As a nonprofit charitable organization dedicated to relieving global hunger and poverty, Heifer International provides gifts of livestock and plants, as well as education in sustainable agriculture, to financially disadvantaged families around the world. Heifer teaches sustainability by giving a gift and instructing the recipients of that gift to use that resource efficiently. This act, known as passing on the gift, became a main theme for the design team as they began a building that would receive the first U.S. Green Building Council (USGBC) LEED® New Construction (NC) Platinum rating in Arkansas.
**Design Theme**

The goal was to design a sustainable headquarters in Little Rock, Ark., that would exemplify Heifer’s mission, express their sustainable attributes for educational purposes, and allow all employees to work as equals. Completed in 2006, the building’s gentle curve emanates from the overall four-phase master plan, conceived as a series of concentric rings expanding outward from a central commons that represents the impact point of a gift. The ringed site physically and metaphorically expresses the ripple effect of passing on the gift, which is also reflected in the Headquarters’ layered planning. Crafted to maximize sunlight and rainwater while conserving energy and avoiding pollutants, the headquarters sees a 52.6% energy saving over the ANSI/ASHRAE/IESNA Standard 90.1-2001, *Energy Standard for Buildings Except Low-Rise Residential Buildings* budget building.

The 22-acre reclaimed site, among the largest brownfield recoveries in Arkansas, was once an industrial railroad switching yard whose tracks bisected the property. Existing masonry structures were crushed into a gravel material for use on the site and bricks were reclaimed for site paving. Overall, 97% of the materials were recycled, and the savings in reclaimed usable material paid for the entire site demolition.

A narrow, 62 ft wide floorplate and north-south orientation enable daylight to penetrate to the center of floors, giving every employee daylight and a view. The majority of employees are given the best northern views to the Arkansas River, Riverfront Park and Clinton Presidential Library. Five balconies provide views of the Arkansas River, Riverfront Park and the William J. Clinton Presidential Library.

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**Building at a Glance**

- **Building Name**: Heifer International Center
- **Location**: 1 World Center, Little Rock, Ark.
- **Size**: 94,000 ft²
- **Started**: 2000
- **Completed**: 2006
- **Use**: Headquarters with offices, conference rooms, library and wildlife habitat
- **Cost**: $17.9 million
- **Distinctions**: LEED-NC® Platinum Rating; AIA Committee on the Environment (COTE) Top Ten Green Project for 2007; Chicago Athenaeum American Architecture Award in 2007; AIA Gulf States Honor Award 2007

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**Owner**: Heifer International

**Architect and Interior Designer**: Polk Stanley Rowland Curzon Porter Architects, Ltd.

**Landscape Architect**: Larson Burns Smith

**MEP and Structural Engineers**: Cromwell Architects Engineers, Inc.

**Civil Engineers**: McClelland Consulting Engineers, Inc.

**Sustainable Design Consultant**: Elements

**General Contractor**: CDI Contractors, LLC

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The building provides views of the Arkansas River, Riverfront Park and the William J. Clinton Presidential Library.
on each floor used for outdoor meeting rooms and tree-like columns extend visually into the wetland, representing the symbiotic relationship possible between the man-made and natural. The building and site blend seamlessly into Riverfront Park, extending existing paths into the building for access to the river and trails.

The building incorporates a raised floor system, light and motion sensors, low or non-toxic emitting materials, and high recycled material content. An inverted heavy timber roof directs rainwater through an exposed collection system to a tower for reuse as gray water within the building. Glass wrapped stairs are pulled to the edges and float over water, allowing natural convection to pull cooled air off the water’s surface up through the stairs.

Water is collected through permeable gravel-pave parking into bioswales between parking bays. Vegetation naturally scrubs pollutants and moves it to where it is needed. Water is then stored in the wetlands that surround the building, irrigating the site with little reliance on outside sources. An industrial wasteland is becoming a thriving ecosystem.

**Daylighting**

The design team made several key decisions early on that had a major impact on the overall efficiency of the building. The most significant of those was optimizing the daylighting capabilities of the facility. With a

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**WATER CONSERVATION SYSTEMS**

In this project, water is retained, recovered and recycled to reduce the use of potable water from the city. Water conservation features include collecting rainwater, recovering water from the lavatories, and using condensate from one ventilation unit. These features and others, such as waterless urinals in the men’s toilets, produced a 65% reduction in potable water use compared to a conventional building.

