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CHANDLER'S CATALYST

BY JEFF STANTON, AIA, AND JON SILHOL, P.E.

Before construction of the new Chandler (Ariz.) City Hall, some residents avoided downtown south of the historic core, which consisted largely of abandoned structures, deteriorating parking lots and inappropriate zoning (such as an adult bookstore). Despite this, city leaders took a radical step for a typical suburban community in the Phoenix area by locating the complex in the heart of downtown Chandler with the goal of bringing density back to the city center and catalyzing future development.

At the same time, this seat of local government also lacked an identity as many of its departments were spread across various facilities. The new complex brought these entities together into a single facility, creating a community center that could generate pride for its citizens. The complex is not only a reflection of its community, but also serves its needs.

Implementation of energy and water reduction strategies, the ability of the employees to connect to the natural environment through views and daylighting, employee engagement of their own thermal environment, improved indoor air quality and re-engagement with the community all contribute to defining Chandler City Hall as a high performance facility. The project has spurred the establishment of 10 new downtown businesses, which created 125 jobs, and additional mixed-use developments are planned.

Project Description

The low- to mid-rise government complex covers two city blocks and is bisected by a street. A five-story office tower and two one-story buildings connected to the tower occupy the north block. The tower houses city departments, while one-story buildings contain an art gallery, council chambers and a television studio. The south block is devoted to a three-level parking structure and two one-story buildings, which contain a neighborhood redevelopment office and a print center.

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Opposite **Views looking north along Arizona Avenue and looking east toward the complex courtyard. Extensive glazing is used to improve the pedestrian experience.**

Above **Chandler City Hall's shade scrim has become a community art piece. At night, colored LED lights illuminate the moving panels to provide a kinetic light show.**

Building Envelope

The project demonstrates strategies to reduce a building's overall energy footprint. Situated in a cooling-dominated environment, the first line of defense is the building envelope.

Passive shading strategies along with a high performance envelope help knock out much of the solar heat gain. The office tower is oriented on an east-west axis to maximize north and south exposures while minimizing east and west exposures. The entire facility incorporates cool roof technology, high performance glazing and well-insulated walls and a roof with R-values of R-19 and R-30, respectively.

Computer analysis helped determine optimum spacing and dimensions for shade fins that were installed along the south façade of

BUILDING AT A GLANCE

Name Chandler City Hall

Location Chandler, Ariz. (30 miles southeast of Phoenix)

Owner City of Chandler

Principal Use City hall complex
Includes City offices, council chambers, print shop, parking garage and local TV studio

Employees/Occupants 206

Occupancy 100%

Gross Square Footage 184,900

Conditioned Space 137,692

Distinctions/Awards
AIA COTE Top Ten Green Projects, 2012

Illuminating Engineering Society of North America (IES), Paul Waterbury Award for Outdoor Lighting Design, 2011

Illuminating Engineering Society of North America (IES) Awards of Merit, 2011:

- Outdoor Lighting: Building Façade and Courtyard
- Outdoor Lighting: Art Scrim
- Interior Lighting: Council Chambers
- Energy and Environmental Design: Daylighting and Energy Efficient Design

Total Cost $47 million
Cost Per Square Foot $254

Substantial Completion/Occupancy
October 2010

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Above **The shading canopy outside the entrance to the council chamber lobby helps protect the envelope from heat gains and provides a walking path for pedestrians.**

Below **The project includes a modern council chambers. Much of the wood used in the building is FSC Certified.**

the tower. This design blocks direct sun in the summer, but allows for some penetration during the winter.

The western façade of the office tower features an intricate and artistic shading system that contributes to reducing building energy consumption, but also serves as a civic art piece. This structure consists of more than 1,800 perforated stainless steel metal panels, or "pixels," that individually hang from above, allowing them to swing with the wind.

The perforations are sufficient to allow daylight and views, but shield occupants from a significant amount of glare. At night, colored LED lights, blue from above and amber from below, illuminate the moving panels to provide a kinetic light show. The east façade uses the same hanging perforated panels, but the panels are not lit.

HVAC

A water-cooled system was selected for the project based on required cooling loads, increased efficiencies as compared to air-cooled systems and the distribution and layout of buildings. Water-source cooling is much more efficient than air-side cooling at transferring heat, reducing energy consumption and saving energy.

