Stratified Systems Case Study Library

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The Science of Comfort™

Project: **San Francisco International Airport: Terminal 2**

Named one of the top 5 terminals in the world *- Skytrax*

Healthiest Workplace for Large Companies - *San Francisco Business Times*

Best Infrastructure - *San Francisco Business Times*

Location: **San Francisco, CA**

Project Cost: **$383 million**

Square Footage: **640,000 ft²**

Lead Architect: **Gensler**

Associate Architects: **Michael Willis Architects & Hamilton Aitken Architects**

Mechanical Engineer: **SJ Engineers**

Sculptor: **Janet Echelman**

Price Representative: **Norman S. Wright**

The Challenge: In 2008, the San Francisco International Airport (SFO) embarked on a renovation project to restore the historic Terminal 2 (T2). Minimizing the building's environmental footprint and achieving LEED certification were crucial goals of the terminal's design. The architect's design vision required that custom diffusers integrate seamlessly into the space. It was imperative, however, that the special design not negatively impact performance.

The Solution: Price designed the custom diffuser to Gensler's specifications, employing their state-of-the-art laboratory to confirm the diffusers would work as expected, and also to provide smoke test videos demonstrating the airflow patterns. In buildings with high ceilings, displacement ventilation has the advantage of conditioning only the occupied zone and not the large volume of space above it. This reduces supply air volume, thereby reducing utility cost. In addition, given the higher supply air temperature of displacement (around 65 °F), the building can increase economizer hours to take advantage of "free cooling." These energy savings were critical to the terminal achieving its sustainable design goals and LEED targets.

Project: **JE Dunn Construction Headquarters**

Location: **Kansas City, Missouri**

Project Cost: **$22 million**

Sq. Ft: **204,227 ft²**

Architects: **BNIM/360 Architects**

Mechanical Engineer: **Lankford Associates**

Mechanical Contractor: **Barnes & Dodge**

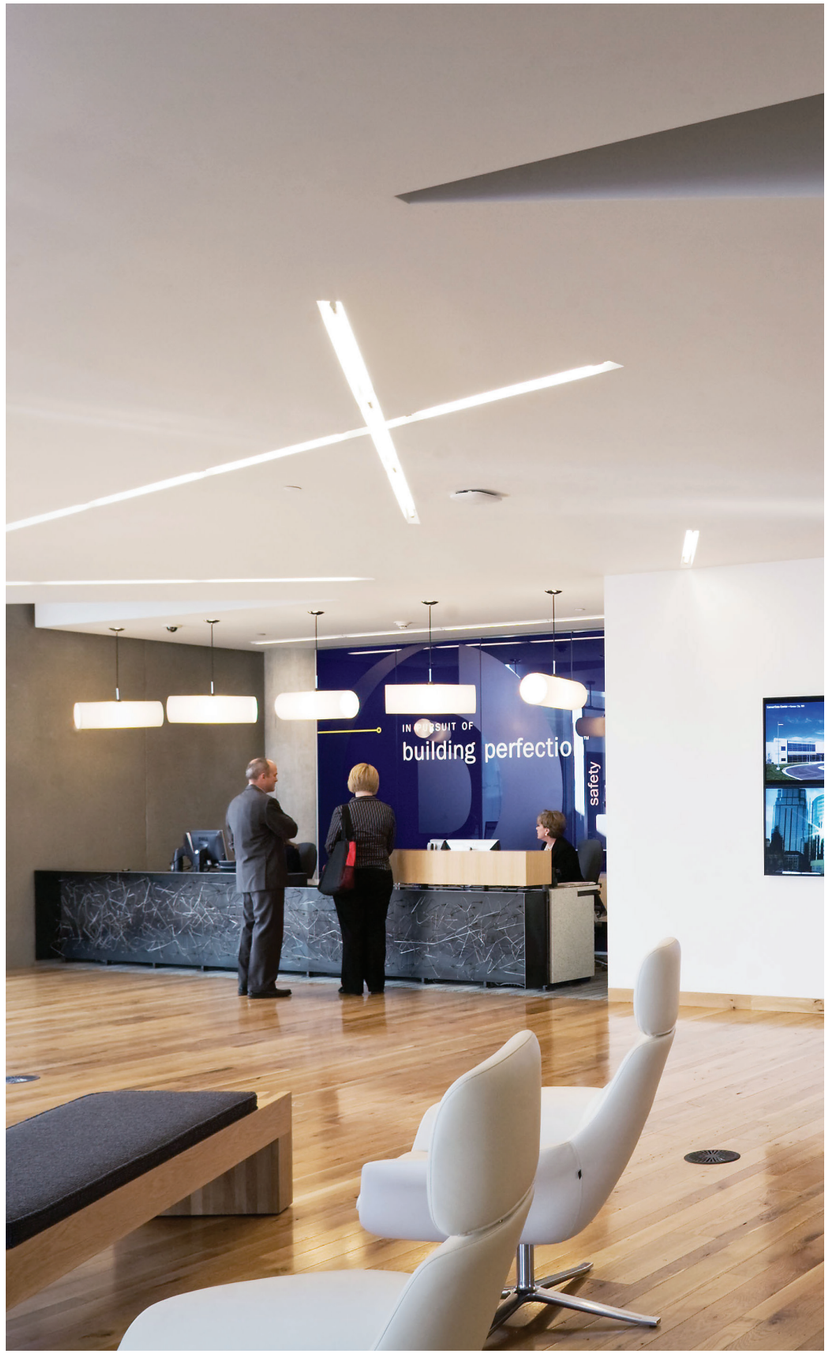
Price Representative: **Jorban Riscoe Associates**

