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Student project involved in engine heat research for GM and DENSO

Dr. Parviz Merati, chair of the Department of Mechanical and Aeronautical Engineering (MAE), is leading the third phase of ongoing General Motors research. He said that the new $84,000 grant brings GM's total investment in research to about $250,000.

According to Merati, the first two phases of the GM project have led to several breakthroughs in understanding the under-hood heat phenomena.

For this phase, DENSO Manufacturing has also added a $50,000 grant to purchase Stereo Particle Image Velocimetry (SPIV), a new laser system that measures the velocity of a flow.

"When I wrote the DENSO grant, I indicated that we were working on the GM grant," Merati said.

With the assistance of mechanical engineering (ME) graduate students **Charles Davis** and **Jacob Nink** and four MAE undergraduate seniors, Merati is exploring heat, a major problem under the hood of a car. "We're trying to understand the physics of the under-hood buoyancy flow to find ways to cool down the under-hood environment as fast as possible."

When a car is driven for a long time, the heat is very intense, and it does not easily dissipate when the car is turned off. "If it's parked in an area without much wind, it takes about an hour or more to cool down," Merati said. "This is what is known as thermal "soak" in the industry."

"Heat is not good for any under-hood component, and there's a tremendous amount of heat, especially over the top of the under-hood," Merati said. "In some regions you get a temperature of 200 degrees C; it carries a lot of radiated heat that we can see glowing from the exhausts."

Some of those involved in the engine heat research are (from left) **Dr. Parviz Merati**, MAE chair and project leader, **Rob Messner**, ME senior; **Dr. Javier Montefort**, MAE assistant professor; and **Kevin Kalchik**, ME senior. They are posing with a full-scale model of a car's engine block and exhaust pipes that was enclosed in a tempered-glass case to study the heat flow. Missing from photo are seniors **Charles Gauthier** (ME) and **Thomas Spencer** (AE)

For their senior design project, **Charles Gauthier**, **Kevin Kalchik**, **Robert Messner**, and **Thomas Spencer** are learning the new SPIV system and how to use it to measure the three components of flow velocity in X, Y, and Z directions. "It's a state-of-the-art system that non-intrusively measures these components using a pulse laser system," Merati said.

To use the system, a full-scale simplified model of a car's under-hood including the engine block and exhaust pipes has been created. A tempered-glass enclosure enables the students to use the lasers and to study the results of the heat that radiated and convected from the exhaust at 600 degrees C and the engine block at 100 degrees C. Heat pipe principle is used to keep the temperature of the surface of the engine block at 100 degrees C.

Merati said that all the under-hood components are instrumented with thermocouples to measure the temperatures. "These are very high temperatures, and there are so many components that are affected," he said.

"The SPIV technique measures the convection-type flow under the hood," Merati said. "The dominant structures of the under-hood flow are similar to the mushroom structures observed in thermal plumes within the atmosphere."

"GM wants us to do this so they can use our experimental results to verify their computational fluid dynamics (CFD) codes," he said. "Whenever you have a complicated flow as such you don't know if your computational methods are good, and you need to verify them experimentally. That's what the students are doing."

If the students prove that computational results are good, then GM is going to use CFD to model much more complex under-hood geometries," Merati said.

Messner said the senior design team plans to complete the testing this month. "We should have data by the end of February," he said.

For more information on the project, contact Merati at parviz.merati@wmich.edu

Send your thoughts or suggestions for future topics to the editor at jerrie.fiala@wmich.edu Thank you.