



C A S E S T U D Y



EL DORADO HIGH SCHOOL STUDENTS GET THE 'WOW' THEY DESERVE

Design Team for New High School Saved \$2.7M with Wood Framing

When the new high school in El Dorado, Arkansas opened its doors for the first time in August 2011, students, parents and community members had just one word to say. "Wow."



The new 322,500-square-foot, \$44 million building makes a big statement in the relatively small community of El Dorado, located in southern Arkansas. El Dorado has a population of about 20,000, and high school students had been attending a 1960s-era 165,000-square-foot high school with outdated buildings connected by a maze of exterior corridors. Parents and community members wanted more for their young people.

In 2007, Murphy Oil Corporation established the El Dorado Promise, a unique scholarship program for graduates of El Dorado High School that pays their tuition to go to college. Over the long term, the program is expected to increase enrollment in the district's schools. Therefore, while current enrollment at the high school is approximately 1,350, the School District wanted a facility that could accommodate 1,600 students.

In addition, a state-wide school facility assessment several years ago identified a number of shortfalls with El Dorado's existing high school, providing the impetus for a new facility. "The school's assessed facility cost index (cost to address deficiencies versus cost to build new) exceeded the range in which the state would fund a portion of the construction cost," said project architect Blakely C. Dunn, AIA, NCARB and principal of CADM Architecture, Inc. So, the community moved to build a new high school.



Wood and Building Codes

El Dorado High School was one of the first schools in Arkansas to make extensive use of wood following a change in state policy that had previously prohibited wood in school construction. In 2008, the Arkansas School Facilities Manual was modified to reflect the *International Building Code* (IBC), which allows the use of wood in a wide range of building types. Instrumental to the change was technical information provided by the American Wood Council, APA and Anthony Forest Products, which demonstrated wood's safety and performance capabilities. Since then, the South Carolina's Public School Facilities Manual has also been changed to allow greater use of wood in school construction.

What the code allows:

- Type V is the most common type of wood construction and is allowed for school design. One-story Type V schools can be up to 87,875 square feet and two-story Type V schools may be as large as 138,750 square feet. These areas may be exceeded with the use of two-hour firewalls.
- Designers accustomed to working with steel or concrete often design buildings using Type IIA or IIB construction. However, nearly identical height and areas can be achieved with wood framing in Type IIIA or IIIB buildings.
- In Type III construction, untreated wood is permitted in roof and floor systems and to frame interior walls. Exterior walls may be wood where fire-retardant-treated (FRT) lumber and plywood is specified.
- In Type I and II construction, Type IV heavy timber is allowed in the roof structure and for secondary members. Wood is often used to add visual appeal in libraries, gyms and other common spaces.

Wood Allowed School District to Meet Budget

According to Dunn, the state of Arkansas would determine its funding contribution based on a maximum construction cost of \$134.78 per square foot. However, the initial budget estimate was just over \$60 million, which was \$50 per square foot too high.

"Originally, the project was designed in steel and masonry, which is common for a building of this size," said J. Richard Brown, P.E., principal engineer with Engineering Consultants, Inc. in Little Rock. "But the budget was too high. So our response was to look at other framing types. That's where we found considerable savings."

During the early pre-construction stages, CADM worked with construction managers Baldwin & Shell to evaluate various systems—structural steel, pre-cast concrete and wood versus steel framing—and ultimately made the decision to maximize the use of wood framing throughout the project. "By just changing the framing, we were able to save about \$2.7 million, which was five percent of that original \$60 million budget."

Dunn said the intent was always to use exposed wood products in the building, as "an acknowledgment of where we are in Arkansas. Wood is easy to work with and has great aesthetic qualities. But really, our decision to extend the use of wood into the non-exposed areas of the building was purely based on our efforts to reduce the overall cost of the school."

Dimension lumber is found in the school's exterior and interior load-bearing walls, and I-joists were used for the second floor, which supports a concrete floor slab. I-joists were also used for the roof structure of the two-story building. Altogether, the project used:

- 521,760 square feet of plywood
- 632,928 board feet of dimension lumber
- 230,000 board feet of glued laminated (glulam) beams
- 134,376 lineal feet of wood I-joists

The contractor broke ground in March 2009 and the project was completed in July 2011. Final construction and site development costs (with no furniture, fixtures or equipment) totaled \$43.2 million, which was right on the target of \$134 per square foot.

Project Goals = Space, Security and 'Wow'

As can be imagined, the community had a lot to say about the new high school design. "Of course, in a small town, you have a lot of people willing to offer their opinion," laughed Dunn. "You don't really have to ask."

The official process began in October 2007, when CADM began meeting with the 20+ member design review committee. The entire group traveled to northern Arkansas and Texas to see design examples of other large schools. A smaller group traveled to California to gain additional perspectives.