The roof is sloped to facilitate the collection of rainwater in a 20,000 gallon tank. The stored water is made available to offset use of potable water. Over the course of a year, more than 528,000 gallons of water are recovered from the roof and used instead of potable water. Water is also recovered from lavatories and showers for recycling and re-use. Over the course of a year, more than 259,000 gallons of this gray water are recovered and recycled. The condensate from one of the ventilation units is added to the water for recycling. Only one unit is used because the length of the building prevents gravity drainage of the other ventilation unit’s condensate for recycling.

The condensate and gray water are drained into a two compartment gray-water tank. The gray-water system strains and filters the water and uses an ozonation system to sterilize it for use in appropriate systems. The ozonation also prevents foaming when the water is recycled and reused. An ultrasonic water level measurement device controls the admission of rainwater or RPZ isolated potable water to the system.

The water is used as flushing water for the toilets in the building and makeup water for the cooling tower. If the gray water and condensate drainage can supply these uses, no rainwater or potable water is admitted to the system. If the level drops to a point that indicates additional water is needed, then rainwater is admitted from the rainwater tank. If rainwater has been exhausted and more water is needed, than potable water is used. This building is projected to use 1,182,000 gallons of potable water per year compared to a conventional building’s requirement for 3,402,000 gallons of potable water. The project has no landscape irrigation that uses potable water and no irrigation was considered in the conventional building calculations even though conventional landscaping would consume large amounts of water. The natural water feature that surrounds the building is not supplied by the gray-water system. Site groundwater is used for that purpose.
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north-south orientation to maximize daylighting, the building has an arc footprint approximately 400 ft in length and 62 ft in width. The thin 62 ft width means that no part of the floor is more than 30 ft from a window. To further project light into the building, light shades were used on the south side. Optimizing the daylighting capabilities of the building considerably reduced the lighting heat load and the energy savings produced by the lighting systems.

A dimming control system combined with T5 lamps supplements daylight with artificial light only as needed, so that artificial light is produced as efficiently as possible. Additionally, space occupancy sensors turn lights off when spaces are unoccupied. This further contributes to the facility’s energy savings.

The lighting system produced the greatest single energy savings. In the final energy analysis, lighting energy used was calculated to save 57.3% of the lighting energy required by the Standard 90.1 budget building.

Raised Floor Air-Distribution System
Heifer International desired the building to provide a flexible work environment for employees. The design requirements included optimizing comfort, flexibility and sustainability. A raised floor system was chosen because it met all three of these design requirements. Several different types of raised floor systems were evaluated, and a steel and concrete composite system was selected with an 18 in. clear space below the floor. Great care was taken during construction to minimize air leakage within the floor system.

A variable air volume (VAV) air-distribution system was chosen because it is believed to be the most efficient system for moving heat from the occupied space where it is produced to the air-handling unit that moves it to a place where it is unobjectionable.
The VAV system used on this project is also known as an underfloor air delivery system (UFAD). A raised floor, similar to those used in many computer rooms, allows air distribution as well as room to run network cables and other utilities. This system enhances energy performance by distributing the air while requiring little pressure. Additionally, the fan system in this building saves 72.6% of the energy required by the Standard 90.1 budget building. The UFAD system also gives control to each person and provides the highest degree of effectiveness in distributing ventilation air. The vertical pattern of airflow tends to capture heat and local contamination and take it directly to treatment instead of mixing it through the space first as many other systems do.

UFAD systems require a warmer air supply than standard overhead distribution systems. Typical overhead air-distribution systems require 55°F supply air because it is mixed with the warm air at the ceiling before making its way to the occupant sitting at his or her desk. To cool the occupied space, this UFAD system was designed to provide 62°F supply air at the floor diffuser. As the air heats up, it rises and returns to the UFAD units via an overhead return system. However, the warmer UFAD supply airflow doesn’t allow for dehumidification at the UFAD units without the use of reheat, which was not an option. So, dedicated ventilation units were used for the outside air requirements and dehumidification of the building.

The overall size and footprint of the building led to a design that has one UFAD unit per floor on each end of the building for a total of eight UFAD units, and one ventilation unit on each end of the building for a total of two ventilation units. A single ventilation unit serves four UFAD units, providing all of the outside air to the mixing box of the UFAD unit. The outside air damper for the UFAD unit is controlled by the zone humidity sensor, zone CO₂ sensor, and zone pressure sensor to maintain proper humidity level, CO₂ level, and building pressure. The ventilation units use variable speed drives and critical zone reset to maintain the required airflow to each of the UFAD units. Critical zone reads the position of each control damper located in the mixing box of the UFAD units and adjusts the pressure so that at least one damper is 85% open and no damper is more than 95% open.