A central area for the main equipment helped reduce the initial cost. The central plant houses two 300-ton high efficiency centrifugal variable speed chillers. The chilled water system also uses a plate-and-frame heat exchanger, which takes advantage of water-side free cooling when ambient conditions are appropriate.

Chilled water produced by the central plant is distributed to 20 air-handling units (AHUs) located throughout the facility. Many of these AHUs serve an underfloor air distribution (UFAD) system.

The underfloor system reduces energy use, provides flexibility for future remodeling and provides better indoor air quality. The UFAD system is an open plenum without ductwork or "air highways" to minimize the fan energy consumption at the main AHUs.

WATER AT A GLANCE

Annual Water Use 149,853 gallons (estimated)

ENERGY AT A GLANCE

Annual Energy Use Intensity (EUI) (Site) 57 kBtu/ft^2

Electricity (From Grid) 57 kBtu/ft^2

Annual Source Energy 190 kBtu/ft^2

Annual Energy Cost Index (ECI) $1.82/ft^2

Savings vs. Standard 90.1-2004 Design Building 14%

Heating Degree Days (base 65˚F) 983

Cooling Degree Days (base 65˚F) 5,268

Average Operating Hours per Week 78

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ENERGY USE, 2012

	kWh
January	243,700
February	238,300
March	213,060
April	218,440
May	225,620
June	269,560
July	306,106
August	325,180
September	362,460
October	242,220
November	221,180
December	249,840
Total	**3,093,440**

The interior spaces are provided with manual adjustable floor grilles that allow for individual controllability. In the perimeter spaces, fan-powered terminal units with floor grilles have dual openings that automatically adjust to the changing perimeter loads.

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The terrace provides an outdoor place to gather that is largely protected from the sun. Employees gather here for breaks or meetings during the day. Events are hosted here at night.

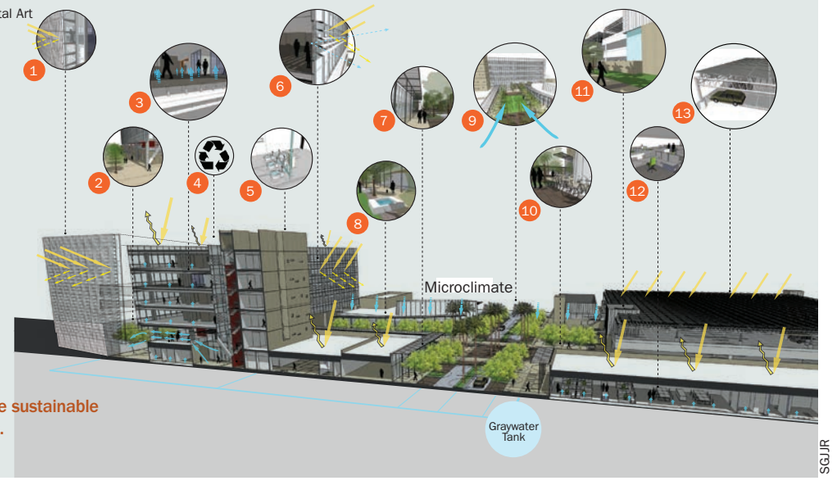
The perimeter-space floor grilles allow supply air directly from the main AHU to serve the space during the cooling mode through a damper, and allow the fan-powered terminal units to be disabled. The damper is closed during the heating sequence, allowing the space to be heated through the fan-powered terminal units.

The fan-powered terminal units include electric resistance heating coils. This design was chosen due the number of heating hours in the metro Phoenix area and initial system cost and payback.

The AHUs also operate under a demand-controlled ventilation strategy, which assists in energy conservation. Dedicated outdoor air units in the tower precondition the outside air before it is delivered into the building. High efficiency motors and variable speed drives are used throughout the facility.

SUSTAINABLE ELEMENTS

1. Low Angle Sun Shading /Environmental Art
2. Shaded Walkways
3. Raised Floor System
4. Building Recycling Program
5. Graywater System
6. Louvers Provide Sun Control
7. Shaded Sidewalks
8. Cooled Microclimate
9. Cooled Breezeway
10. Bicycle Parking and Showers
11. Cooling Tower/Water Feature
12. Flexible Work Spaces
13. Future Photovoltaic Shaded Parking



SGJR

This diagram shows many of the sustainable and energy reduction strategies.

