UNIVERSITY of DETROIT

A university professor uses SaberDesigner™ to help Ford Motor Company and his students gain new perspectives on the engineering design process. At Ford, his simulations identified the previously overlooked wire harness as having a significant impact on overall system performance.

Most of us take our cars for granted. We open the door, adjust the seat and turn the key in the ignition. The engine fires up and we pull out into the street. All the vehicle electronics — the power door locks, the seat positioner, the ignition controls, the anti-lock braking system, even the headlights and radio — work as expected. But designing all these individual subsystems to work in perfect harmony is a tremendously complicated challenge for automotive engineering teams.

Faced with the rapidly increasing complexity of its electrical subsystems, Ford Motor Company called on noted professor and consultant Dr. Armand Ash-Rafzadeh ("Dr. Ash") to develop an improved design process. The goal was to expand Ford's design awareness so they could manage the performance of systems as a whole — not just the individual performance of subsystems.

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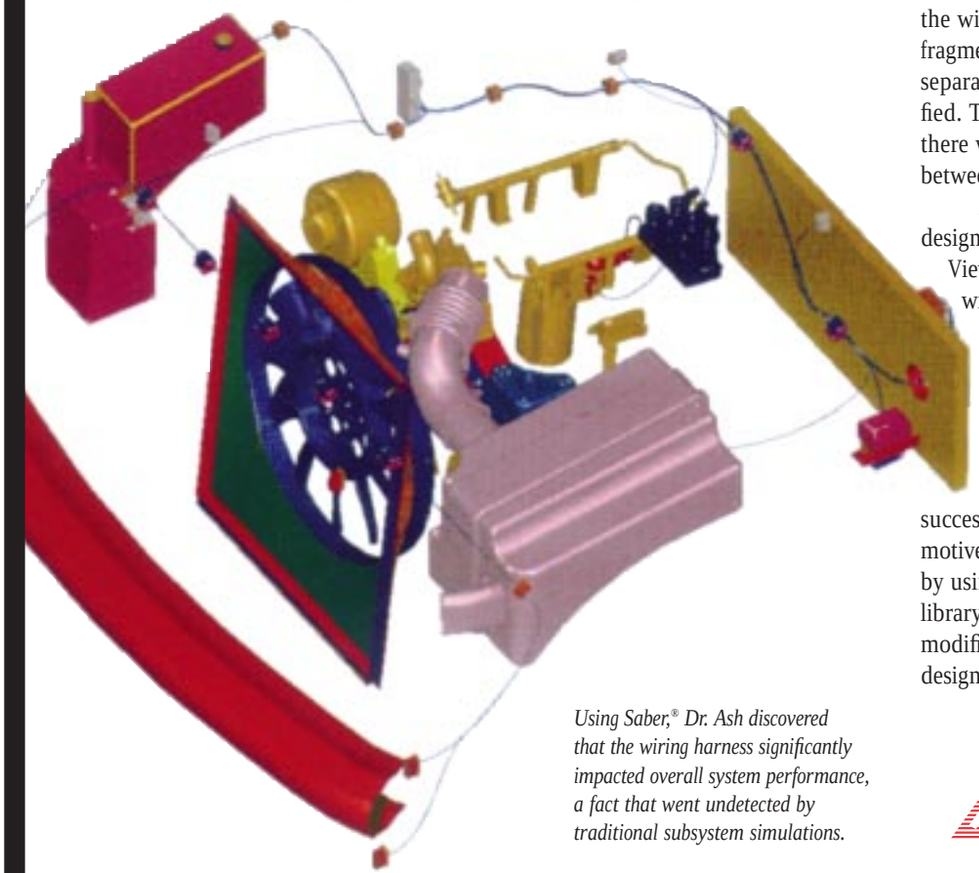
>
> **Dr. Armand Ash-Rafzadeh**

Ford's prevailing design program focused on subsystems, rather than total system and connectivity between subsystems. "The old methods didn't take the wire harness into account. Design and testing were fragmented," said Ash. The individual systems were separately designed, simulated, prototyped, and modified. This caused problems with simulation because there was no way to account for the interconnections between the vehicle subsystems.

