

Hardstone Construction

Architecture, Engineering & Construction Case Study



Challenge

Hardstone Construction of Las Vegas wanted to deliver a better experience to its project owners by streamlining processes to eliminate on-site conflicts between sub-contractors and the resulting time delays and cost overruns.

Solution

Hardstone chose Dassault Systèmes' 3DEXPERIENCE Platform for creating virtual product with the CATIA application to develop an integrated 3D model of the Tivoli Village mixed-use project. The model was the basis for pre-fabrication validation and on-site construction coordination.

Benefits

The 3D model reduced material waste and cost, accelerated component design, and increased accuracy to eliminate pre-fabrication mistakes and on-site conflicts for a total savings of more than \$2 million.

Efficient construction management with 3DEXPERIENCE

Pat Henderson, president of Hardstone Construction in Las Vegas, has experienced the best and worst the construction industry has to offer.

As senior vice president and president of two of the largest U.S. construction companies, Henderson's experience includes managing more than 100 public works building projects valued at more than \$3 billion. During his 30 years in the business, he has known the satisfaction of bringing a project in on time and on budget. But he has also experienced the frustration of watching deadlines pass as unexpected conflicts lead to cost overruns that can climb to 20% or more of a project's value. The overruns routinely total millions of dollars, prompting lawsuits that push the total cost for a project even higher.

Henderson knew there had to be a better way. Impressed by the computerized productivity technologies that have revolutionized discrete manufacturing, he longed to apply those same applications to the construction industry's challenges. As computerized tools for the construction industry continued to lag their counterparts in manufacturing, however, a solution seemed out of reach.

A unique vision

When famous architects began to apply the same computer technologies used in manufacturing industries to the challenges of complex, free-form curtain walls, Henderson grew increasingly frustrated with the larger construction industry's lack of progress. If no one else would apply these same tools to general construction, then he decided he would blaze the trail himself.

When Hardstone Construction was named general contractor for the multi-phased Tivoli Village mixed-use project in Las Vegas in 2007, Henderson's chance finally arrived. With 2 million square feet of

retail, office and parking space, including 16 buildings set atop a tri-level, underground parking garage, the coordination challenges presented by Tivoli Village – and the risks of project delays and cost overruns – were enormous.

Due to its unusual levels of complexity, the Tivoli Village project ran into trouble early. The drawings provided by the owner were in a continual state of flux. Because the drawings lacked the detail required for construction, major design revisions were required. The lead architects, structural engineer and mechanical/electrical/plumbing (MEP) engineer abandoned the project midway through construction. In the midst of all this turmoil, the owner asked Hardstone to not only complete its original construction coordination assignment, but also to add full design to its contract responsibilities.

It was a daunting challenge, but Henderson agreed. To mitigate the risks, his small, locally based company turned to Dassault Systèmes (3DS), the 3DEXPERIENCE Company and world leader in 3D Design, Digital Mock-Up (3D-DMU) and Product Lifecycle Management (3D-PLM).

CATIA, the 3DS application for virtual product, had already proven itself in the Architecture, Engineering & Construction (AEC) industry on iconic projects ranging from the Walt Disney Concert Hall in Los Angeles to the Guggenheim Museum in Bilbao, Spain. With Tivoli Village, Henderson planned to prove for the first time that CATIA could be successfully applied to a mainstream construction project.

A calculated gamble

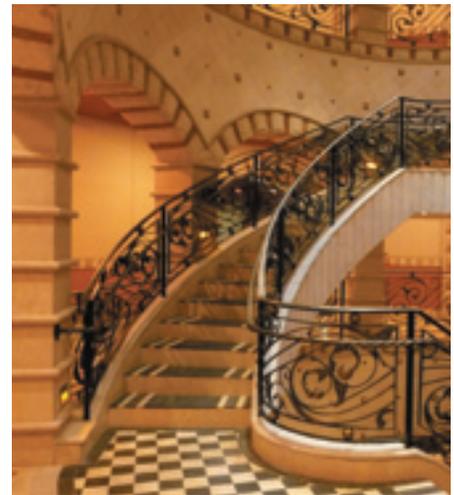
To many in the construction industry, Henderson's bold move seemed like a Las Vegas long-shot. Apply the same technology used to architect complex, one-of-a-kind monuments to a retail and office complex? They simply couldn't see the potential.

