PRODUCT APPLICATION

Trusting 3D roadway modeling to tackle a tricky intersection

The future is now in California

By Karen Weiss, P.E.

A preconstruction view of EDCDOT's roadway project in Cameron Park, Calif.

PROJECT DETAILS

Project

Cameron Park intersection, El Dorado County, Calif.

Engineer

El Dorado County Department of Transportation

Product Application

AutoCAD Civil 3D

In a recent survey conducted by **Rebuilding America's Infrastructure** magazine, transportation industry respondents named 3D modeling as the factor having the biggest impact on the transportation and infrastructure industry during the next five to 10 years. Indeed, 3D modeling is already making a real difference in the quality, speed, and cost of building and rebuilding our nation's infrastructure.

3D models for a 3D world

Designing infrastructure is an inherently 3D process, but the traditional approach uses 2D workflows. Just as designers who used to rely on drafting boards now use computers, many departments of transportation (DOTs) are currently moving from 2D workflows to 3D workflows for design and construction. And like the jump to computers, the move to 3D shows impressive benefits in speed, accuracy, and quality.

Using 3D modeling software, DOTs can visualize a transportation project at any stage in the design process, thus minimizing errors by identifying problems far earlier, when they can be corrected much more easily and at less of an expense. In addition, using a realistic 3D model means that DOTs can run multiple design scenarios and quickly see the associated cost and time impacts on the project.

These benefits are precisely what the El Dorado County Department of Transportation (EDCDOT) in California experienced during a recent complicated road design project, after it made the switch to a process that employed a 3D model-based design approach.

El Dorado County DOT goes 3D

El Dorado County encompasses a region of about 1,788 square miles in east-central California, bordered by Sacramento County to the west and Nevada to the east. This highly diverse county comprises a variety of towns and cities such as South Lake Tahoe and Placerville, the expanding Sacramento suburbs, parklands, and the Sierra Nevada Mountains. With about 1,100 miles of maintained roadway, EDCDOT is continually busy with repairs and improvements.

The challenge — Cameron Park was once a rural town in El Dorado County, but today it is rapidly developing and evolving into a more suburban center. As growth has continued, EDCDOT has worked to ensure that its roadways keep up with the demands placed on it by increased capacity. One intersection in particular presented a unique design challenge.

In order to accommodate adjacent commercial and residential development, an increasingly busy roadway in Cameron Park was scheduled to be widened and signalized.

The deadline for meeting the construction season was quickly approaching when it was deemed necessary to incorporate additional grading, utility, and structural work into the intersection project. If the design process was not completed in an accelerated fashion, then a whole construction season would be missed and the intersection would continue to operate at an insufficient level of service, causing safety concerns.

The solution — Like many DOTs that relied solely on paper drawings previously, El Dorado's original bid set plans existed in hard copy only. In the past, using these paper-based plans meant that evaluating the feasibility of incorporating the necessary revisions would typically have taken weeks or even months to accomplish.

But with the construction season's end approaching rapidly, keeping the intersection reconstruction project on schedule meant the design, analysis, and plan revisions would have to be completed at an accelerated pace.

Luckily, EDCDOT recently began transitioning to AutoCAD Civil 3D software, a 3D design and analysis tool. The 3D-model-based approach enabled a more streamlined process to evaluate different intersection configurations, grading, and utility placement alternatives. This allowed EDCDOT greater flexibility as it dynamically tested feasibility of alternatives.

Using the original 2D plan documents, a 3D corridor was built in Civil 3D using subassemblies that modeled what was represented in the original 2D design. Integrating the corridor model into the 3D existing surface allowed easy analysis of proposed modifications in a virtual environment.

With the 3D roadway corridor model built, roadway alternatives could be compared and accessed more quickly. The model allowed the El Dorado team to interact graphically with model elements and adjust both horizontal and vertical alignments in a 3D environment. Working in a 3D model based environment enabled the team to assess impacts more easily, since the project needed to stay within current right-of-way boundaries, avoid specific heritage oak trees, and clear existing utilities.

