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The story behind blimps, goosenecks, plungers and icebergs

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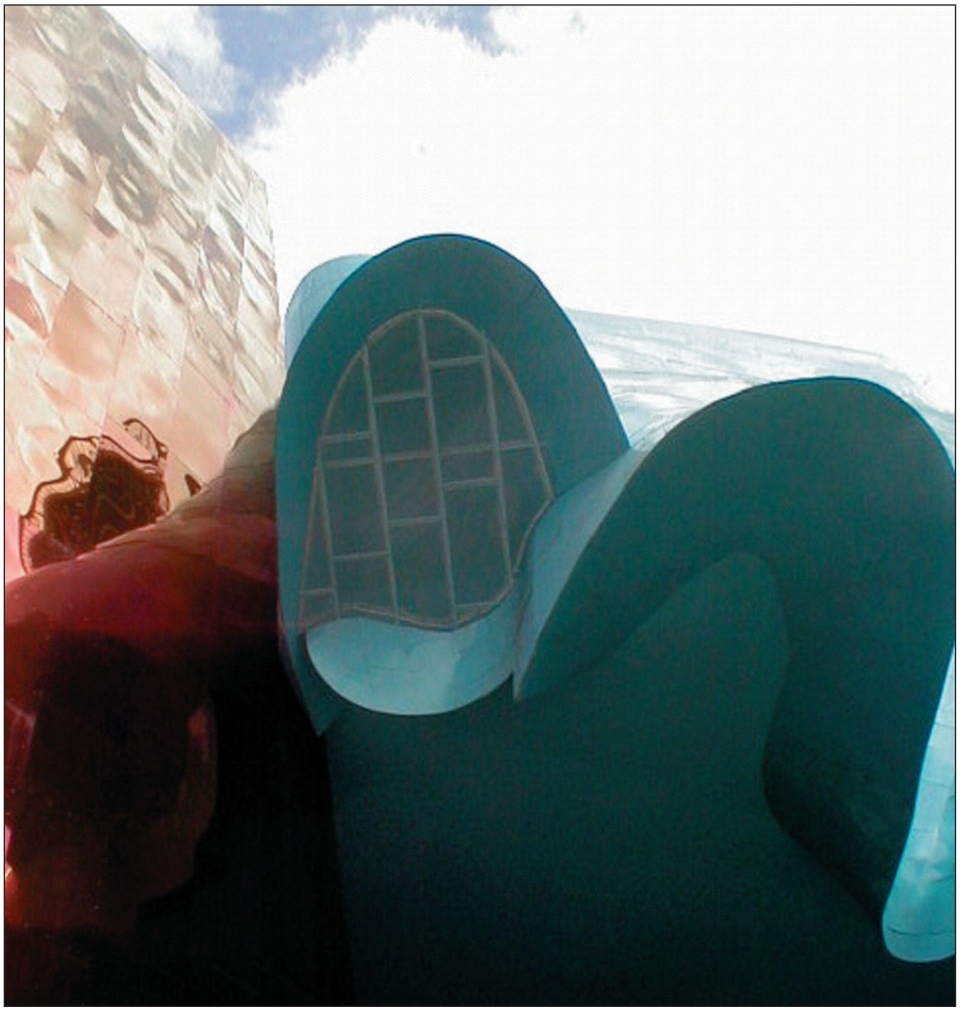

The lights dim and "show smoke" puffs out in waves across the room. Everyone waits with anticipation. Not for the music to start, but rather for the smoke alarms to blare. No noise is good news, even music to the ears of the Notkin mechanical engineering team.

Duplicate this situation hundreds of times throughout the project and you begin to understand the day-to-day details of designing heating, ventilation and cooling systems for a complicated structure with unique environmental requirements.

Like a chameleon, EMP's mechanical system is constantly adapting the climate of each building area, maintaining a 2 to 3 percent difference in air temperature and humidity to preserve artifacts at optimum conditions. Add the challenge of providing systems flexibility for a myriad of different space uses and numbers of people, as well as containing noise and vibration, and you have a system that goes beyond standard engineering practices.

Breathing life into EMP

One place visitors will not likely see is the main mechanical room, filled with a dense maze of ducts, conduits and piping serving various zones in the building with chilled water, hot water, potable water, nonpotable water for humidifiers, as well as industrial-level compressed air for exhibits.