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The owner requires the electrical and data rooms to be conditioned by supplemental systems. A variable refrigerant air-cooled system serves this purpose and reduces the number of condensing units while increasing the efficiency of the system.

The mechanical cooling condenser water system includes a water feature at the southern end of the courtyard that allows the water from the cooling towers to cascade down a wall into a pool. The basin is piped to the condenser water pumps.

As the prevailing winds enter the courtyard, an evaporative cooling effect is created. This effect, in combination with landscaping and shade structures around the courtyard, lower the effective temperature, creating a microclimate.

Lighting

An ambient/task lighting approach reduces lighting power densities throughout the complex. Daylight studies quantified the amount of light that would penetrate the interior and how far it would reach into the space.

Lighting in the open office areas of the tower is designed to take advantage of available daylighting and use energy-efficient fluorescent lighting when necessary. Daylighting control strategies allow lights to be fully dimmed during approximately 80% of daylight hours.

Pendant mounted indirect lighting was chosen for visual comfort and for more uniform light levels. By illuminating the ceiling plane,

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Above A poet and graphic artist created the "Sustainable Pathway," which provides visitors a self-guided tour of the building's sustainable elements marked by descriptive signs that note whether the strategy is socially, economically or environmentally focused.

Top City Hall connects the city's past to the future. Stone relates to the city's history, while curtain wall and louvers systems give it a modern feel. High performance glazing and multiple shade structures are used throughout the project.

KEY SUSTAINABLE FEATURES

Water Conservation: Dual flush valves for all water closets and low flow urinals, lavatories, showers and kitchen sinks. Low water use landscaping and native landscaping. Graywater system uses blowdown water from the condenser water system to supply a majority of the water closets and urinals.

Recycled Materials: Structural and framing steel, aluminum curtain wall and windows, insulation, cabinetry, access flooring, acoustical ceilings, carpet tile.

Daylight Harvesting: Integral photosensors on pendant mounted fluorescent fixtures adjust artificial light levels based on available daylight. Solar light tubes are installed in the one-story building open offices where the floor plates were too deep to allow daylight from the windows to penetrate into the space.

Solar Powered Lighting: Solar powered marker lights in concrete walkways on the top level of the parking garage. They collect power from daylight that is stored in a capacitor and released as LED lighting after dusk.

Individual Controls: Manual floor grilles in the underfloor air system for temperature control. Occupancy sensors with dimmers for private offices. User push button overrides for lighting and HVAC systems.

Transportation Mitigation Strategies: Bike racks, showers on site. Located within a quarter-mile of four bus stops with four different bus routes. Carpool vehicles owned by the city provided in the parking garage with reseved parking spaces. Four electric charging stations provided in garage for city-owned electric vehicles.

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Open offices are located along the perimeter to maximize the number of employees who benefit from natural light and views. These areas, such as this space in the tower, are served by underfloor air distribution.

the number of pendant fixtures was reduced, also reducing costs.

The high performance fixtures use a single T5HO lamp in cross section and are spaced on 15 ft centers for an average of 30 footcandles on the desks. Daylight harvesting zones consist of an 8 ft zone of perimeter fixtures with full dimming and an 8 ft zone of transitional fixtures with full dimming. The remaining space uses fixtures without dimming capabilities.

Photosensors on each fixture in the dimmed zones seamlessly maintain uniform light levels throughout the day as daylight levels change. Single-story portions of the complex use a combination of perimeter glazing and solar light tubes to bring in daylight.

LED lighting installed in the parking garage lowers the garage lighting energy use by 32% when compared to a conventional metal halide solution. Integral occupancy sensors and daylight harvesting photocells that step-dim each fixture drop the wattage an additional 45%.

When unoccupied, the dimmed garage lights lower the lighting power density to 0.033 W/ft^2. The roof deck fixtures are controlled by time clock to turn off during daylight.

Water

As with any facility located in a desert region, water conservation is critical. Inside, low-flow fixtures conserve water, while high-efficiency drip irrigation and low-water use native plants save water outside.

The reuse of graywater in water closets, urinals, outdoor water features and to irrigate landscaping further reduces potable water demand. The condenser water system at the central plant uses a chemical-free water treatment system. Then the water is collected and stored in an underground storage tank and treated with ultraviolet light before reuse.