The Challenge: JE Dunn is one of the largest general building contractors in the United States and a leader in sustainable design. As a reflection of their commitment to sustainability, they set aggressive LEED targets for their new world headquarters office building, located on the eastern edge of downtown Kansas City.

In order to create the perfect "model" of a high performing office space, the company needed an air distribution system that would help achieve LEED Gold status through superior energy efficiency while also offering maximum flexibility. Finally, the highly variable climate of Kansas City, along with the building's exterior being primarily glass, meant that both heating and cooling needed to be incorporated into the HVAC system.

The Solution: The desire for a highly flexible, energy efficient workspace led to the implementation of a raised access floor and Price Underfloor Air Distribution System (UFAD) system. JE Dunn has worked on numerous UFAD projects and wanted to use their Headquarters as a live demonstration of the advantages offered by it. The thermal stratification created by UFAD is a significant contributor to the reduced HVAC energy consumption. Additionally, stratification improves indoor air quality as contaminants are moved out of the breathing area as the warm air rises, and then removed via high level returns.

This improved energy efficiency, along with the individual comfort control offered by Price's face-adjustable UFAD diffusers and improved indoor air quality all contributed to JE Dunn successfully achieving its LEED Gold target at an energy usage of only 2 watts per square foot.



Project: **Legacy Junior High School**

Location: **Layton, UT**

Square Footage: **163,000 ft²**

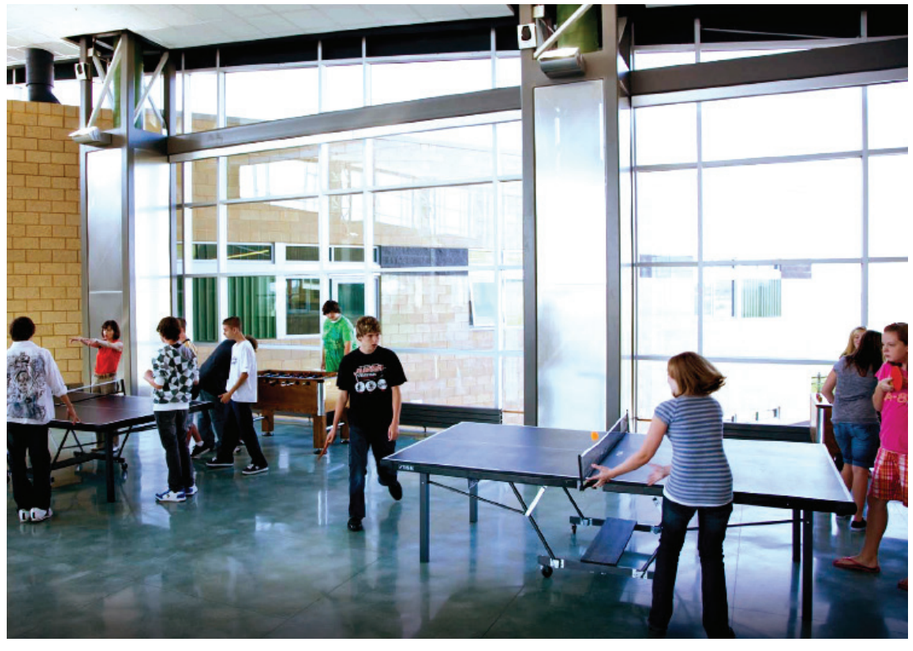
Arcitect: **VCBO Architecture**

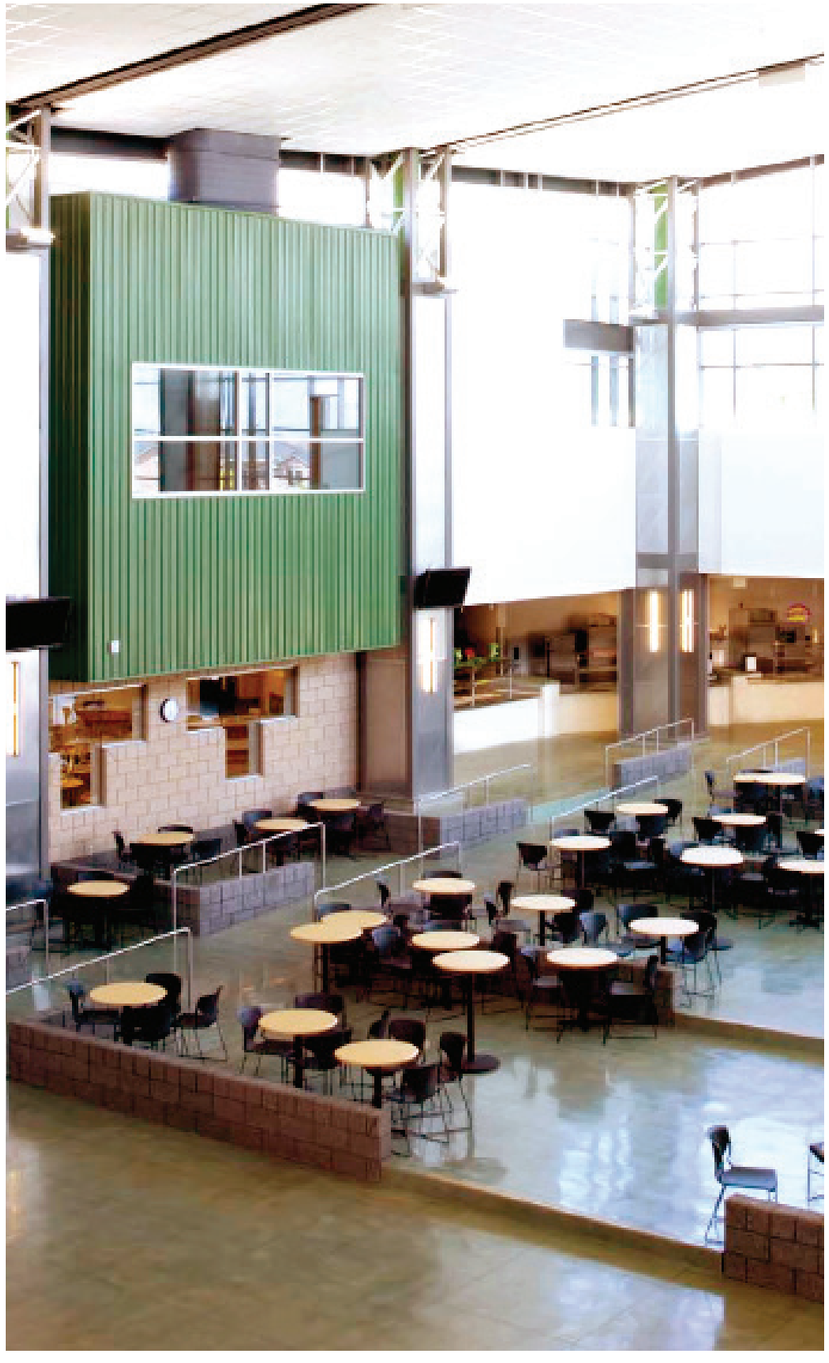
Engineers: **Van Boerum & Frank Associates, Inc.**

Price Representative: **Midgley Huber**

The Challenge: The Davis School District in Utah has long been dedicated to creating environments that maximize student learning potential. With this objective in mind, the district challenged Price to design a central heating system that was comfortable and student-oriented. Improved air quality was a primary design goal, as quality air has been shown to increase student performance and reduce airborne illness. It was also essential that the chosen HVAC system was quiet – a critical design consideration for all schools – as well as aesthetically pleasing. Any additional energy savings would be considered a bonus.

