Engineers Make Omaha Home of

By Rachel Davis
Associate Editor

Nebraska, a state not known for its exotic animals, now has a place where pumas prowl and bobcats growl, where death adders slither and hummingbirds quiver. A team of engineers and architects recently made a home for these creatures in Omaha by creating what they say is the world's largest indoor desert.

Work began five years ago on the $31.5 million Desert Dome, which opened on April 1, as an addition to Omaha's Henry Doorly Zoo. The two-story building contains more than 10,000 tons of concrete in its ringwall and structural slab, which is enough to pour a four-inch slab over six and a half football fields, and includes more than 500,000 pounds of steel reinforcement.

The upper level of the building features three different desert environments, while the lower level, scheduled for completion on April 1, 2003, will feature nocturnal animals and a Louisiana swamp environment. Next year, the exhibit of nocturnal animals will be dimly lit during the day, so that the animals will think it is night and come out for the visitors. At night, industrial lighting will come on so that the animals will think it is day and get their sleep.

On the upper level, visitors experience the Namib Desert of southern Africa, the Red Center of Australia, and the Sonoran Desert of the southwest U.S. and northwest Mexico. The dome contains a 30-foot-tall sand dune, a 55-foot-tall mountain, a hummingbird canyon, a cactus forest, and a desert cave, among other exhibits.

Nature of the Beasts

Engineers had to take into careful consideration the unique nature of the animal life in the Desert Dome as they designed the structure. Animals inhabiting the Desert Dome include meerkats (a member of the mongoose family), venomous snakes, antelopes, monitors, lizards, bobcats, roadrunners, and caracal cats.

NSPE members and Professional Engineers Steve Alvine and Jeffrey Stevens both took part in this unique project. Alvine's firm, Alvine and Associates Inc., designed the dome's electrical and mechanical equipment, helped with cost estimates, and developed a new central cooling plant. "I needed to learn more about animal husbandry than I ever thought I would as an engineer," says Alvine.

Stevens, vice president of Shaffer & Stevens Engineering PC of Omaha, took part in the structural engineering aspects of the project. Other firms on the project team included Temcor, a Carson, California, company that specializes in geodesic dome structures; Omaha architect ASD Stanley J. How and Associates; and general contractor Kiewit Construction.

Stevens says the scheduling and structural engineering of the Desert Dome were challenges, because a variety of processes and materials were required for designing the foundations, floor systems, and display structures. The hollow, 55-foot central mountain and the other steel-framed rockwork structures were also irregularly shaped and varied in dimensions. "It's also the kind of facility where, as a display would become reality, the owner would see things they'd like to do differently," says Stevens.

The top of the Desert Dome is a spherical, glazed structure created by Temcor that covers the desert without any support columns. This geodesic dome is 230 feet in diameter with a rise of 105.5 feet, spans an acre of land, and provides 82,000 square feet of exhibit space. The company's construction process, using a center erection tower, allows the dome to be built from the center outward to the perimeter. Workers assembled the frame on the ground and lifted the dome as each strut ring was completed.

To provide maximum shade in the summer and maximum light in the winter, the dome has 1,760 tinted acrylic, triangulated panels that alternate between three shades and clear panels. Designers used a computer program to simulate the height of the sun during each season to determine the location of the panels. The darkest panels are located at the top to provide shade from an intense, high sun in the summer. Clear panels are located at the sides to let in more light in the winter, when the sun is low in the sky. To extend the length of time that light is available during the winter, Alvine and Associates also designed 32 large, metal halide lights.

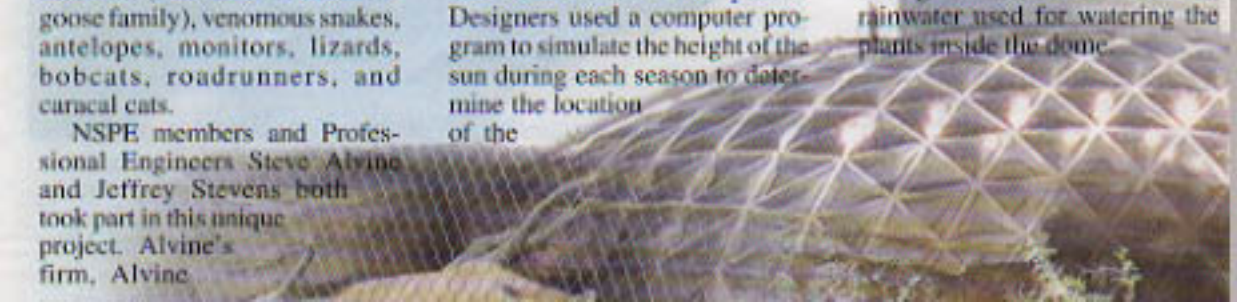
Penthouse in the Sky

The dome's 200,000-pound frame supports 150,000 pounds, including a foot-thick concrete floor and a "penthouse" at the top that is 37 feet in diameter and 15.5 feet high. The penthouse holds the exhaust fans and a heat recovery unit that reclaims heat in the winter and helps warm the dome. In the summer, exhaust louvers expel hot air from the building. The penthouse is situated on the concrete floor, 44.5 feet in diameter, which muffles mechanical noises.