But Henderson believed that creating a highly accurate 3D model of a virtual Tivoli Village before trying to build the real one would allow his team to recognize and eliminate risks with low-cost bits and bytes rather than high-cost physical materials and workers. If he



I am convinced our Dassault Systèmes (3DS) solution has the power to eliminate many problems that abound in the construction industry. I believe it will reduce waste in construction by upwards of 10 percent.

Pat Henderson, President, Hardstone Construction



Left: Tivoli Village is one of the hottest new destinations in Las Vegas to shop, dine and work. Top Right: Bell and clock tower demonstrate the project's attention to aesthetics. Bottom right: Interior stair features decorative details and elaborate wrought iron.

was right, the payoff would be a seamless transition from design to execution with fewer delays, fewer conflicts and significant bottom-line savings.

By improving coordination and communication, Henderson also bet that using the 3DEXPERIENCE Platform for virtual product with the CATIA application would make the workplace smarter, safer and more efficient; allow all stakeholders to collaborate more effectively; and make it possible to employ the same 3D models used to build the project for its long-term operation and maintenance.

By the time the first phase of Tivoli Village opened in 2011, Henderson's had proven the value of his vision. Using the CATIA

application, Hardstone managed in-house coordination of all trades to reduce installation time and material cost for concrete work, metal stud framing and MEP runs and brought the \$300 million project in on time with zero dollars in contractor or subcontractor claims. He estimates that savings were between \$500,000 and \$1 million in potential framing cost overruns alone, and between \$2 million and \$3 million overall.

"I am convinced our use of 3DS solutions has the power to eliminate the problems that abound in the construction industry," Henderson says. "I believe it will reduce waste in construction by upwards of 10 percent. When you consider the trillions of dollars spent on construction in the U.S. alone, that is a very significant savings."

Live coordination enables lean construction

Because use of the CATIA application was rare in the AEC industry, finding skilled users with architectural knowledge was a challenge. Henderson therefore relied on a diverse trio of CATIA experts: Patrick L'Heureux, who studied aerospace technical construction and previously worked for Pratt & Whitney; Nicolas Cantin, who studied mechanical engineering and previously worked for Bombardier; and Becher Neme, who studied architecture and urban design and previously worked for renowned architect Frank Gehry. The trio worked together in Los Angeles before joining Hardstone.

The three-man team, working as senior project members with a support staff, modeled the entire architectural envelope, structure, and mechanical/electrical/plumbing (MEP) systems in-house. "It shows just how powerful CATIA is that the three of us were able to do all of that work ourselves," Neme says.

Using the linked models and up-to-date information built into them, the Hardstone team achieved "live coordination" of the Tivoli Village project, producing highly coordinated shop drawings for the construction teams directly from the 3D model.

"Live coordination enabled by our model reduced the need for time-consuming coordination meetings," Neme explains. "We provided the general contractor with a fully coordinated model and a precise quantity take-off that he could pass on to consultants and subcontractors."