FAÇADE SHADING STRATEGY: EAST AND WEST

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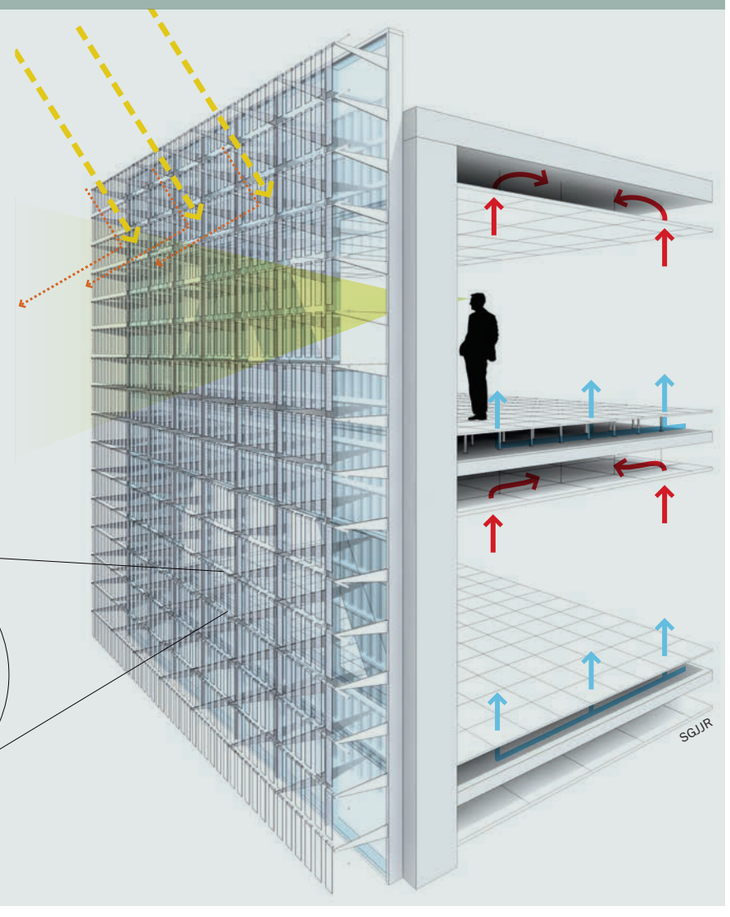
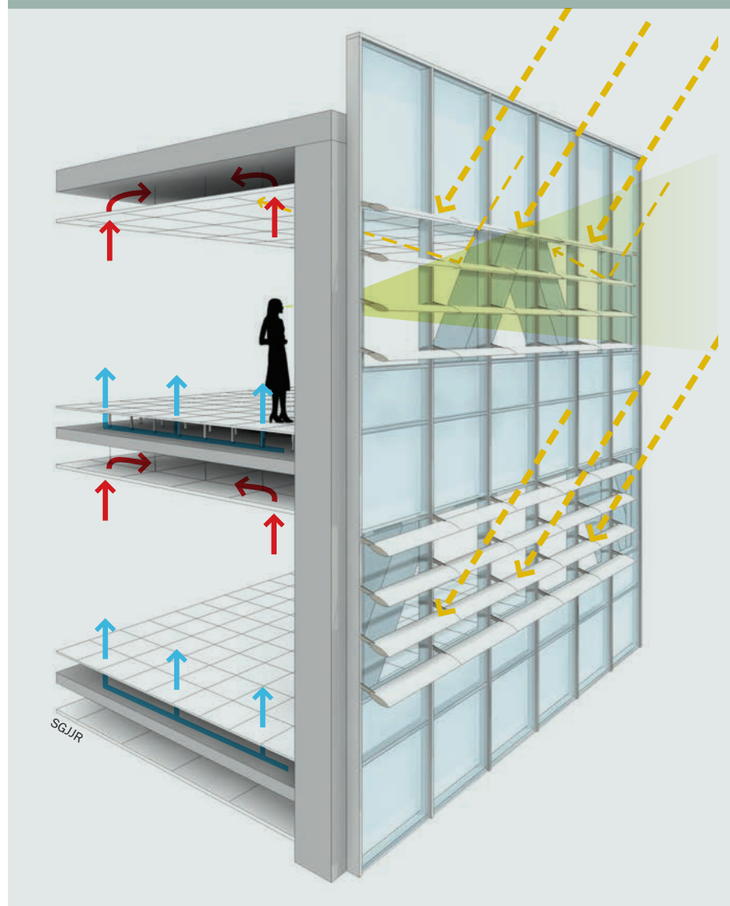
The east-west axis of the building provides minimal exposures along these sides, which reduces the envelope loads. *Turbulent Shade,* a commisioned installation, is composed of individual perforated panels that move with the wind, help reduce sun glare and heat gains on the east and west façades, and act as a public art piece.