**Chilled Water Production System**

While the value of mechanical systems is a combination of first cost, operating cost, maintenance cost and repair cost, the low-bid system of awarding contracts frequently results in selecting low first-cost and placing the decision primarily in the hands of the contractor. For Heifer, a different procedure was used to give the decision to the owner and select on the basis of overall value.

The design team solicited proposals from three manufacturers who furnished price, performance and maintenance data. A life-cycle cost analysis was performed on the three
proposals. On bid day, the contractor was required to base his proposal on the basis-of-design chiller and provide the amount to be added or deducted for substitution of each of the other two chillers that had been evaluated. One of the bid alternatives, a centrifugal compression chiller, was selected to be installed. Providing high-efficiency cooling, the centrifugal compression chiller uses HFC-134a. The refrigerant was required to be an HFC compound since the selection was made before the USGBC had revised its LEED® credit regarding the use of HCFC refrigerants to permit the use of HCFC-123.

A variable primary pumping system was used. All chillers have limits to the amount of water that is allowed to be pumped through the evaporator and condenser. The low design flow of building chilled water and the variable flow system must be limited to provide at least the minimum flow required by the chiller. A bypass valve was used to meet this minimum flow requirement.

The design flow for the chiller is 300 gpm and the chiller minimum flow requirement is 204 gpm. Thus, the smallest amount of water pumped when the chiller is operating must be 204 gpm. This limits the mass flow savings in the pump energy equation, but not the savings due to the pressure reductions from the use of critical zone reset control. The pump energy savings are still high while keeping the chiller flow within the manufacturer’s requirements.

Plant efficiency is enhanced by use of a series flow flat-plate heat exchanger. The return water from the building either passes through the heat exchanger to reduce the load on the chiller or, if the heat exchanger cannot make a contribution to reducing the load, the water bypasses the heat exchanger. The space cooling energy saves 72.6% of the energy required for the Standard 90.1 budget building. Part of this is due to increased efficiency of the plant, but much of it is due to avoided load from the daylight harvesting and high-efficiency lighting system.

The cooling tower was selected to operate at a three-degree approach to entering wet bulb rather than the five-degree approach that is normally used. While this tower has a somewhat greater cost, it will improve efficiency over the life of the building. The cooling tower fans are also equipped with variable frequency drives. The three-degree approach and the variable frequency drives result in cooling tower energy use.
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that saves 66.6% of the Standard 90.1 budget building requirement.

The cooler water also increases the period of time when the heat exchanger is efficient to run. The normal selection is for a three-degree approach, but the heat exchanger was selected to provide 100 tons of capacity when operating at a one-degree approach to entering condenser water. With the combination of the cooling tower and the heat exchanger, chilled water leaving the heat exchanger can be cooled to within four degrees of ambient wet bulb whereas the normal selection parameters would only approach within eight degrees of ambient wet bulb.

An example of how this helps: If the return water from the building is at 66°F and the ambient wet bulb temperature is at 60°F, then the heat exchanger can reduce the 66°F return chilled water to 64°F and reduce the chiller load by a little more than 8%. The standard selection would require that the ambient wet bulb temperature be 54°F to contribute the same 8%. And, at a 54°F ambient wet bulb, the actual performance of the selected cooling tower and heat exchanger would be 33% with water sent to the chiller at 58°F. This also means that the heat exchanger can assume the entire building load at a higher ambient wet bulb temperature which results in many more hours of available cooling operation without having to operate the chiller.

**Chilled Water Distribution System**

Because HVAC energy consumption is largely the movement of heat from an area where it is not desired to an area where it is unobjectionable, considerable attention was given to the energy necessary to transport heat.

For this project, the UFAD system offered the opportunity to further reduce the amount of chilled water that had to be pumped. The UFAD system uses 62°F supply air, a temperature that can be produced with relatively warm chilled water. If all dehumidification requirements are met by the dedicated ventilation units, then 54°F water will efficiently meet the sensible cooling requirements of the space and cool the air to 62°F.

The amount of ventilation air varies with the amount of air required to properly pressurize the building and to comply with ANSI/ASHRAE Standard 62.1-2001, *Ventilation for Acceptable Indoor Air Quality*. To ensure adequate dehumidification, the minimum pressurization airflow was used to calculate the required dew point of the ventilation air. That dew point, 47°F, led to 42°F as the chilled water temperature necessary to achieve the required dehumidification.