A precise model enables precise coordination

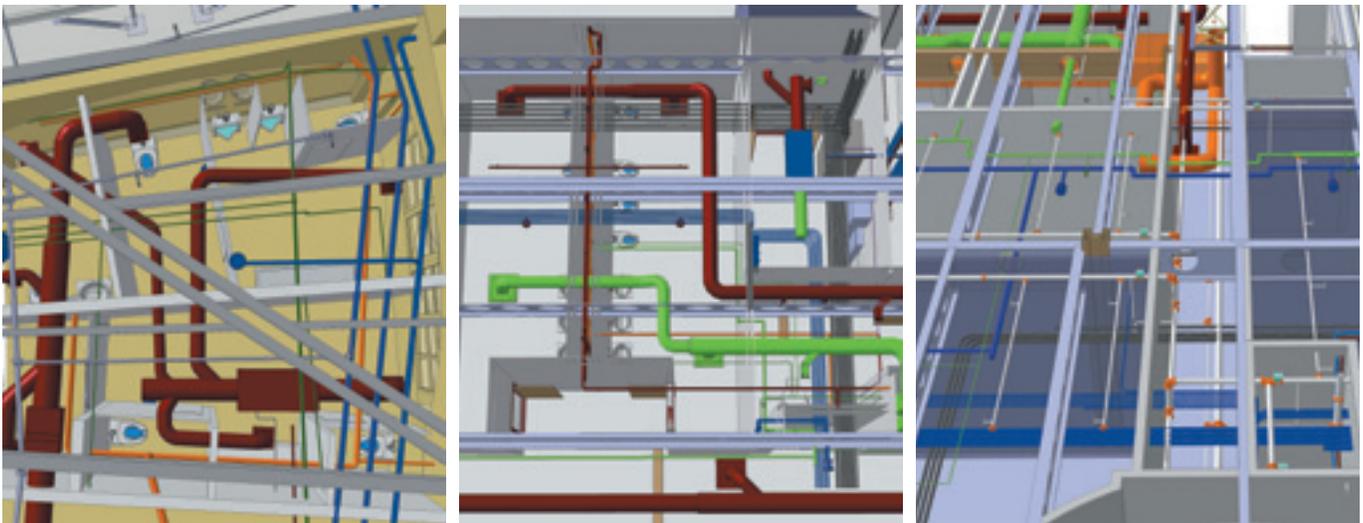
The 3D model also significantly reduced design time by automating the process to design repetitive construction components. One key advantage of the 3DEXPERIENCE Platform for virtual product with the CATIA application is that repetitive 3D geometry does not need



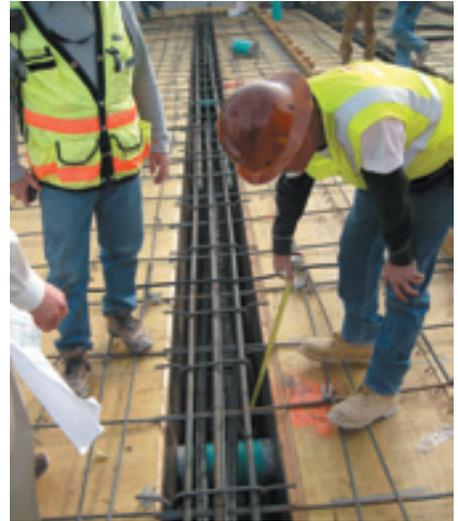
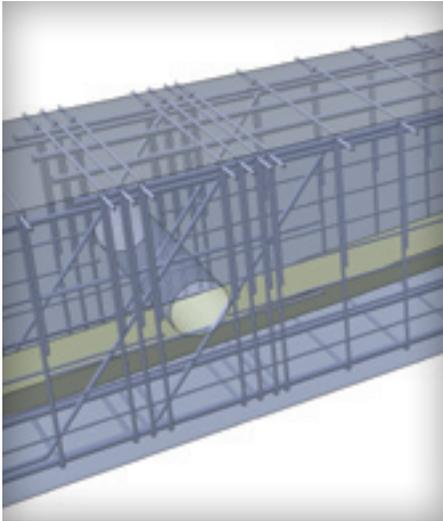
to be modeled manually. Instead, data for components such as concrete beams with post-tension cables, rebar, CMC steel beams and window surrounds are modeled with parameters drawn from spreadsheets and design tables supplied by the architect or designer.

"Because of Dassault Systèmes' extensive experience in manufacturing, only CATIA offers this, and it was a truly unique advantage," Cantin says. "These tasks would have been time-consuming and subject to high risk of human error if they were modeled manually. In fact, without the automation process enabled by 3DS, most builders would not model them in the first place, which could lead to mistakes, re-work and cost overruns."

The highly detailed structural 3D model also had a direct impact on the MEP model. Neme estimates that repeated iterations between initial design and final shop drawing production allowed Hardstone to optimize the MEP routing to reduce materials by 30 percent.



Coordination models for mechanical, plumbing, electrical and fire sprinkler runs allowed each trade to see how their installations needed to share limited space.



Concrete beam rebar models provided accurate materials estimates and facilitated field verification of rebar placement before concrete was poured.

“Because the model reflects exactly what would be built, it gave us the comfort to model the MEP runs precisely,” he said. “That is good for the budget, but also for the environment. Because we order everything to fit based on the model, there is no waste.”

Workflow improvements eliminate conflicts, cost

Eliminating the on-site conflicts of multiple trades trying to work in the same area at the same time also improved on-site safety and construction sequencing.