Ash faced this challenge by developing a new design process he called the "Wire Harness Centric View" (WHCV). This new methodology isolates each wire harness rather than each subsystem. Thus, the design perspective becomes essentially that of a wire harness connected to all of its components. To simulate the complex interactions of these linked systems, Dr. Ash turned to Analogy's SaberDesigner.

"We put the system together and were very successful," said Ash. "I believe that this is the first automotive design effort that models the total vehicle system by using mostly generic device models from the Analogy library." Using WHCV helped identify the crucial circuit modifications needed, and it did so very early in the design cycle.



Using Saber,® Dr. Ash discovered that the wiring harness significantly impacted overall system performance, a fact that went undetected by traditional subsystem simulations.

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SABER SUCCESSES

"Using Saber helps my students become really ingenious. It brings out the 'real' engineer in them and lets them apply their skills with greater creativity and effectiveness. Those who become proficient with Saber really gain a higher-level understanding of the systems they work with."

Ash's consulting firm, Mechatronics, Inc., placed eight Saber-trained employees as subcontractors to Ford. Using the lessons learned from the WHCV program, Ash began specifying the device models needed for a Total Vehicle Analysis.

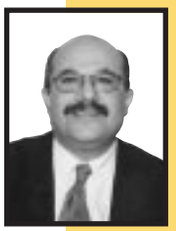
The first step was to apply Ash's newly-created Vehicle Element Identification Process (VEIP). VEIP was used to develop a list of "commodities" — components in the vehicle that were to be simulated — and a complete specification of the simulation model. In addition to generating the requirements for Analogy's MAST® modeling, VEIP also simplified data management and the creation of schematic symbols.

Ash began by using Saber and his new process to analyze a complete steering system. The process used vehicle sensor data, the digital signal processing capabilities of MATLAB®, and the system and mechatronic simulation capabilities of Saber and MAST. The objective was to identify the source of noise that occurred at low speeds and disrupted the steering-fluid flow rate. Results from the Saber simulation allowed designers to modify the control circuit to maintain the proper fluid levels.

On subsequent projects, Ash and his team made full use of Saber's capabilities. "We used everything [in Saber] that there was," said Ash. "Monte Carlo was most helpful. We evaluated the negative performance impacts that came from the interaction of component tolerances. We also quantified the contribution of each component or component cluster." Ash also used Monte Carlo analysis to study how component combinations can affect subsystem performance. "We can measure performance levels and buy the appropriate quality of components needed by that particular subsystem."

"My ultimate goal is to get as many companies involved in the VEIP process as possible," said Ash. "We'd like to provide this solution to other companies in the industry. Ford is fanatical about this. They realize that this is a very important strategic tool for automotive design. It doesn't only perform systems analysis, it changes the whole design culture. It gets you involved in data management, data structures, and many other processes. The automotive industry knows the importance of this, but few companies have made the necessary commitment to change. It hasn't yet been integrated into their engineering cultures."

Based on his successes at Ford, Ash obtained Saber as a teaching tool for his classes at the University of Detroit. He identified promising graduate students and brought them into his projects.



Armand Ash-Rafzadeh was born and raised in Tehran, Iran. He earned a BSEE in 1974 from the University of Technology in Tehran. He came to the U.S. for postgraduate work at the University of Oklahoma where he earned an MSEE and a Ph.D. in signal processing and sensor modeling. Ash was awarded a unique post-doctorate fellowship at the University of Oklahoma for research in biomedical engineering, specializing in turbulent blood flow analysis using multi-dimensional ultrasound sensors. He transferred to the University of Detroit in 1987 to participate in their excellent research program in blood flow. He began working with hospitals but, understandably, soon found himself gravitating towards the local automotive industry. He is currently an associate professor in the electrical engineering department at University of Detroit, Mercy, and serves as co-chairman of the CAE-EDA-SAE Modeling Standard Committee task force.

Dr. Ash's success story was chosen by Analogy's review board as the second-place winner in the 1997 Saber Success Award program.

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