FAÇADE SHADING STRATEGY: SOUTH



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Shading fins along the south façade of the office tower are optimized to reduce sun glare and heat gains. The underfloor air distribution system provides better indoor air quality in the office spaces.

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Above **The building's cooling tower water feature creates a microclimate around the pedestrian area. It is lit at night and is part of the campus experience.**

Right **Chandler City Hall has spurred the establishment of 10 new downtown businesses, which created 125 jobs, and additional mixed-use developments are planned.**

Below **The main tower lobby uses natural light and brings the exterior elements inside. It provides a connection from the street into the courtyard.**

During the summer, excess water is generated, so no potable water is used for the exterior systems and the majority of the interior fixtures. Less water is generated during the winter and requires some use of potable water. In all, these strategies are estimated to reduce domestic water use by 69.5% and potable water use for wastewater by 81.4%.

BUILDING TEAM

Building Owner/Representative
City of Chandler

Architect, Mechanical and Electrical Engineer, Lighting Design, LEED Consultant SmithGroupJJR

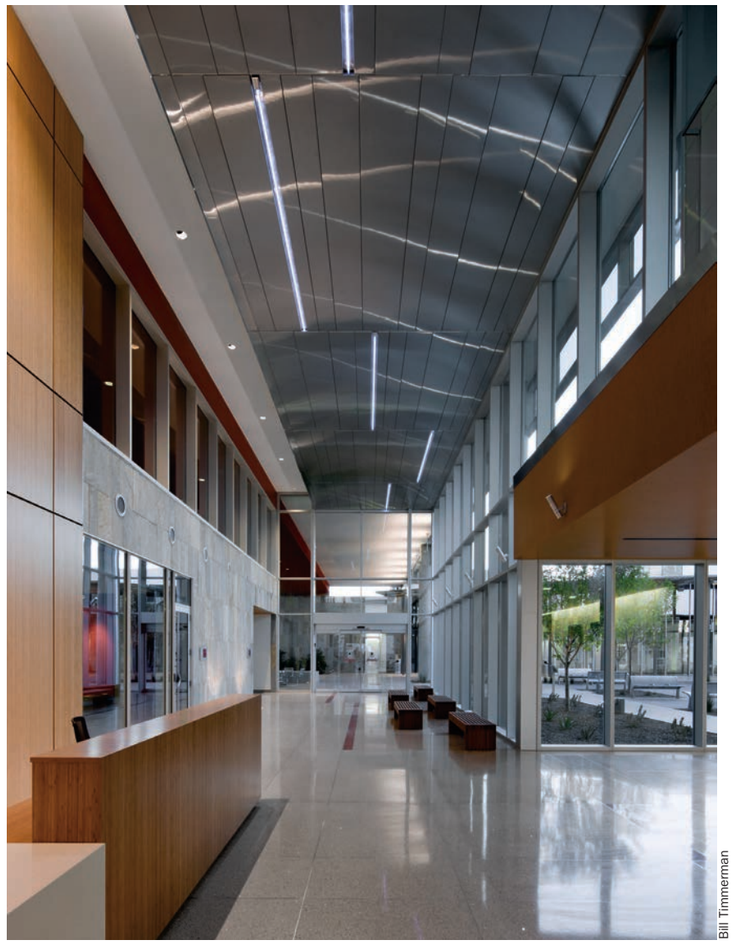
General Contractor Sundt

Energy Modeler Quest Energy

Structural Engineer Caruso Turley Scott

Civil Engineer Dibble Engineering

Landscape Architect GBtwo



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Energy Model, Performance

Energy modeling and minimum energy performance as demonstrated by ANSI/ASHRAE/IESNA Standard 90.1-2004's Energy Cost Budget approach was modeled using the eQUEST (DOE2.2) computer software. The principal features of the baseline building model complied with Standard 90.1-2004.

Improvements to the model were then made to reflect design improvements to the building envelope, lighting and HVAC systems, resulting in a predicted net energy use intensity (EUI) of 43.1 kBtu/ft^2·yr.