“The model improved the installation workflow on site,” L’Heureux says. “There was practically no time wasted on resolving conflicts between different trades on-site during construction. We simply didn’t have conflicts.”

That saves not just time, but a significant sum of money. On a framing budget of \$5 million, change orders might easily add 20 percent or more – an additional \$1 million. At Tivoli Village, the cost for change orders was zero.

Pouring the project’s concrete beams is another example. The job required hundreds of work forms with different dimensions. Most work forms were used dozens of times in different locations. The Hardstone team numbered each one in the 3D model so that it could track which form was being used for which beam. That maximized reuse of the forms, allowing the team to build fewer and move them to new locations in the right sequence to maximize efficiency.

“Instead of pouring the job one phase at a time, we were able to push the schedule because we knew exactly how many forms we had and when each form would be available again,” L’Heureux explains.

The model also helped with offsite manufacturing of key components. For the window surrounds, for example, stone was pre-cut hundreds of miles off-site and shipped to Las Vegas. The Hardstone 3D coordination team produced detailed shop drawings for the stone cutters, and detailed instructions for the construction teams on how to install them, including complete diagrams of which pieces were required for each window. When it came time to assemble them, each window surround fit together flawlessly.

“We were obsessed with finding ways to apply manufacturing processes to construction,” Cantin says. “It was exciting to be able to apply the same kind of automation that has revolutionized the aerospace and automotive industries to on-site construction.”



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Patrick L’Heureux, 3D Construction Coordinator, Hardstone Construction

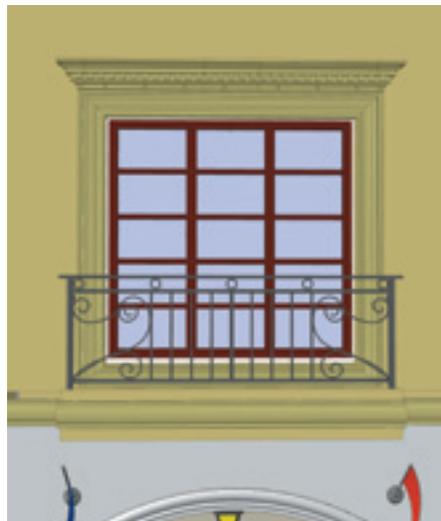
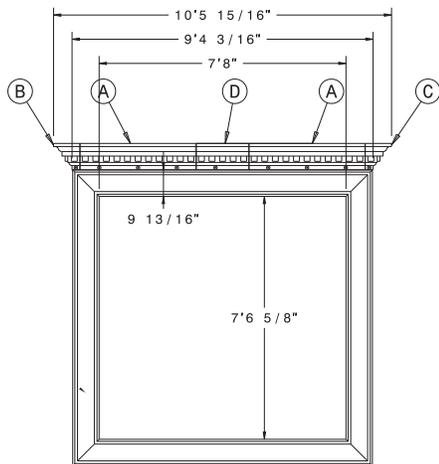


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**Nicolas Cantin, 3D Construction Coordinator,
Hardstone Construction**

On-site visualization changes collaboration experience

The 3D model changed the on-site experience for construction crews in other ways, too. For example, Neme says that crews loved working with the shop drawings and images of the master model, which was provided using the 3DEXPERIENCE Platform for 3D communication with the 3DVIA application.



Detailed models showed workers precisely how molding pieces should be assembled (left) and how a finished window would look (center). Detailed moldings created off site fit together perfectly in every case (right).

The 3DVIA application gave work crews unprecedented insight into their jobs in context of the total project. A plumbing subcontractor, for example, typically gets drawings that show only the plumbing; the 3D model available to plumbers on the Tivoli Village project not only showed the plumbing plan, but every other system that shared space with the plumbing.

