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VSI
RESEARCH & FORENSIC CONSULTING

Vector Scientific reconstructs real world accidents with simulation

THE CHALLENGE

After a tragic car accident, Vector Scientific, Inc. sought to determine whether the passenger would have experienced the same injuries had he worn his seat belt.

THE BENEFITS

· Analyze vehicle accident reconstruction,

· Assess occupant injury risk,

· Assist forensic experts in their researches.

"While a car crash happens in a blink of an eye, **Visual-Safe MAD** *gives us the ability to slow down the event for our clients and demonstrate why and how individuals get injured in crashes. It also allows us to* **provide visual insights into occupant movement, injury mechanisms and seat belt effectiveness by selecting different views and display options like no other tool."**

Dr. David Raymond, Senior Biomechanical Engineer, Vector Scientific, Inc. and Assistant Professor of Mechanical Engineering at California State University Los Angeles

Vector Scientific, Inc. is a research and forensic consulting firm specialized in injury biomechanics and accident reconstruction. The company's expertise in the complementary disciplines of occupant injury analyses and vehicle accident reconstruction includes state-of-the-art application of occupant and vehicle computer simulations.

Determining the vehicle dynamics and simulating the passenger movement

Vector Scientific began their forensic reconstruction by determining the vehicle dynamics of the crash. They performed detailed vehicle and scene inspections. They performed laser surveys of the roadway and land surrounding the roadway for the purpose of generating a 3D map of the accident scene. Positions of physical evidence, such as tire marks, gouges in the dirt and on trees, were meticulously measured and plotted. This information served as input for the software used to determine the vehicle crash dynamics. Once vehicle dynamics were comprehended, these were used to determine kinematics and injury mechanisms relative to the occupant.

Vector Scientific used Madymo software to analyze the movement and injury response of the human body to impact and ESI's software Visual-Safe MAD to process and analyze the simulation output.
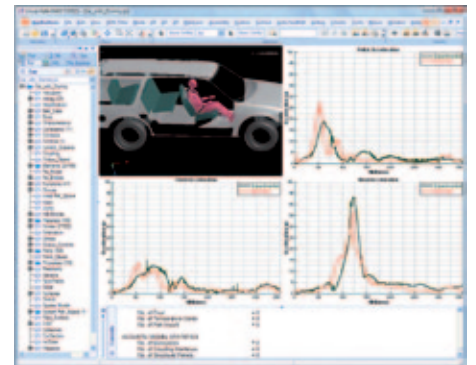

Visual-Safe MAD's Graphical User Interface

Before simulating the real world accident, Vector Scientific ran a validation simulation to evaluate the model. They subjected the simulation to the same impact defined in the Federal Motor Vehicle Safety Standard (FMVSS) 301 test. The FMVSS 301 test is performed on every vehicle to determine the integrity of its fuel tank. In order to comply with the FMVSS 301 requirements, vehicles must withstand certain specified impact tests ranging from 20 to 30 miles per hour (approximately 32 to 48 km per hour), without leaking fuel in excess of 1 ounce per minute following the tests.

Forensic simulation of real world crashes is especially difficult however because real world collisions are so unique that, unlike standard FMVSS tests, there is no comparable simulation data available. In such instances, Vector Scientific will evaluate trends and run design-of-experiments to gain insight into occupant kinematics and injury mechanisms.

For this case, they compared the model output with the data and high speed film taken from the physical test. The simulation results matched up closely, providing a strong indication that the model could be trusted to provide accurate results.
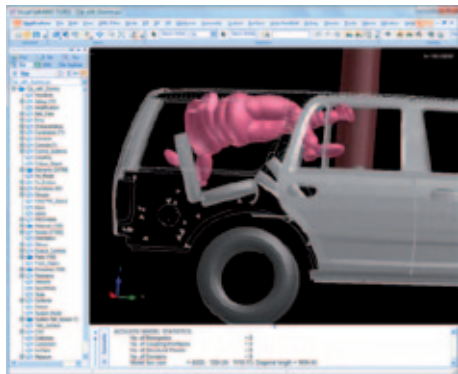

Unbelted occupant excursion and impact to third row seat back

"An important advantage of Visual-Safe MAD is that it allows for analysis and visualization of the simulation's animation as well as engineering data in a time-synced manner," said Dr. David Raymond, Senior Biomechanical Engineer at Vector Scientific. *"I view the engineering data while watching the simulation to make sure that the results make sense.* **Visual-Safe MAD and Madymo work well together even when you are dealing with unknown variables associated with a real world accident.** *For example, in a situation where you don't know exactly how the seat was positioned you can run a design of experiment with ranges to see how it*

affects the outcome. In many cases you will discover that the unknown variables either have little effect on the outcome or that you can make a good estimate for the unknown variable by matching the simulation results to physical evidence."

Comparing outcomes with and without seat belts

They first ran a simulation of the accident with the passenger unbelted. The simulation showed the man being thrown through the vehicle and hitting the third row seat back and spare tire which was wedged in the rear cargo area in a vertical manner. The simulation matched physical evidence such as contact marks and the occupant's final point of rest. Next, they ran a new simulation with the front passenger's seat belt fastened. They found that in this case the seat belt reduced the passenger's velocity to the point that he was contained to the first two rows of seats, mitigating the injurious impact to the third row and spare tire. Taking advantage of a unique capability of Visual-Safe MAD, they superimposed the two different simulation iterations. The resulting animation dramatically highlighted the effect of wearing a seatbelt during the accident. In this case, it was used to show graphically that the occupant's injuries resulted primarily from being unbelted.
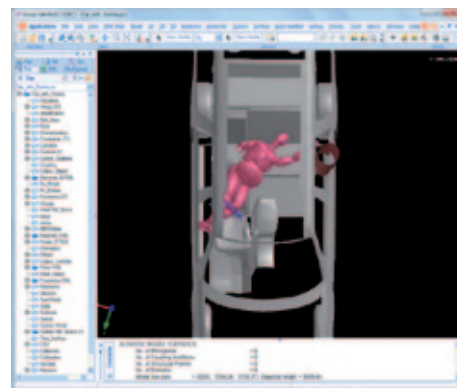
Maximum rearward excursion of belted occupant

Another key aspect of Vector Scientific's analyses is assessing occupant injury risk. *"We use injury risk assessment tools developed through the automotive industry during our investigations,"* said Dr. Raymond, *"That includes injury criteria developed over the past 50 years."* In the future, Vector Scientific will continue using simulation with Visual-Safe MAD to resolve such injury cases.

"Visual-Safe MAD has many of these criteria functions built into the post-processing software, making injury risk assessment of the simulated crash seamless and straightforward."

Dr. David Raymond

To find out more about ESI's Visual-Safe MAD, please visit: www.esi-group.com/passenger-safety

ABOUT VECTOR SCIENTIFIC, INC

VSI (Vector Scientific, Inc.) provides high quality forensic consulting services and conducts original research in order to advance the science of forensic biomechanics and engineering. To find out more: www.vectorscientific.com

ABOUT ESI GROUP

ESI is a pioneer and world-leading provider in virtual prototyping that takes into account the physics of materials. ESI has developed an extensive suite of coherent, industry-oriented applications to realistically simulate a product's behavior during testing, to fine-tune manufacturing processes in accordance with desired product performance, and to evaluate the environment's impact on performance. ESI's solutions fit into a single collaborative and open environment for End-to-End Virtual Prototyping, thus eliminating the need for physical prototypes during product development. The company employs over 800 high-level specialists worldwide covering more than 30 countries.

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