BUILDING ENVELOPE

Roof
Type PIB (Polyisobutylene)
Overall R-value R-30
Solar Reflectance Index (SRI) 104

Walls
Type Furred out concrete masonry unit (CMU) with batt insulation and steel framed with batt insulation
Overall R-value R-19
Glazing Percentage Approximately 40% for the north buildings and 10% for the south buildings

Basement/Foundation
Slab Edge Insulation R-value All slab on grade (where slab is recessed for raised floor, R-13 batt insulation of wall construction extends down to slab)

Windows

	Lobby, Bridge and North Façade	Elsewhere
Type	VE1-2M	VRE1-54
Effective U-value for Assembly	0.29	0.30
Solar Heat Gain Coefficient (SHGC)	0.38	0.31
Visual Transmittance	70%	47%

Location
Latitude 33.31° N
Orientation East-west

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The council chambers and office tower are shown at night. The council chamber "glass box" is lit by fixtures located in a cavity wall, giving a glowing effect.

The facilities teams have been working through issues related to coordinating the project's BMS system architecture and controls with the owner's central controls system. The system optimization process has been ongoing for the last two years of occupancy.

This was coupled with the central plant not being properly programmed per the occupancy schedule until April of 2012. Because of these initial issues, the first year (Nov. 2010–Oct. 2011) EUI was 75 kBtu/ft^2·yr. Energy performance improved as the project team worked through the building issues, resulting in a second year EUI (Nov. 2011–Oct. 2012) of 57 kBtu/ft^2·yr, a 24% reduction. Although the energy use is still above the prediction, this still represents a significant reduction over the national average of 90 kBtu/ft^2·yr.

As the system architecture is being fine-tuned, the team will examine occupancy use patterns. These findings will be compared to the model assumptions to determine how energy consumption can be further reduced and more closely aligned with the model predictions. The owner plans to perform an occupancy survey once the systems have been fine-tuned.

The city is in negotiations with a solar provider to install a 232 kW photovoltaic array on top of the parking structure. The system will produce approximately 396,000 kWh in the first year of operation.

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Right The courtyard provides an intimate space where city functions can be held. The breezeway at the north end of the site helps provide air movement through the space.

Below Internal view looking north with *Turbulent Shade*'s scrim on the exterior (left). This shading device reduces solar heat gain while still providing views to the outside. The glass office fronts enhance interior daylighting.

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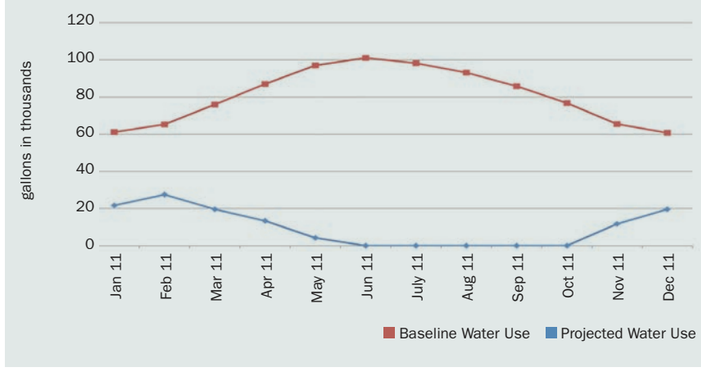
INVITING PEDESTRIANS BACK TO DOWNTOWN

The Chandler City Hall site design encourages community connectivity and pedestrian use through shading, multiple pathways and appropriately scaled urban spaces. Landscaping is an integral component, providing shade and integrating a much needed ecological component into an area that was primarily devoid of it. Concurrent with the project design and construction, the city widened Arizona Avenue (which runs along the complex's west side), added on-street parking and added crosswalks to slow traffic down and encourage more leisurely pedestrian use.

Chicago Avenue, which bisects the site, allows for a flow-through connection to existing nearby municipal services to the east. Crosswalks along Arizona Avenue will connect people to future mixed-use developments to the west. People can also access the historic district through the north end of the site via a breezeway under the office tower.

This complex of community functions is pushed to the edges, creating an urban street level pedestrian experience, while providing a central courtyard at its heart. The courtyard creates a sense of place and identity, giving the citizens of Chandler a destination that becomes the community "living room." This park-like space has been designed to be used for both formal and informal gatherings.