The Solution: Displacement diffusers from Price were incorporated throughout the school, including classrooms and common areas. Keeping with the architect's design specifications, the diffusers were placed in opposing corners of the classrooms. The architect, engineer and Price worked together to ensure that the diffusers were integrated seamlessly into the school's infrastructure. The warmer, lower velocity air from the displacement ventilation system minimized cool drafts and helped students stay comfortable and concentrated. The system was also extremely quiet and energy efficient, resulting in Legacy Junior High being recognized for their commitment to environmental sustainability.





Project: **Manitoba Hydro Place**

Building of the Year, 2009 - *ArchDaily*

Honourable Mention for Innovation in Architecture - *The Royal Architectural Institute*

Location: **Winnipeg, MB**

Project Cost: **$278 million**

Square Footage: **695,250 ft²**

Architects: **KPMB Architects and Smith Carter**

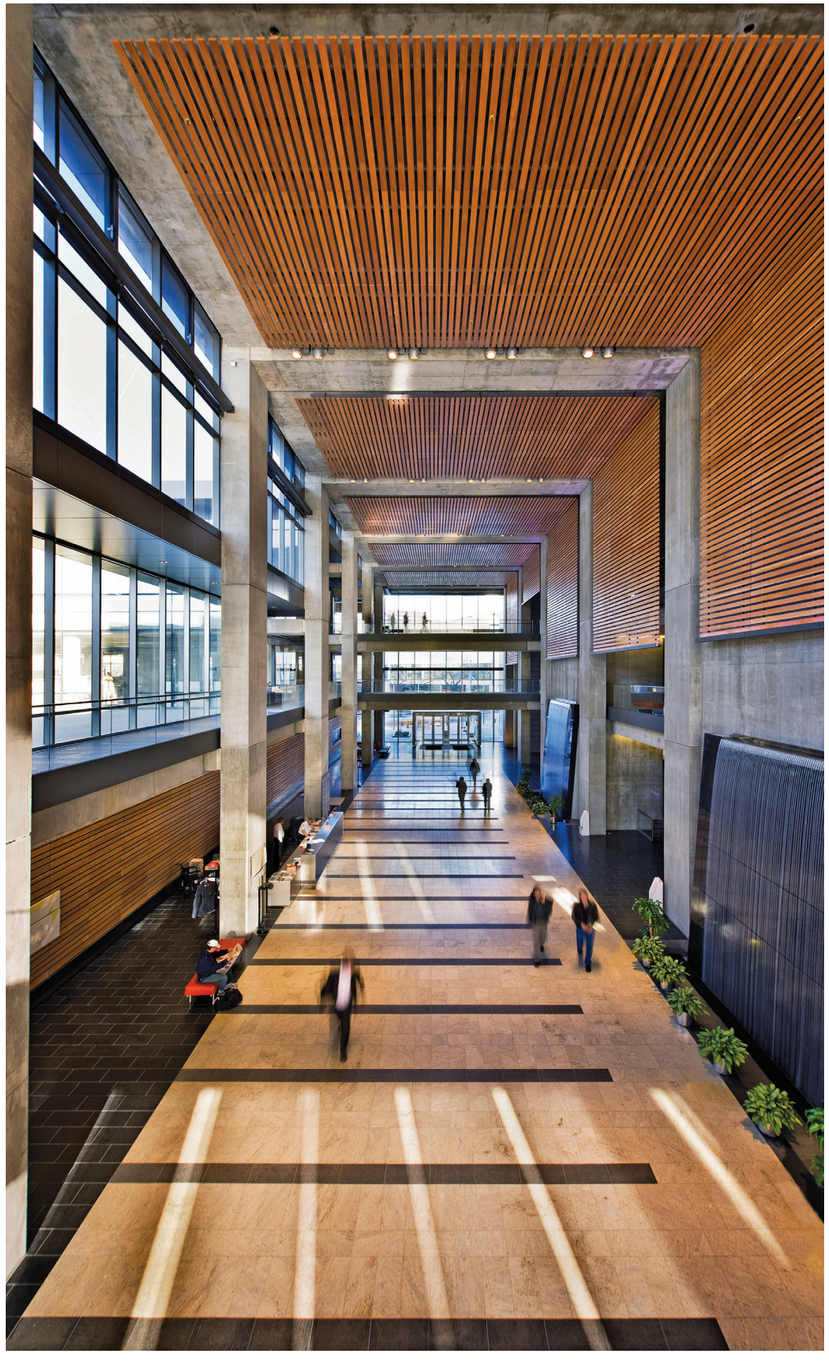
Mechanical Engineer: **AECOM**

Energy/Climate Engineer: **Transsolar**

Price Representative: **E.H. Price, Winnipeg**

The Challenge: Superior energy efficiency was a design mandate throughout Manitoba Hydro Place, the new headquarters of Manitoba's primary energy utility. Therefore, delivering ventilation air in an efficient way was essential. The design of the building called for high ceilings in the gallery. If overhead mixing ventilation were used to condition the space, a significant amount of energy would be wasted cooling the unoccupied zone in the upper levels. However, if a ventilation system were installed at eye-level, as is common in displacement systems, it would be essential that the diffusers be integrated into the gallery's architectural design vision.

