fungi, and bacteria attacking collection materials can also cause serious damage. For the mechanical designer, mold has become a critical design/liability issue in more recent times. Excessive rh over extended operating periods, particularly in tropical microclimates, can accelerate mold growth, particularly where optimum temperature, available food (including some collection materials) and darkness prevail (e.g., collection storage areas).

8. Natural, pre-construction, and operating mechanical system emergencies (leaks through openings in exterior building envelopes, air handling drain pans flooding, leaking piping in walls to which collections are attached, etc.) are fortunately quite rare. Early discovery or prevention requires an appropriate response policy by both museum and contractor personnel. If damaging mold is to be avoided from a mechanical engineer's design perspective, every effort should be made to locate water piping and other utilities (storm and roof drainage piping, etc.) away from museum areas that are likely to house valuable and often irreplaceable collection objects.

CASE HISTORY: NEW MUSEUM HVAC REDESIGN CHALLENGES

One of California's best-kept museum secrets is San Sylmar, a unique and beautifully appointed exhibit museum located in the foothills of the San Gabriel Mountains. Here visitors can find one of the world's most outstanding collections of beautifully restored antique, classic, and special interest automobiles and mechanical musical instruments, including a 1917 Wurlitzer theater pipe organ.

The organ is located on the top floor along with music boxes and orchestrations

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(formerly used in ballrooms in place of an orchestra and comprising a piano, accordion, and percussion) and is still functional. It was painstakingly collected over the years by famed collector J.B. Nethercutt and his wife, Dorothy. The walls and staircases leading to the top floor are decorated with musical notes and clouds that house additional Nethercutt collection items. Adjacent to the top floor is an elaborate Louis XV-style dining room where the Nethercutts entertained their invited guests.

San Sylmar's collection may seem a bit out of place in its working class neighborhood, which is literally surrounded by factories. The Nethercutt Museum, which beautifully complements San Sylmar, is located across the street and houses a 1930 Cadillac, 1913 Rolls-Royce, and a 1933 Duessenberg Arlington Torpedo sedan, along with a 1934 Packard Dietrich convertible sedan, and a rare 1948 Tucker, along with an array of antique cars, most of which were formerly housed at San Sylmar.

When one enters the building through the 10 ft-high solid bronze double Renaissance cast doors, they will find an array of restored vintage cars. After first receiving a brief history of the museum, one is directed by a curator into the Grand Salon, with its spectacular black and dark green marble floors, long marble columns, and crystal

chandeliers where the remaining Nethercutt car collection, including a 1906 Franklin and a 1912 Cadillac (with mother-in-law seat) is housed. At the top of the staircase leading from the Grand Salon are a 1927 piano and a 10-ft mahogany Tiffany clock.

MAJOR PROBLEMS AVERTED DURING CONSTRUCTION

Design Build Systems' (DBS) involvement began with a phone call from the owner of a well-known Southern California mechanical contracting company. DBS had already worked with the firm on a number of major commercial, industrial, and institutional projects. They also had worked with one or more of Nethercutt's industrial firms, Merle Norman Cosmetics and Nethercutt Laboratories. Although not involved with the then ongoing construction at San Sylmar, the owner was asked by Nethercutt to recommend a MEP consultant to conduct an independent review of the project's D-B mechanical contractor's installed system, in light of concerns regarding the HVAC system's suitability for housing his extensive personal collection.

In addition to the priceless museum collection items, Nethercutt's planned penthouse residence at San Sylmar would have to accommodate 15th- and 16th- century interior wood paneling and other similar antique furniture.

Following a walk through of ongoing construction at San Sylmar with Nethercutt and a brief review of MEP construction documents available at the jobsite, we estimated that San Sylmar was then 65% to 70% complete. The HVAC system consisted of a series of commercial, vertical self-contained, DX-type, packaged, water cooled air conditioners located on a number or rear facing metal balconies with ductwork penetrating the adjacent exterior walls. However, there was no provision made for humidification. It soon became clear that there must have been some disconnection between the D-B mechanical contractor retained by Nethercutt and his San Sylmar HVAC system requirements.

Our initial concerns were explained to Nethercutt, including the possible delays to ongoing construction schedules that could arise. In view of probable redesign issues we might uncover during our peer review, we agreed to proceed with this assignment provided we were allowed to take over immediate control of all construction management at San Sylmar, including instituting a formal changeorder review/authorization process (which did not then exist). Nethercutt agreed to our retention conditions and immediately scheduled a meeting to introduce Meckler Associates (MA) to his entire consultant/construction team. Nethercutt had personally hired his initial team as an owner-builder working through his structural engineer and a well-known interior design firm as his prime professionals. Since Nethercutt had hired no architectural firm, it became clear to us that San Sylmar was literally designed from the "inside out" by the above referenced prime professionals and D-B contractors.

Our first action item at the kick-off meeting with Nethercutt's team was to stop all HVAC and ceiling construction work until our design analysis could be completed and, if needed, new construction documents issued.

