

Engineer Improves **Airflow** and **Saves** \$75,000 in HVAC Costs For WKU Arena.

HVAC retrofit brings air conditioning via fabric ductwork to the 10,000-seat DIDDLE ARENA AT WESTERN KENTUCKY UNIVERSITY.

BOWLING GREEN, KY Faced with many design challenges that could diminish future HVAC performance for the \$26 million renovation of **Western Kentucky University's E.A. Diddle Arena**, mechanical engineer, Don Greulich, started thinking "outside the box" for a cost-efficient solution.

Originally Greulich, President of Kerr-Greulich Engineers Inc., Louisville, KY, plus design team co-members, Edward West, PE, director of WKU construction management services; and Tony Kleyer, vice president of project architecture firm, Louis & Henry, Louisville, considered ceiling-hung metal ductwork that would distribute air to the arena's 10,000-capacity spectators as well as the basketball floor. The 42-year-old home of renowned WKU Hilltopper basketball had a previous design that was a heat-only system from mezzanine level air handlers.

When structural consultants proved the dome-shaped roof was already near load bearing capacity, Greulich was forced to look at alternatives such as lightweight fabric duct instead of traditional ceiling-hung metal ductwork. Fabric duct not only proved to be 90 percent lighter than similar sized metal duct thus allowing the preferred ceiling hung air distribution, but it also saved the project \$75,000 in materials while providing a more even air dispersion than metal duct with registers. "I think everybody thinks metal when they first approach air ducts, but fabric duct turned out to be the better solution regardless of weight, just because its linear diffusers disperse air much better than the traditional metal duct/register concept," said Greulich, who had used fabric duct previously on several smaller projects.

"Fabric duct provided a good solution to the structural hurdles we faced with the Diddle renovation," said West, "plus it also provided some aesthetic value from something you would normally want hidden ductwork."

Added, Louis & Henry's Tony Kleyer: "By not adding weight to the roof, the fabric duct allowed us to do many other things that would have been impossible with the weight load of metal duct, such as adding catwalks and television platforms."

Greulich specified TuffTex™ fabric duct by fabric duct manufacturer, DuctSox, Dubuque, IA. Installed by sheet metal sub-contractor, Haase Heating & Air Conditioning, Henderson KY, and overseen by mechanical contractor Hussung Mechanical Contractors Inc., Louisville, the 720 linear feet of round 36-inch-diameter duct is positioned 30 feet above the spectator section and 70 feet from the basketball floor.

Through the facilitation efforts of manufacturer's representative, R. L. Craig Company Inc., Louisville, factory engineers used computer aided design (CAD) modeling to design ductwork airflow featuring both long-throw orifices and air dispersing linear vents. Specifically the air dispersion is designed as such: 1) six-inch-diameter orifices at 4 o'clock targeting the court; 2) a 1-1/8th-inch linear mesh vent at 5 o'clock targeting the seats; 3) a 1/4-inch-wide linear mesh vent at 6 o'clock targeting seating below the duct; 4) a 1/2-inch-wide mesh vent at 8 o'clock targeting more seating. "This is the first DuctSox application that has combined linear mesh vents and long-throw orifices," said Nick Paschke, DuctSox's midwest regional sales manager.

While the previous system was considered noisy, the design team reduced HVAC operational noise substantially. Even though fabric transmits less HVAC mechanical noise than metal duct, Greulich also specified duct attenuators by Commercial Acoustics, Phoenix, AZ, and 18 Trane, Tyler, TX, 12,000-cfm air handlers with built-in sound attenuation characteristics.

To the delight of Louis & Henry Group's Kleyer, the custom-colored "Hilltopper" red duct hangs aesthetically like a banner when not supplied with air. Large diameter fabric duct from 38-inch to 80-inch in diameter requires a dual rail system for aesthetics and weight-bearing purposes. Since only a single H-track rail would allow the duct to hang like a banner, Greulich and Kleyer purposely specified the largest diameter DuctSox possible (36-inch-diameter) for single rail hanging and then built the supply air portion of the HVAC systems around the duct size. "Using the fabric duct system as a continuous WKU red colored "banner" inside this circular building gave the Design Team yet another opportunity to provide visual excitement for the renovated building's interior environment. The red banner really has added an addition layer of aesthetic richness for the Diddle Arena renovation. It has helped to bring a 20th century building into our current century," added Kleyer.

The rail system was easily hung with Gripple Inc. Batavia, IL, hangers attached to the domed open ceiling architecture structure. Since the ductwork is easily disassembled, the university is considering silk-screening its logo or paid advertising logos on the duct when it's taken down for future laundering.

The air handlers are supplied with two new 400-ton Trane chillers. Heating is handled with each air handler's on-board 4 million-BTU boiler. Although the university has a district steam plant, Greulich specified on-board boilers for better control since the district system doesn't provide heat year-round.

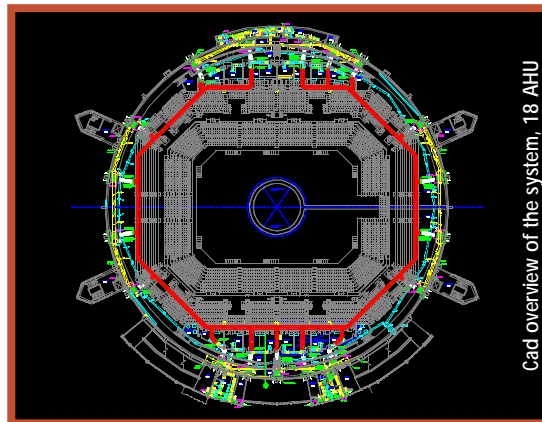
The building is controlled to a temperature range of 68°F to 75°F with a Johnson Controls, Milwaukee, WI, Metasys building control system. If either temperature is surpassed, heat or cooling is activated. Greulich designed the space for continuous ventilation however, that's efficiently

controlled by proportionate control valves that mix make-up air with re-circulated air in the air handlers. Outside air is introduced as needed and is determined by CO2 sensors that open or close outdoor dampers on each air handler.

Using fabric duct also added to the expediency of the project, which had to be completed by November's first basketball game after the entire arena was gutted except for the floor and seating four months earlier. The fabric was installed in approximately two weeks while metal duct could have taken almost twice as long, according to Mike Kleinhenz, project manager, Hussung Mechanical Contractors.

Additional time and money was saved with fabric duct when the air distribution design needed a rerouting soon after installation to allow site lines to two large screen monitors and luxury skyboxes that were late add-ons to the arena's design. Rerouting metal ductwork would have delayed the project an extra week or two versus the modification of fabric duct. Instead, Ductsox's re-engineered lateral and vertical

changes that included eight 45-degree elbows and 18 tees complete with factory-installed internal flow straightening devices based on Hussung's field measurements. The additional ductwork was completed with an estimated cost savings to the university of \$10,000 versus metal duct, according to Greulich. ■



Cad overview of the system, 18 AHU



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