The ventilation unit coils were selected to provide 47°F leaving air with chilled water rising from 42°F to 54°F. The UFAD units were selected to provide 62°F leaving air with chilled water rising from 54°F to 66°F. If the loads are equally divided between ventilation units and UFAD units, then the overall rise is from 42°F to 66°F or 24 degrees. This only requires half the water flow of a conventional 12 degree rise system, yielding a design flow of one gpm of water per ton of refrigeration and reducing pumping energy.

As discussed previously, a variable

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**LESSONS LEARNED**

Several things have become apparent during construction and operation.

**Air Leaks** It is more difficult to seal a building against air leaks than it is to agree to a leakage target with a contractor. Much effort was put into sealing the building, but actual leakage significantly exceeds the target. The target was an ambitious 0.1 air changes per hour (ACH). The ventilation system was set up to deliver enough air to compensate for 0.5 ACH. Trend logs of building pressure show that actual leakage exceeds 0.5 ACH.

**Larger Tank** A larger rainwater tank would improve the water performance of the building. While the installed tank provides 528,000 gallons per year to the gray-water system, the precipitation that falls on the roof averages 631,000 gallons per year.

**Unexpected Dust** Roofs are dusty places when the rain begins to fall, and it is necessary to service the filters and strainers on the gray-water system more frequently than on other hydronic systems.

**Control Sequences** Very complex control sequences require additional designer time to ensure that the end performance matches expectations.
primary pumping system was designed for the chilled water system. The control of the variable speed chilled water pump uses critical zone reset to maintain the required flow to all of the cooling coils. Critical zone reset is part of the prescriptive requirements of Standard 90.1 for the air side of VAV systems. It also can be used with water systems although this is not required by Standard 90.1.

Critical zone reset reads the position of each control valve and adjusts the pressure so that at least one valve is 85% open and no valve is more than 95% open. Control valves add resistance in order to limit the flow allowed through the valve. If the valve is more open, less pressure is required to deliver the needed flow. The 95% value is chosen to allow for the lag of the system in changing pressure values so that no zone is lacking water needed to meet the load. The 85% is chosen to allow for a 10% acceptable range and to introduce additional stability into the control loop.

The combination of reduced flow and reduced pressure, while still meeting the load, significantly reduces pumping costs for the project. Pumping energy calculated for this project saves 57.2% of the energy required by the Standard 90.1 budget building.

**Heating System**

Heating water is produced by two pulse-combustion high-efficiency boilers. Finned-tube heating convectors are located in recesses along the outside walls of the building to offset heat losses in winter. Heating water flow is also variable, but the many small control valves made implementation of critical zone reset impractical. Therefore, a convention differential pressure control system was used for the hot water pumping system.

**Comfort Control Systems**

A direct digital control system was provided to control all of the building systems. Controls were carefully set up to prevent simultaneous use of heating and cooling in the same space. Furthermore, space sensors that include relative humidity are used at various locations in the building. These sensors determine if the dehumidification provided by the ventilation units is insufficient, adequate or excessive. Based on the relative humidity measurements, the temperature of air leaving the ventilation unit is raised or lowered to maintain the design humidity level in the space. As the setpoint of the ventilation unit is changed, the required chilled water temperature is also changed, resulting in higher chiller efficiency as the required water temperature is raised.

**Energy Use Summary**

The heated and cooled part of the building encompasses a little over 83,000 ft² in four stories. The energy use is 44,816 Btu/ft² per year. This compares to the Standard 90.1 budget building at 95,979 Btu/ft² per year, for a savings of 56.1%. The LEED® savings of 53.6% is based on the estimated dollar value of projected utility bills. The largest single group of points in the LEED® system is directed to optimize energy performance with 10 points available. This project earned nine of those points. The success is a result of the team approach and the sustainable goals set forth by the building owner.

As Heifer International continues to address the problems of hunger in the world, they demonstrate that green can be functional and attractive, as well as energy efficient. They also act as good stewards of resources that are necessary for the fulfillment of their mission.

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**ABOUT THE AUTHORS**

Reese Rowland is a design principal at Polk Stanley Rowland Curzon Porter Architects, Ltd. Todd Kuhn, P. E., is a mechanical engineer and John Hodoway is a senior mechanical designer at Cromwell Architects Engineers, Inc.