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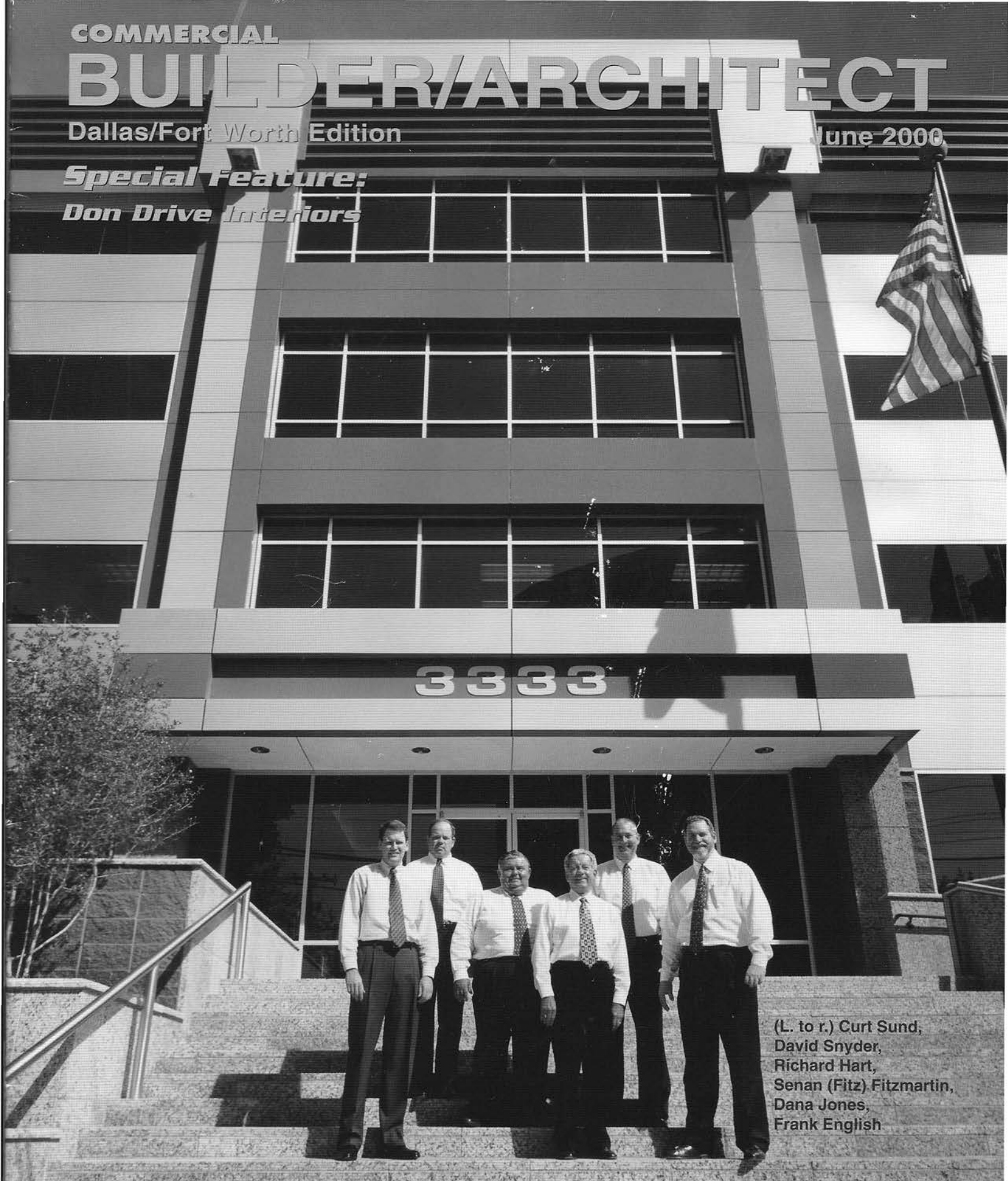

(L. to r.) Curt Sund, David Snyder, Richard Hart, Senan (Fitz) Fitzmartin, Dana Jones, Frank English

Constructors: Growing from the Inside Out

Bridging the Gap

By John E. Spencer, Precision Data

"All times are modern for those living in them." Words from a modern man, no doubt. Another modern man, speaking of a great mystery left by "ancient" people, theorized that it would take 100,000 men 20 years to build a monument so large. His labor estimate may have been close, but the time? There are an estimated 2.5 million blocks in the structure weighing from two tons to over 70 tons each. To finish in a short 20 years you would have to place 350 of those blocks each day. This, after whittling them down with copper tools until the fit and finish was so tight a credit card wouldn't fit between them. Of course the riddle to the construction of the Great Pyramids is still as much a mystery to us as it was to the "ancient" Greek historian Herodotus, when he made that calculation 500 years before Christ was born.