The temperature in the dome is kept between 72 and 75 degrees Fahrenheit, using chilled water from the zoo's central plant. At night, the central plant freezes large tubs of ice, which melts during the day. Cold water from the tubs runs through insulated, direct-buried PVC pipes and provides air conditioning for the Desert Dome and other buildings.

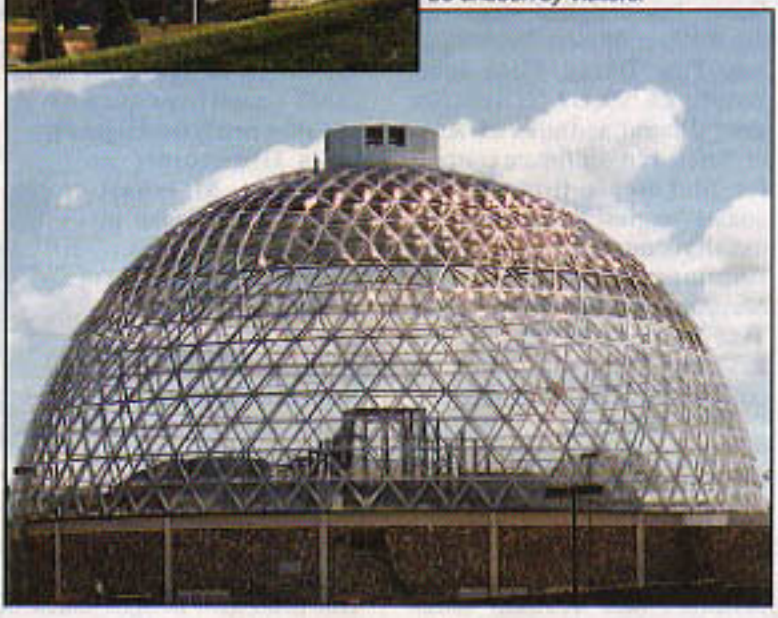
Alvine and Associates designed the cooling plant in a separate location because of space limitations, as well as noise and aesthetic considerations. The remote location also prevented drifts of humid air and chemicals from the cooling towers from affecting the glazing on the dome panels, Alvine says. To keep the temperature steady, sensors are located throughout the building and monitored through a life-support computer.

In addition, the building contains an irrigation and drainage system that allows staff to water the plants without rotting the roots. A gutter system on the outside of the dome is connected to two 20,000-gallon underground storage tanks, which collects rainwater used for watering the plants inside the dome.



Largest Indoor Desert

Temcor's construction process uses a center erection tower, which allowed the dome to be built from the center outward to the perimeter. Workers assembled the frame on the ground and lifted the dome as each strut ring was completed. Alvine and Associates Inc. designed the clear dome's electrical and mechanical equipment to be unseen by visitors.



A Design Challenge

"The whole thing being a [clear] lid was one of the biggest obstacles," says Gary Lange, mechanical project manager. "One of our greatest challenges was determining how to get the power, water, and HVAC ductwork through the building without the public seeing it."

Most of the air moves underground through reinforced concrete pipe and rises at the perimeter of the building. Strategically placed ducts come out of the ground at certain points and are hidden within the structure and rockwork, Lange explains. Electrical circuitry is similarly run underground and hidden within the rockwork, as well as the central mountain inside the dome. Illumination lights were placed above the mountain to shine down on the central mountain, and light fixtures were placed around the perimeter to highlight the dome and make it "glow like a jewel at night," Alvine says.

Project engineers also designed special features to create an environment that closely simulates the natural environment of the exhibit's animals. By running hot water through underground polyethylene tubing, they created "hotspots" in the rockwork for the reptiles to warm their bellies in areas highly visible to the public. Warming the soil is also important for the growth of some of the desert plants, since Nebraska can experience temperatures as low as –20 degrees Fahrenheit in the winter. And to help the reptiles keep their skin healthy, engineers placed special lamp sources that emit ultraviolet light around the dome.

Alvine says he has enjoyed watching the animals get used to the environments the engineers created for them, particularly Natalia the leopard, who paced for a while before settling into her "desert" surroundings, he recalls.

He also has found a great deal of satisfaction just watching the public take in the exhibit. More than 200,000 people have visited the Desert Dome since its opening. "That's what I loved about the job—seeing the people throng to the building, oohing and ahhing, and getting to see animals you don't typically see in the Midwest," says Alvine. "And seeing the kids who can't wait to turn the next corner."