"We talked about creating a building that would meet our needs with the space we required," said Bob Watson, superintendent for the El Dorado School District. "We also talked about how we could balance our desire to use local building materials with the budget. That's where things really started to fall into place."

Space was their biggest need. Classrooms in the old high school were too small to accommodate the requirements of modern technology. They also needed more common space for their cafeteria, band, orchestra and choral programs.

Security was another objective, explained Watson. "At our old high school, students and faculty had to move from building to building via outside courtyards and walkways. In today's world, we just didn't consider that a safe environment." Dunn added that the goal was to improve observability and security for the students, both internally and from exterior threats. "All schools across the country have this challenge; it's nothing unique to El Dorado."

Understandably, they wanted to build a state-of-the-art facility. Everything in the new structure is based on fiber optics, including Internet, telephones, television and security access control. The web-based mechanical systems can be monitored and adjusted from anywhere in the country with a laptop computer.

Their fourth goal was to create what Watson calls the 'wow' factor. "Nationwide, we appear to have a drop-out issue in high schools, and we're not immune to the problem in El Dorado. We wanted something that would attract young people—not only with the course offerings, curriculum and activities, but with an appealing facility."

Inspiration for Graduation

Of the students that graduate from El Dorado High School, more than 80 percent go on to college. This compares to a rate of 62.5 percent for the state of Arkansas, according to a 2008 study by The National Center for Higher Education Management Systems.

"The El Dorado Promise gives our students extra incentive to graduate and go on to college," said Watson. "So we

want them to stay in school once they're here. Community leaders said that, if we were going to build a new school, they wanted an attractive building that appealed to students, and that's what we gave them."

El Dorado's new high school incorporates a two-story 'Main Street' inside the building, with a 23-foot-wide hallway and skylights to bring in natural light. "We even have street lights down the main corridor to create an atmosphere of being outside so the students never feel like they're hemmed in," said Dunn. "The resulting hallway is not only attractive, but also very warm and inviting. It was important to the district that we not just enclose space; we wanted to create an environment that maximizes the potential for students to learn."

Open Spaces, Exposed Beams

The City of El Dorado has a number of properties in the downtown area listed on the National Register of Historic Places, so some of CADM's design work was done to acknowledge the town's history with what Dunn called "a nod to the past."

The two-story building forms a large X, stretched in the middle. The two wings intersect at 90-degree angles and the center forms a large octagonal circulation area with administration and common use spaces, including a dining area. The wings, also referred to as the Main Street corridors, feature large laminated beams spanning the space.

"The basic geometry of the building was determined by our desire to have very clear circulation routes and open spaces where students could congregate," said Dunn. "We also wanted a configuration where students could see each other and faculty and staff could see students, with as few places as possible where students could go unobserved."

Main circulation corridors are 24 feet wide; they intersect in a two-story, 55-foot-diameter octagonal core, which the architect refers to as the 'Octunda.' Principle areas include two-story common spaces with second floor corridors on either side, which open to the floor below. Glass handrails allow students to look down into the Main Street corridor, which is lit from above by 50-foot skylights. There is also a 16-foot-diameter skylight at the apex of the octagonal core, which makes extensive use of exposed glulam construction.

A compression ring measuring 16 feet in diameter and 5 feet deep at the top of the octagon consists of 5-foot-deep glulam beams. Additional beams come down at each of the points of the octagon. Instead of a tension ring at the base, Brown said they designed a unique steel tension rod system that extends across the 55-foot space like a web. They used connection plates at the base of the beams and large steel rods that attach to an octagonal steel plate in the middle, which resists the thrust of the octagonal dome.



Designers used exposed wood and natural light to create an environment that would motivate students to stay in school.





Wood Brought Architectural, Structural and Financial Benefits

“Architecturally, we chose to expose the wood products where it was appropriate, but we concentrated on the principal circulation areas and public spaces,” said Dunn. “Structurally, we made the decision during the design development phase to extend the use of wood products to save money. Historically, we would have done steel-frame floor and roof construction. However, we changed the exterior wall construction to wood-frame and used wood I-joists for the floor and roof construction to save money—and it did. These changes alone saved the El Dorado School District \$2.7 million.”

The design team also took advantage of wood’s aesthetic qualities to add value throughout the school. “We used exposed wood products in structural systems and in elements such as doors, millwork and trim to provide a unique architectural aesthetic that helps to naturally soften and warm the spaces,” said Dunn. For example, maple wood deflector panels were installed along the walls in the 450-seat performing arts theater to help acoustically tune the space.

Dunn said they also poured concrete on top of the second floor (comprised of wood I-joists and plywood sub-floor) to provide acoustical separation and to achieve the fire rating. “We did an acoustical analysis of that design compared to steel construction, which is more typical, and found them to be within one dB of each other. So, even with concrete on top of the wood I-joists and plywood sub-floors, we got within one dB of our acoustical requirements and still saved money.”