Our second action item was to institute a formal changeorder submission/approval process requiring that no new work could proceed without a formal changeorder approval from our office. We distributed forms and written instructions required to process and receive owner/MA approval. Payments were authorized promptly following timely inspection of actual work progress as confirmed by our firm's field personnel.

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Where discrepancies between our own MA estimates and changeorder requests existed, we met weekly with the affected MEP subcontractor and general construction trade personnel to resolve differences. Fortunately, we received excellent cooperation and generally prompt submission of the required documentation. We, in turn, provided fair, prompt treatment to all changeorder requests

with subcontractors, also moving more aggressively toward earliest possible completion and beneficial occupancy for our client.

As a result of the subsequent MA-completed MEP design analysis, it was determined that 150 additional cooling tons would be required to accommodate visitors at peak building cooling demand. This required substantial redesign of ductwork, installation of automatic temperature and humidity controls, additional fans, and larger fan motors.

In addition to modifications to existing package air conditioners to accommodate additional new chilled water cooling coils and new high-efficiency filters, electric steam humidifiers and a new 150-ton air cooled chiller, associated new piping, chilled water pumps, manual and automatic valves, supports, a new chiller platform, and sound traps were also installed. This hybrid design approach, which included the physical integration of a separate chilled water distribution system to supplement the existing vertical package air conditioner deficiencies, saved countless dollars and reduced the overall time needed to upgrade and complete San Sylmar.

More importantly, commissioning efforts and joint operator training confirmed compliance with our upgraded design/operating specifications and enabled San Sylmar building operators to become familiar with our hybrid HVAC system's seasonal modalities prior to and continuing through start-up.

San Sylmar opened shortly thereafter to large visitor crowds and rave reviews. Except for some subsequent downtime for needed repairs immediately following the 1994 San Fernando Valley earth-



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quake, weekly tours have remained available to the public, Tuesday through Saturday.

Had the original D-B mechanical contractor paid closer attention to the above described museum design considerations (namely #2, 3, and 4), much time and client expense could have been saved.

CASE HISTORY: UNIVERSITY MUSEUM PRESENTS REMODELING CHALLENGES

Located in north Orange County, California State University, Fullerton (CSUF) is home to more than 30,000 students. CSUF is a comprehensive university and is located about 30 miles east of downtown Los Angeles and Hollywood and is in close proximity to major museums and the entertainment and design industry of Los Angeles and Orange Counties.

The Department of Art is one of three departments within the College of Arts at CSUF and the department considers itself uniquely positioned to meet 21st-century art challenges.

Since 1963, the Main Art Gallery at CSUF has brought to the campus carefully developed art exhibitions that instruct, inspire, and challenge the visual arts student. Museum caliber exhibitions of national interest are presented to the entire student body, faculty, and the community. These act not only as an educational tool, but also create interaction between various departmental disciplines and between the campus and the community. In 1970, the Main Art Gallery was housed in its current permanent location within the Visual Arts Center. Since then, the gallery has earned national visibility for its program in Museum Studies and Exhibition Design, in which museum pre-professionals may obtain both conceptual and practical experience.

The Visual Arts Center at CSUF not only offers bachelors and masters degrees in various aspects of fine art, but also offers a program in Museum Studies. The Main Art Gallery at CSUF hosts four museum-quality shows a year exhibiting internationally known artists, and the 3,000-sq-ft facility is somewhat unique in that the gallery serves as a laboratory for students learning the “art” of managing a museum. The facility has removable walls that allow for

a variety of collection configurations.

Prior to Goss Engineering, Inc.’s (GEI) involvement, the curator had serious challenges, since the art gallery was connected to the main building HVAC system. One challenge was that the building energy management and control system (EMCS) operated the building HVAC system, turning it off in the evenings and on weekends. This operation was incompatible with the evening programs and weekend shows, and required the curator to make special arrangements with physical plant operators who would override the control system. This arrangement proved somewhat unsatisfactory due to coordination challenges (arrangements between different departments) and the fact that the whole building would be conditioned in order to serve the Main Art Gallery, which GEI found to be an obvious waste of energy.

Additionally, the building HVAC system was not designed for precise temperature and humidity control requirements. In fact, the existing building HVAC system had no humidity control at all.

The solution was a standalone unit for the gallery. The design involved the installation of a new 10-ton packaged heat pump HVAC system to precisely control temperature and humidity. Humidity control is maintained at 50% rh.

The GEI design team was also recognized for its work on the project by SCE (the local electric utility) for its successful retrofit of the Art Gallery lighting system.

LESSONS LEARNED

Maintaining close working relationships between the mechanical and other design engineers (electrical, structural, acoustical, etc.), client/operator representatives responsible for preserving the collection, architects, interior designers, curators responsible for assembling future exhibits, museum conservation personnel, and client pre-selected contractors or equipment vendors, where applicable, is essential to overall program success and to avoid subsequent damage to planned and/or future museum collection items.

Equally important is a clear understanding of current and foreseeable collection needs. Lack of attention to any one or more of the above referenced eight major HVAC design considerations can lead to major operating problems for clients, potential costly litigation exposure, and/or damage to a MEP design firm’s reputation. **ES**

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