ANNUAL PROJECTED VS. BASELINE POTABLE WATER USE



Design and Material Selection

The overall design and material selection embody a reflection of the progressive nature of this high-tech community and a timelessness that respects the past. The single-story buildings are a modern interpretation of the regional historic vernacular that emphasized mass (heavy building materials such as stone), punched window openings and shaded walkways.

Stone is used to inject a timeless quality while representing a civic center aesthetic. Metal and glass are predominately used throughout the complex to express to the community, "We are about the future, and one of openness and transparency."

The project team took a minimalist approach to interior material selection, which also reduced maintenance requirements. Durability was a key criterion to improve the building life cycle, and materials were chosen for their environmental attributes to create a vibrant, modern environment, free from many hazardous pollutants.

Finance

Chandler city offices were previously housed in several leased facilities. Ten years ago the city committed to building its own facility. The City did not borrow money for the construction, but financed the project by saving a portion of the development fees from projects that were built during the time of economic prosperity. This made more sense in the long run than to continue leasing in a market that was volatile.

The total project cost was $70 million, $47 million of which was devoted to construction. A portion of the additional funds was used to buy property, to demolish abandoned and deteriorating buildings around the project site and to clean up the properties.

The timing of the project saved money because it started when the economy started to show the first signs of the downturn. As the project continued and the economy continued to decline, the cost of construction also fell, ultimately saving $4 million over the initial estimate, which offset first costs of the project's sustainable design features. The project's timing also helped strengthen the city's economic base by providing job opportunities to contractors during a slower economy.

Conclusion

The City Hall complex has given the city a place to call home and has had helped spur development in downtown Chandler. The building features sustainable elements that are important in the Southwest.

The shading devices reduce envelope heat gains and a gray-water system helps prevent hundreds of thousands of gallons of potable water from being used. The daylighting systems provide a great working environment. All of the systems, designed through an integrated team approach, help reduce the energy consumption of the building. ●

Mark Greenawalt

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Top **This water feature at the southern end of the courtyard allows water from the cooling towers to cascade down a wall into a pool. The basin is piped to the condenser water pumps.**

Above **Chandler, Ariz., sought to reconnect to its community by building the new City Hall in the heart of its run-down city center.**

LESSONS LEARNED

Educate Occupants on How UFAD Works and Advantages of Using a VRF System. The design team worked with key owner representatives during the design and construction phase to explain how the systems would differ from those in their existing spaces. Most of the occupants are in areas with underfloor air distribution. The owner representatives did a good job of explaining to the employees how the floor grilles work and how to adjust the manual floor grilles.

Variable Refrigerant Flow for Riser Electrical Closets. The owner required that all electrical and data rooms be cooled by a 24/7 source. The central plant was to operate on a typical office schedule, and a single chiller was too large to meet the electrical and data equipment room loads. A supplemental air-cooled variable refrigerant flow system was used because these equipment rooms stack in the tower. A single condensing unit on the roof with piping risers serves indoor evaporators on each floor. This system saved floor space and initial cost by avoiding the use of a smaller chiller or multiple condensing units.

Communication Between the Design Team and Contractors Regarding Systems Integration. Early and frequent communication between the design team and various contractors is crucial to a successful project. Two building automation contractors were responsible for different portions of the project, and one contractor was responsible for all systems integration to the owner's enterprise system. Issues with the system architecture delayed the commissioning process.

The owner, design team and contractors worked together to resolve the issues. Communication between all involved could have been better. Early meetings between the people that will be involved throughout the project will provide for a better end product.

Occupancy Sensors. Wall-mounted occupancy sensors with full range dimming were installed in each of the private offices. They were located within sight of the doorway, so all private office lights would turn on as someone walked down the hallway. Stickers were placed on the interior of the sensor cover so that it wouldn't "see" people in the hallway.

It was later learned that these units were programmable to become vacancy sensors, which means that they would need to be turned on manually, but turn off automatically when the room becomes unoccupied. This would have solved the nuisance tripping and conserved more energy than the sticker solution. Vacancy sensors are now the design team's standard design specification.

Post-Occupancy Follow-Up. The design team worked with the owner and contractor after construction ended on miscellaneous construction items. The team and commissioning agent did not follow up regarding the details of how all the building systems were operating. It would be beneficial after any project to track the energy use to verify if the systems are operating correctly and that the programming was done properly. This along with submetering data will help ensure buildings stay on track or exceed their energy reduction goals.

ABOUT THE AUTHORS

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