The Solution: Manitoba Hydro Place's ambitious energy efficiency goals made Price Displacement Ventilation a natural choice. Displacement ventilation results in room air stratification, and causes warm, contaminated air to collect at high levels outside the occupied zone. This had the dual benefit of improving air quality and saving energy. Additionally, the system didn't condition the air above the gallery's occupied zone, resulting in reduced supply air volume and fan power energy savings. To ensure that the diffusers fit into the architectural design of the gallery, Price supplied customized black DF1R Diffusers. These were recessed into the wall and featured false corners, so the diffuser had no breaks from one end of the room to the other.



Project: **Kauffman Center for the Performing Arts**

Grand Conceptor Award, 2013 (Best Overall Engineering Achievement) - *American Council of Engineering Companies*

Location: **Kansas City, Missouri**

Square Footage: **285,000 ft²**

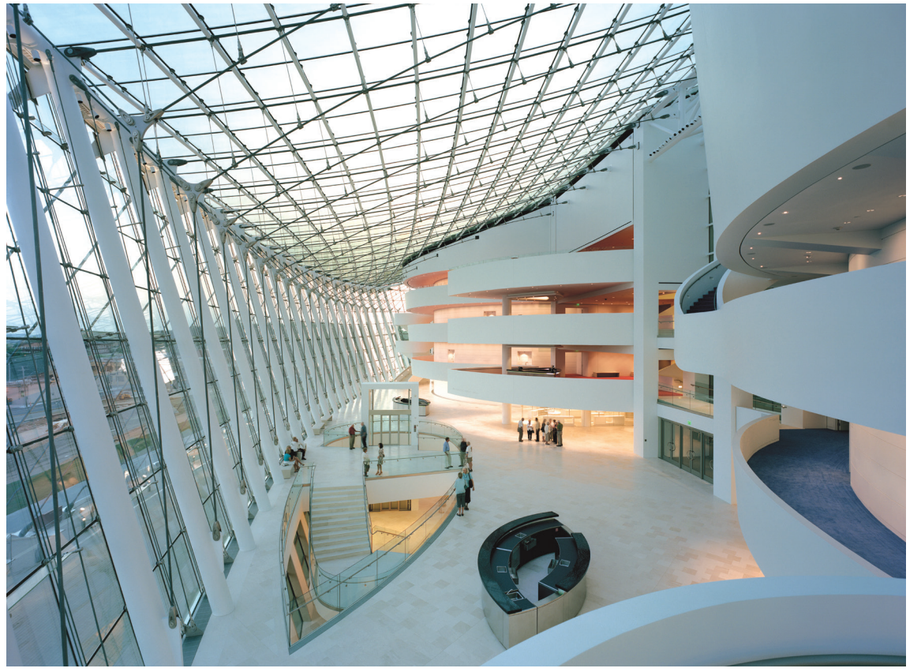
Design Architect: **Moshe Safdie Architects**

MEP/Fire Protection Engineers: **Arup USA Inc.**

Price Representative: **Jorban Riscoe & Assoc**

The Challenge: The primary goal of the Kauffman Center design team was simple: maximize patron comfort. Achieving this, however, was no easy task. Placing underfloor diffusers beneath auditorium seats offered distinct energy efficiency advantages, but also risked creating uncomfortable drafts around the ankles of theater-goers. Additionally, the theater's sound-conscious design demanded that the HVAC system be both quiet and hidden. The Center's lobby – a four-story atrium with 40,000 ft² of glass and high solar load – posed another challenge. It was clear that efficiently conditioning the open space would require a hybrid approach combining a variety of air delivery methods, including underfloor air distribution and displacement ventilation.