Serving as "lungs" for the building, the ventilation equipment alone distributes air throughout the building at the rate of 210,000 cubic feet/minute -- enough air to fill a Goodyear blimp every minute.

To avoid running miles of ductwork and piping in ceiling cavities, four other satellite locations house other mechanical systems, totaling about 12 percent of the 140,000-square-foot facility (not counting systems housed in ceiling cavities). You have to look closely to find these satellites -- the first over the bridge topping the monorail, one in the top doughnut of Sky Church, another in the ceiling of the parking garage, and the last in the café, where a third level houses just the mechanical room.

In refrigeration terms, cooling is measured in terms of tons of ice. Cooling EMP's interior required a 1,000-ton chiller or cooling plant. "Think iceberg," says Dick Geoghegan, one of Notkin's senior engineers. "Enough heat is generated in the building to melt an ice cube the size of a 4,000-square-foot house every hour."

Heightened power loads meant increasing cooling capacity by more than 50 percent than originally planned and a third chiller became necessary. Cooling loads well in excess of 120 watts per square foot were designed in the exhibit support rooms to handle the high-end electronics, exceeding what is normally found in computer mainframe rooms.

Integrating systems with building aesthetics

Looking down at EMP from the Space Needle, it's difficult to spot the black slash in the roof, which is an air well providing outside air to the air-handling unit serving Sky Church and elevator fans.

Other areas on the exterior skin feature folds that capture outside air. One wall houses an elaborate "goose neck" where outside air comes in underneath the fold, turns back on itself, and then moves down through a shaft inside the

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building to the basement where air handling units are located in the mechanical room.

Inside the facility, exposed ductwork enhances the building aesthetics. LMN architect David Arnold explains: "After extensive trial-and-error and research with building models, Notkin found the perfect balance for routing ductwork in either an understated way along the architectural lines of the building shell or as a graceful link to other exhibits." Even reflected light from surrounding colored walls on the galvanized steel of some ductwork adds visual excitement to the interior.

Creating a giant air plunger

Enter Sky Church, a 64-foot atrium with a 40-by-70-foot LED screen, and you immediately understand the magnitude of ventilating, heating and cooling a space serving small groups of visitors who are touring the facility at 11 in the morning, and then 500 people rocking out at an evening concert.

To achieve efficient air movement, air is distributed from the top of Sky Church, then pushed down to a partial extent like a giant air plunger, which then falls down the rest of way because it is cooler. The air is returned via grilles located near the floor and the plunging process is repeated.

Minimizing and capturing heat to save energy

A major challenge in the Sky Church area was to save energy and avoid high heat gains from the LED screen. Heat load testing performed at a similar screen installation in California led to a cost-effective and low-energy solution. Now a small dedicated fan coil unit throws cooled air down behind the screen, rather than a costly and larger 100-ton air-conditioning unit serving the entire space.

Any excess heat that is generated in the building is reused for heating and humidity control in other building spaces. With a "load shedding" program, non-critical areas like the classrooms or lobbies can rise up 2 degrees so that cooling capacity is saved for critical areas like the guitar gallery where small rises in temperature could cause cracking and stress in 100-year-old guitars.

Containing noise and vibration

When entering the lobby, you won't be able to hear visitors experiencing their own rock star moment in the sound box floating in space above you. Ductwork is acoustically clad with special shock wall construction so rock concert noise levels would not be transmitted to other areas of the building.

Even museum staff sitting in the administrative area directly below the Artist's Journey ride will not be disturbed by the high-energy noise effects and vibration. A large isolation area between the two spaces contains ductwork on springs. Like other areas of the building, no hard connections exist between any moving device and the distribution system.

Maintaining a rain-free environment

"In 1999, a low-density office area was converted into an assembly area holding artifacts where temperature and humidity had to be held to very tight tolerances," explains John Rowland, president of Notkin Engineering. "When skylights posed the potential of condensation dripping on artifacts below, infrared heaters became a low-cost and effective solution."

Another example is the entry to Artist's Journey. To ensure that moisture on the glass lid doesn't "rain" on people or

the electronics, sensors mounted in the mullions constantly measure the glass temperature and the amount of dehumidification occurring in the space.

Responding to future change

Since EMP will be constantly evolving in space uses and technology, optimum flexibility in the mechanical system was paramount. The building's flexible infrastructure will continue to control changes in the environment, but don't be surprised if you hear the whisperings of HAL in 2001 Space Odyssey. This means that everything's working, just as planned.

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