The facility was built as Type III-A construction, fully sprinklered. It has one-hour fire ratings for the structural frame, interior bearing walls, second floor construction and roof construction. Because of the building’s size, the design team specified fire-retardant-treated wood studs and plywood for the exterior walls. At the time it was built, El Dorado’s new high school was the largest wood-frame school in Arkansas.



Arena's Bowstring Trusses Leave Room for Standing Ovation

One feature of the new high school that continues to turn heads is the new 2,200-seat basketball arena, large enough to host a state tournament. "We elected to use glulam bowstring trusses for the barrel-vaulted roof structure in the new arena, so we have single-span, 165-foot glulam trusses with exposed connection plates that are 20 feet deep at the apex," said Dunn. The roof structure also features exposed 2x10s and plywood decking. The open web trusses give the arena a spacious, dramatic feel.

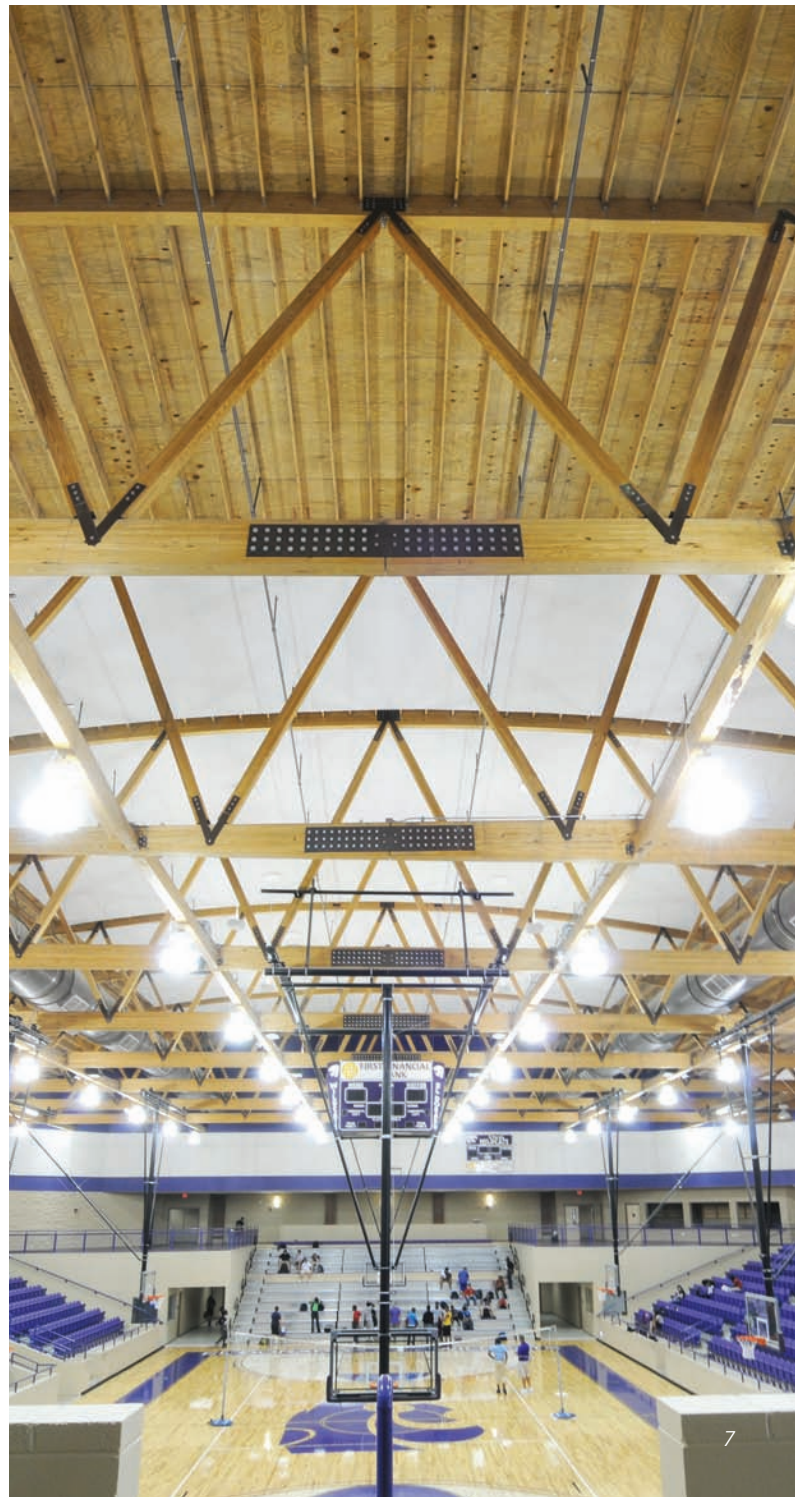
Dunn initially designed the 30,000-square-foot arena using steel. "We did a cost analysis and found that we were able to save about \$60,000 by changing the roof construction from steel to wood. I was very surprised. We got a huge aesthetic benefit from these beautiful bowstring trusses *and* we saved \$60,000."