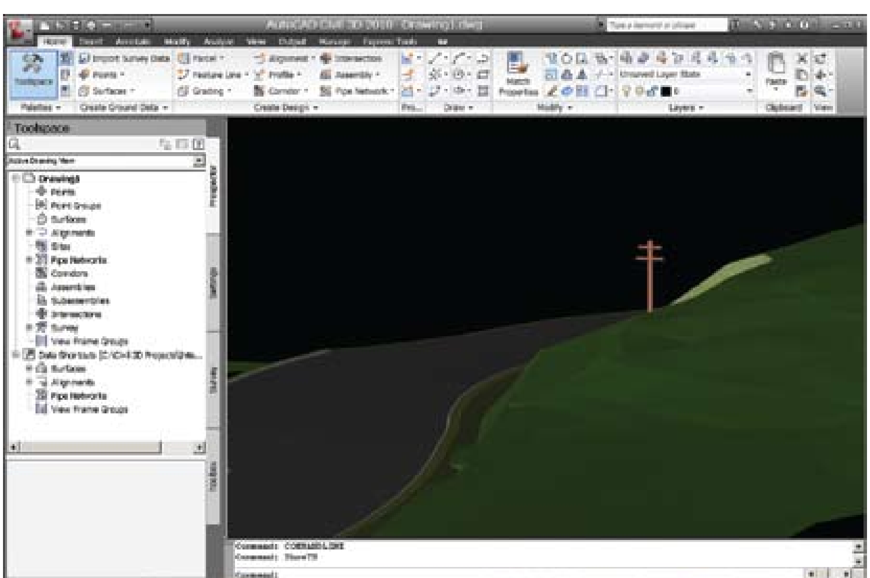
Due to the dynamic nature of the model, modifications to the alignment or profile instantly updated the corridor and its associated daylight lines. As a result, the impacts of the changes were readily apparent, allowing the team to utilize as much of the available right-of-way as possible, avoid environmental issues, and clear existing utilities — optimizing the design all within a virtual environment.

For example, to evaluate different utility configurations it was first necessary to determine the impacts of the grading each configuration would require. Using a 3D-model-based workflow, the department was able to quickly determine the feasibility of the proposed changes and make cost-effective engineering decisions. With this improved approach to design and analysis, the evaluation of alternatives was completed much faster than possible previously.

"Since the site model was dynamic, the analysis of the roadway horizontal and vertical alignments turned weeks of work into three or four hours to analyze the impacts of three different grading alternatives and utility alignments," Steven McVey, EDCDOT principal engineering technician, said. "The impacts of those roadway alternatives could be seen instantly, so it was just a matter of dragging the alignment and profile until the design was optimized, staying within right-of-way and easements, and avoiding environmental considerations."

Last minute requests — Beyond the sheer speed in which 3D modeling software tools can help DOTs operate, it's the flexibility imparted that's equally as important. Once the feasibility study was complete, a local

Using AutoCAD Civil 3D, EDCDOT quickly analyzed utility pole placement and determined where an excavation area would fit into the roadway project.



"The modifications that were incorporated into the design were easily delineated in the plans by utilizing the automated labeling features," said Steven McVey, EDCDOT principal engineering technician.

utility company requested a study that would include the locations where additional utility poles should be placed around the intersection. In the past, that type of last minute request could slow the entire project schedule, but for EDCDOT the solution was simple.

Using the same 3D model that was created in design, the engineering team was able to place the proposed utility poles and evaluate the impacts of the associated grading — all in a virtual project setting. For example, the high voltage utility lines required a specified clearance from any nearby features. In addition, they needed to be placed at an ultimate grade, which would require excavation at the desired location. The ability to model the grading using the software and place a virtual, 3D pole allowed EDCDOT to determine if the necessary clearance from the surrounding hillside could be achieved. Engineers were able to adjust the grading virtually and move the power pole to determine the best solution. This type of virtual evaluation would not be possible using traditional 2D methods.

"The modifications that were incorporated into the design were easily delineated in the plans by utilizing the automated labeling features," McVey said. "By selecting the desired label style and setting the design alignment current, the stations and offsets of key points could be labeled with just a click. All of the plan and profile labeling styles are dynamic and annotative, allowing them to automatically adjust to the rotation and scale of the sheets. This ability expedited the drafting of the plans tremendously."

With the help of the software's efficient modeling capabilities, the additional modifications could be incorporated into the plans and the intersection improvements were sent out to bid on time, keeping the project and adjacent development on schedule while saving a great deal of time, money, and effort.

Into the future

Many DOTs are achieving similar results. As EDCDOT experienced, 3D modeling capabilities for roadways will soon be the norm. Increasingly, roadway design will continue to employ more collaborative methodologies that will change the way roadways are constructed. Real gains in government efficiency, speed, and cost savings using 3D-model-based design are being realized today, and forward-thinking DOTs around the country such as EDCDOT are reaping the rewards. ▼

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