The Solution: Extensive firsthand witness testing was conducted before finally selecting an underfloor solution. Price responded with short lead times and collaborated closely with the engineer, architect and contractors to help achieve a stunning and functional solution. Price was the only manufacturer with the custom capabilities required to design and produce the more than 100 feet of custom curved linear floor grilles that wrap the exterior wall, theaters and staircase. The diffusers blend seamlessly with the space. The chosen solution has significantly reduced the building's energy usage, as conditioning the atrium using traditional overhead air distribution would have tripled or quadrupled the required air volume.



Project: **RBC Centre**

Location: **Toronto, Canada**

Project Cost: **$400 million**

Sq. Ft: **1.2 Million ft²**

Architects: **Kohn Pedersen Fox Associates; B+H Architects; Sweeny &Co Architects**

Mechanical Engineer: **The Mitchell Partnership Inc.**

Price Representative: **E.H. Price Toronto**

The Challenge: Before beginning work on this new 43-storey building, the design team was challenged with two important goals: minimize the building's environmental footprint and achieve LEED NC certification. These crucial benchmarks would not only limit operating costs for owners and tenants, but also provide a comfortable environment for those working in the building.

The building's owner had the additional challenge of educating tenants on how to control the ventilation system in their own environments.

The Solution: The building's height and resulting environmental impact were minimized by using Underfloor Air Distribution (UFAD). The depth of the raised-floor plenum used in UFAD is significantly less than that of a suspended ceiling used to house a traditional overhead system. The energy efficiency inherent to UFAD played a substantial role in RBC Centre achieving a 40% energy cost savings, and these sustainable design features have led to numerous urban and sustainable design awards.

UFAD diffusers provide office inhabitants with a superior work environment, allowing customization of their individual work environments to suit their personal preference. Noise levels are also relatively low, minimizing distraction. The upward airflow of a UFAD system draws contaminants away from the occupied zone, leading to higher indoor air quality (IAQ) than a traditional overhead system. Price continues to work with the project engineers to retrofit products and ensure that the tenants are properly educated on the use of climate controls.

Project: **Banner Health Center Maricopa**

Location: **Maricopa, AZ**

Project Cost: **Estimated $15.3 Million**

Sq. Ft: **40,000 ft²**

Engineer/Architect: **SmithGroupJJR**

Price Representative: **Air Specialty Products**

The Challenge: Banner Health is one of the largest non-profit health care systems across the US. In addition to providing premium patient care, Banner Health has also been nationally recognized for work in improving facility operations and staff training. This demonstrated investment in patient service through innovation has inspired a long-term partnership between Banner Health, SmithGroupJJR, and Price, and this partnership was the foundation for the new construction of the Banner Health Center Maricopa project. Banner Health approached the engineers at SmithGroupJJR to develop a template for prototypical primary care outpatient clinics. The goal of producing this mechanical template was to optimize future facility planning and operations. Banner Health inquired about Displacement Ventilation (DV) in particular, and SmithGroupJJR supported DV as an excellent fit for Banner Health's new facility, given the organization's operational values of ensuring maximum comfort and healthy environments for both patients and staff.

The Solution: SmithGroupJJR involved Price in the design process, where Price assisted in substantiating DV as a viable option for Banner Health projects in several ways. First, Price hosted an operations team from Banner Health at Price Technical Center West, demonstrating mockup capabilities. Then, Price supplied DV diffusers and heated mannequins, and Banner Health designed and provided instrumentation to enable independent on-site testing alongside SmithGroupJJR in a model of a sample room. Finally, Banner Health commissioned Price to conduct Computational Fluid Dynamic (CFD) analyses showing precisely how DV would function in the template Maricopa space.

Potential payback schedules based on energy savings were calculated, and this efficiency, along with DV's significant health and environmental benefits, made DV the perfect choice for this project. After two years of research and testing, Price DV was approved by Banner Health for use throughout the Maricopa facility's public concourses, patient care spaces and staff areas, at an energy usage of only 2 watts per square foot.