Trusses were manufactured just 34 miles away in Magnolia, Arkansas. They were constructed in two pieces and transported via U.S. Highway 82, spliced on site, and lifted into place with two cranes.

\$2.7 Million Savings Speaks for Itself

"When people enter the arena, that unique roof structure is the big talking point," said Watson. "The bowstring trusses gave us another 'wow' factor for the school. Students get the same feeling when they enter our ROTC room, when they use our multi-purpose/cheerleading space and when they walk down Main Street. They're all warm spaces that remind me of the classic old facilities from years ago, but with a modern look."

While Watson is thrilled with warmth and attractiveness of the new space, he is equally grateful for the cost savings realized from the wood inside the walls. "The \$2.7 million savings allowed us to build this facility without sacrificing space, which was so important to us," he said. "To get from the initial \$60 million estimate to the final \$44 million budget, we had to give up things here and there, but we did not give up our space. We were able to create the 'wow' we were after with the exposed glulam structure, and we were able to meet our budget by using wood framing."



Project Overview

NAME:
El Dorado High School

ARCHITECT:
CADM Architecture, Inc.
El Dorado, AR

GENERAL CONTRACTOR:
Baldwin & Shell Construction Company
Little Rock, AR

LOCATION:
El Dorado, AR

STRUCTURAL ENGINEER:
Engineering Consultants, Inc.
Little Rock, AR

COMPLETED:
2011



Carbon Benefits

For more information on the calculations below, visit woodworks.org.

Wood lowers a building's carbon footprint in two ways. It continues to store carbon absorbed during the tree's growing cycle, keeping it out of the atmosphere for the lifetime of the building—longer if the wood is reclaimed and used elsewhere. When used in place of fossil fuel-intensive materials such as steel and concrete, it also results in 'avoided' greenhouse gas emissions.



Volume of wood used:

4,340 cubic meters / 153,140 cubic feet of lumber, panels and engineered wood



U.S. and Canadian forests grow this much wood in:

13 minutes



Carbon stored in the wood:

3,660 metric tons of CO₂



Avoided greenhouse gas emissions:

7,780 metric tons of CO₂



TOTAL POTENTIAL CARBON BENEFIT:

11,440 metric tons of CO₂

EQUIVALENT TO:

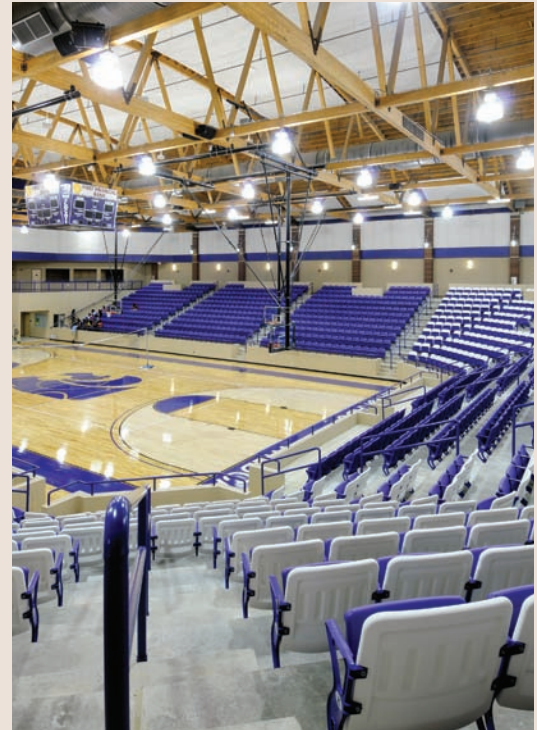
Source: US EPA



2,100 cars off the road for a year



Energy to operate a home for 970 years



Earn one AIA/CES CEH (HSW) by reading this document and taking a short online quiz. For details and learning objectives, visit the Online Training Library at woodworks.org. WoodWorks is an approved AIA provider.



Photos: (under construction) W.I. Bell; (completed building) Dennis Ivy
WoodWorks Case Study WW-007 – El Dorado High School, El Dorado
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Estimated by the Wood Carbon Calculator for Buildings, based on research by Sarthre, R. and J. O'Connor, 2010, *A Synthesis of Research on Wood Products and Greenhouse Gas Impacts*, FPInnovations. Note: CO₂ on this chart refers to CO₂ equivalent



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