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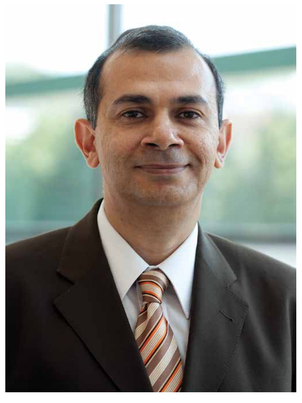
Provost's Teaching Innovation Prize

2014 WINNER



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Professor El-Tawil is accepting this award on behalf of the project team:

Julie Fogarty, PhD Candidate, Civil and Environmental Engineering
Jason McCormick, Assistant Professor, Civil and Environmental Engineering
Dr. Theodore W. Hall, Advanced Visualization Specialist, UM3D Lab
Eric Maslowski, UM3D Lab Manager, Technical Creative Consultant, DMC

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Dancing with Steel Girders: Interacting with 3-D Representations of Buckling Columns in Virtual Reality

Innovation Description

Traditional methods of teaching structural engineering are static, making it difficult for students to visualize and appreciate how complex spatial arrangements change when subjected to varying circumstances. When 3-D objects are depicted in 2-D spaces like screens, boards, or lecture notes, students have no opportunity to reconfigure the models at will. Even when working with 3-D physical structures in a controlled, laboratory environment, it can be difficult, costly, and dangerous to demonstrate limit states, especially those associated with compression members and connections.

By contrast, digitized models in a virtual reality (VR) environment lend themselves to an immersive, interactive experience. Students climb or fly around a model, discovering the size and extent of important features. Instead of seeing just a few 2-D sketches of flexural or torsional buckling, students can quickly "dance" with several different columns undergoing various buckling modes. By discussing with an instructor what they are observing, students identify key aspects that affect the design of column members.

In fall 2013, 24 of 47 students in CEE 413, *Design of Metal Structures,* retook a midterm exam question on buckling immediately after spending 10 minutes in the VR model described above. Twelve students who had initially scored 8 or less (out of 10) raised their scores.

Student Comments

"When first learning of the multiple forms of buckling in structural members, it is easy to inadvertently confuse or combine these physical phenomena. The virtual reality simulation, however, provided a visual means of clearly distinguishing the different forms of buckling."

"Each form was much easier to understand and identify after viewing them in the 3D model."

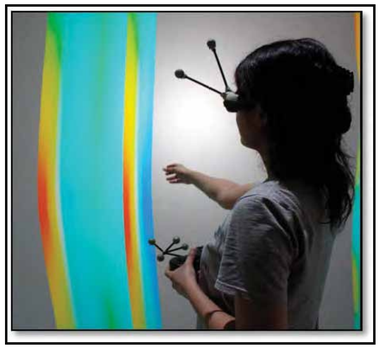
The interactive and immersive "ability to orbit around the 3D columns while they underwent different forms of buckling was truly unique and extremely effective in conveying the intended information."

"My first thought in the virtual reality room was that this is exactly what I've been asking from my professors for years [because] I have been confused about how the item on the chalkboard ties into the rest of the system we are discussing."

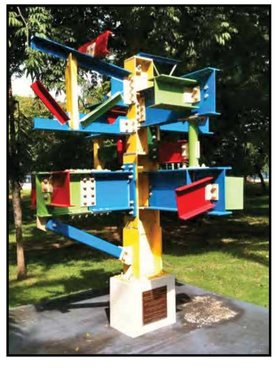
"In construction, it's very difficult to see the full product without experience. If you haven't seen a VAV box or how it fits into the building, how are you supposed to recognize it on the drawings or approve submittals? I would love to see more of these virtual reality applications in more of my classes."

"By expanding this activity to many different aspects of different classes, the students could gain valuable experience for a future career."

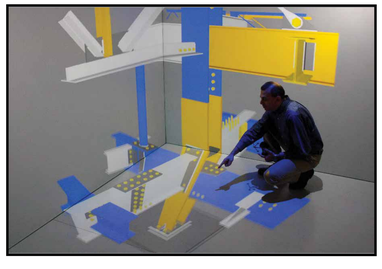
Examples of Teaching Innovation



Student interacting with a buckling column in the UM3D Lab's MIDEN (Michigan Immersive Digital Experience Nexus).



Educational sculpture promoted by the American Institute of Steel Construction for teaching how structural members intersect and are fastened together. Although students can walk around it, the sculpture is static and covers a limited number of configurations.



Digitized version of the steel sculpture lets students remove components, allowing a clearer picture of connections to emerge. The ability to reconfigure at will is a key advantage over the physical sculpture.