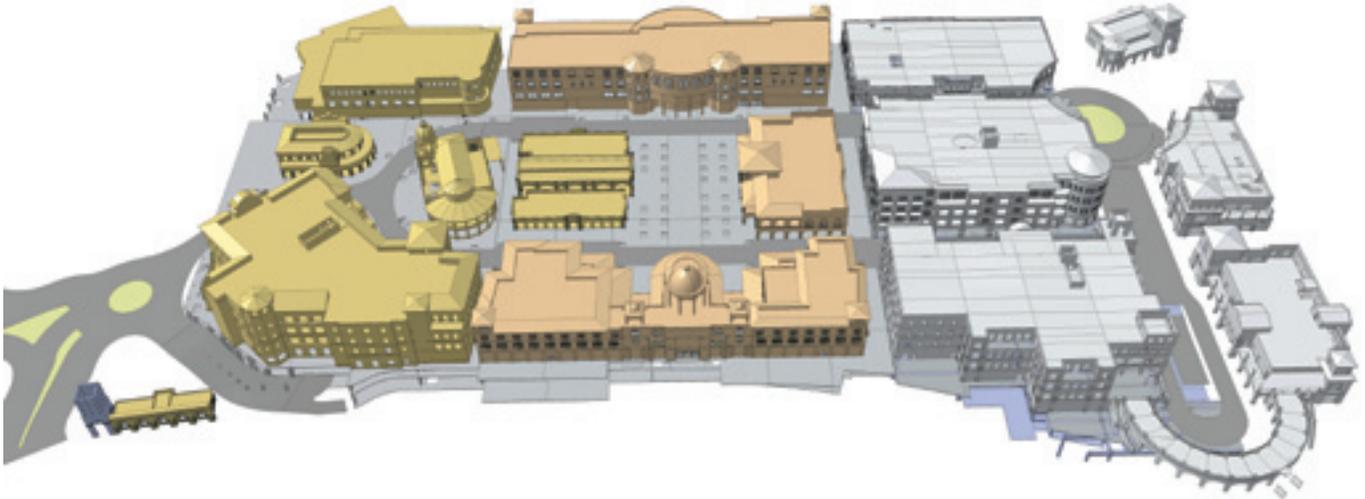
When the workers could see the models in 3D, they easily understood exactly how different systems came together, the order in which they needed to be installed, and the importance of doing their work in ways that left room for the next trade's installations.

"Having the entire model improves communication," Neme says. "Subcontractors can see what the final project is going to look like, so they understand how their work fits into the overall plan and why they have to do things a certain way. It gives everyone a sense of ownership in the project."

The detailed model will also enhance the developer's experience in managing the completed buildings, because the model is an exact representation of the completed buildings. The few changes and modifications that occurred during construction were incorporated into the model as they were approved.

"It is an entirely accurate 'as built' model for the tenants to use, which is amazingly cost effective," Henderson says. "It saves all of the time normally spent collecting information on all of the project changes to give to the owner." Operating and maintenance models can even be added to the master 3D model later, if the owner wishes.

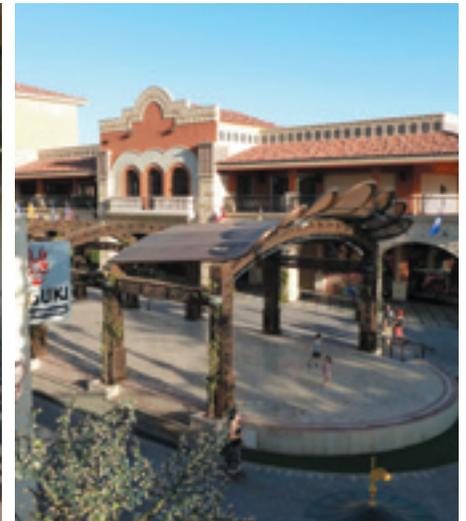
A CATIA 3D model of the full Tivoli Village project shows its three phases, allowing everyone involved to understand the scope of work.



On time, on budget

With Phase 1 of the \$300 million project complete, Henderson says the model created using the 3DEXPERIENCE Platform with the CATIA and 3DVIA applications was instrumental to bringing the project in on time and on budget. He is so convinced that the CATIA application has the potential to transform the construction industry, he has arranged for his daughter to learn how to use it.

“She is going to be in this business long after I am,” Henderson says. “I want her to have the best solutions at her fingertips, and what 3DS offers is far superior to the other 3D solutions being used in construction today. I am convinced it should be the future of this industry.”



Coordination with detailed 3D models allowed Hardstone Construction to deliver every detail of the Tivoli Village project on time and on budget, without a single change order or cost overrun.



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