Project: **“Foundation Headquarters”**

Location: **Seattle, WA**

Engineer: **Arup**

Architect: **NBBJ**

Development Manager: **Seneca Group**

Price Representative: **Dorse & Company, Inc.**

The Challenge: The campus of this family foundation was developed to consolidate five offices and bring the staff of the organization into the same facility for the first time in a decade. The facility was designed to “create a sense of place that reflects the foundation’s work in health and learning… to connect in a campus-like setting designed to facilitate interaction, collaboration and learning.” (NBBJ)

Design-wise, this translated into plenty of open spaces for employee discussion and sustainable design to promote the health and wellness of the employees sharing the space.

The Solution: The 640,000 ft^2 campus addition leverages a combination of Price’s underfloor air distribution, natural ventilation, and Custom Displacement Solutions to create an environmentally-friendly, energy efficient space for this philanthropic organization.

Underfloor air distribution is used to condition the temperature of the core offices and conference rooms. The atrium features operable windows controlled by the Building Automation System. When these windows are closed, high-level natural ventilation terminals with integrated hot water coils operate in minimum ventilation mode.

In addition, Price linear bar grilles and slot diffusers follow the perimeter windows throughout the entire campus to help maintain thermal comfort throughout the year.

Project: **California ISO Headquarters**

Award of Excellence for Sustainable Design - *Structural Engineers Association of California*

Best Office Project - *Engineering News-Record California*

Location: **Folsom, California**

Project Cost: **$140 Million**

Square Footage: **278,000 ft²**

Architect: **Dreyfuss & Blackford Architects**

Mechanical Engineer: **Frank M. Booth, Inc.**

Price Representative: **Norman S. Wright**

The Challenge: When designing its new headquarters, California ISO had two fundamental goals in mind: demonstrating energy leadership and providing a work environment that would position them as a preferred employer for technical and engineering professionals. The team set a goal of 25% less energy usage than outlined in California's Title 24 standard, and targeted LEED certification as a benchmark. Achieving high indoor air quality and thermal comfort while maintaining an architecturally pleasing aesthetic was also an important consideration.

The Solution: Due to the building's various functional areas, displacement ventilation was used in conjunction with underfloor air distribution. In the office space, a displacement diffuser with a heat-cool changeover capability was zoned at the perimeter with variable air volume to allow for perimeter heating. Price collaborated with the design team to ensure that the architectural vision for the campus remained intact. Additionally, underfloor air distribution provided the flexibility to adapt to changes in office layout, a common reality in commercial environments. In the end, the California ISO Headquarters exceeded the project's energy performance goals, with the complex projected to operate 40% more efficiently than Title 24 standards.

Project: **Lucile Packard Children's Hospital Stanford**

Location: **Palo Alto, California**

Square footage: **521,000 ft²**

Architect: **HGA & Perkins+Will**

Engineer / Design: **Mazzetti (MEP)**

Price Representative: **Norman S. Wright**

The Challenge: The opening of the Lucile Packard Children's Hospital ("Packard Children's") building in 2017 more than doubled the size of the existing pediatric and obstetrics hospital campus. The overarching goal was to create an environment that aids healing by providing children, expectant mothers and visitors with warm, comfortable, light-filled and uplifting spaces, while prioritizing air quality, innovation and environmental sustainability.

The Solution: In 2007, the project's engineering firm led a collaborative study on alternate air distribution systems. The study found that displacement ventilation (DV) is as or more effective than standard dilution distribution systems for control of particulates in a patient environment. The study also found that DV greatly reduced energy consumption and increased overall ventilation effectiveness. These results became the basis for the design of Packard Children's. The project adopted DV in the following areas:

- **Patient rooms**: Low sidewall DV with radiant heating reduced fan energy, decreased cooling energy, mitigated reheat energy, improved thermal comfort and lessened ambient noise from ventilation, which has been proven to reduce environmental fatigue.
- **ICUs**: Overhead DV system met code requirements while enabling energy savings and promoting occupant comfort.
- **Entrance lobby**: DV was incorporated into the lobby's structural columns (see bottom left and right photos) to seamlessly integrate the mechanical systems and provide efficient air distribution.
- **Integration of air distribution with architecture**: The design team implemented creative ways to use spaces that would usually be considered "waste areas." For example, in Acute Care Unit (ACU) patient rooms, space under television sets was used to deliver low-velocity air into the room.

Packard Children's was the second children's hospital ever, the fourth hospital in the US and the fifth in the world to earn LEED Platinum Certification. This project has also received several award including the ASHRAE Technology Award Case Studies Honorable Mention, AIA/AAH Healthcare Design Award and the Business Intelligence Group Sustainability Award.

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