Imagine being the designer/builder. Standing in the sun, looking at sand in every direction, you know the owner feels strongly about this project. He wants you to design and build (a new concept?) his tomb. He wants it to be very large and complex. It should have three chambers and a point on top. He's sketched out a facsimile. So you build a model and discover that this thing IS LARGE. Using the proportions of his drawing, the object measures 755.5 feet, (obviously a different number of units for him) and 485 feet tall. The ground will have to be within a half-inch of level at the four corners (which it still is today), and be stable enough to support one of the world's heaviest structures. The blocks will have to be carved in such a way that each surface lays flat against the next, and leans back enough for the outer surfaces to come from four external corners and converge at one point on top. The outside face forms four flat surfaces, flat enough to cover with white, polished limestone that will reflect light back to the heavens.

So after pondering this assignment for the weekend, you ask the owner if he would consider downsizing just a bit, knowing he has asked for something impossible. His response is typical owner—he can get someone else to do it. And he will put you to death if you don't try and succeed. (That part is not as popular as it once was, though the owner/designer relationship can still have its tense moments.)

With your new incentive (funny how small changes in perspective can make the impossible seem easy), you start rounding up the best in the land. The planners, the thinkers, the builders, the surveyors. There was

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no shortage of day laborers.

So how would you find or make a level area (about 13 acres) and set out the four corners of your impossible project? Of course no one is sure how any of it was done, but it is entertaining to add more theories to the millions already out there. (I'm not quite ready to buy into the little green men with pointy heads theory, although I have seen them on some of my projects.)

It is generally accepted that "modern" surveying began in ancient Egypt when the Nile would flood and routinely wipe out all of the fertile farmland boundaries. Land disputes are never casual—humans are fiercely territorial and will kill to preserve their "perceived borders." Changing perceived boundaries to "real" boundaries may have given rise to methods of measurement and, more importantly, concepts of measurement that we still accept today.

Standing in the sun again we would have to first find a spot that will support the enormous weight of our project. Finding what is below the surface is a matter of digging holes in the ground. From different accounts, including the Bible, well drilling must have been around a long time.

Next would come setting out the points for the four corners. Since rope-making was widespread, it is not hard to picture six ropes marked off in equal increments, four lengths about 600 feet long and two about 1,100 feet long (for the diagonals). I can envision legions of day laborers shifting the ropes in a dance choreographed by the architect/civil engineer/surveyor standing on a scaffold high enough to orchestrate the movement with flags. (Reminds me of my days in the field before we had radios. Not as fast but the results were the same.) When the four external ropes were at equal length and the two diagonals agreed with each other, the base was pronounced square. The importance of beginning a project properly is as critical today as it was 5,000 years ago.

To make the site level, having no shortage of manpower, the area could have been excavated just enough to hold water, hauled from wells or the river in a never-ending human chain. It would have been easy to measure down from the liquid surface and level the area with the same accuracy we have today.

Now that the easy part was finished, it would be time to place the first course of blocks. The blocks would have to be carved flat on the bottom and beveled on the top to allow the outside face to be flat and reach the predetermined point on top. That angle works out to be about 52 degrees. (A number that I'm sure strikes esoteric thoughts into pyramid mystics.)

How could they derive such an abstruse angle and carve it in each stone? Modeling. Mankind has possessed (or maybe is possessed

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with), the concept of proportion. Every modern school kid knows how to fashion a grid onto an object and by multiplying each dimension by the scale up (or down) factor, the finished product will be a spitting image of the archetype. And judging by the artifacts found inside, symmetry and proportion were no strangers to these folks.

Last and certainly not least, in terms of effort, is moving the stones in place. If you can make a 13-acre lake in the middle of the desert, you can surely stack 50-ton rocks 500 feet high. No problem. Actually, placing the rocks may have been the easy part.

Just build earthen ramps on each face a little higher than required and drop it right in place. OSHA would not have been impressed.

The modern-day soothsayers and mystics like to point out that the great pyramid of King Khufu on the west bank of the Nile is just a fraction of a degree off of true north. How, they argue, is it possible to point to the axis of our orb without the help of a compass, which we consider to have been invented about 500 years ago?

Even this fact has its earthbound roots.

The ancient sailors navigated this globe long before GPS or compasses by watching the stars. If you stand long enough and watch the sky rotate around a star or point in the nighttime sky, you can imagine standing on a sphere and spinning around. In fact, we know the ancient Greeks conceptualized this fact long ago. To have pointed the Great Tomb toward that point in the sky would not have been hard.

All of the mysteries of the Great Pyramids will probably never be answered. Some have decided the designers and builders can't be of this world. So where in the universe do you find a species that can leave us with such a powerful example of a relentless need to construct?

We need only to look as far as our mirror.

B/A

News from AGC

The AGC/AIA Annual Crawfish Boil continues to be a popular focal point for bringing architects and contractors together in a social environment to strengthen the relationships between the two groups.

Approximately 400 architects and contractors came out to enjoy crawfish and all the "fixins" provided by Tim Murray of Texas Tails (also of Ratcliff Constructors) and listen to the live Cajun band, Texas Zydeco. The Young Constructors Forum sponsored a $50 door prize which was won by Corey Lloyd, the 11- year-old son of Bernard Lloyd of Inturnet.

For information on other upcoming AGC events, contact the AGC office at 972-247-9962.

B/A

The Young Constructors Forum (YCF) functions as a forum in which midcareer construction professionals can network, socialize, exchange ideas and receive training on pertinent issues.