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ROLLING DOWN THE ROAD FOR RESEARCH: DEVELOPING WAYS TO PREDICT AND CONTROL AUTOMOBILE WIND NOISE

Atlanta drivers who may have questioned their eyesight after spotting an unusual car driving the city's interstates at unusual hours may rest assured that their vision is fine. A white car wired with microphones, a bicycle tire, wind vane and wind velocity monitor really was cruising Atlanta expressways between 2 and 5 a.m. some mornings during the last year.

The interestingly equipped 1991 Mercury Sable is part of a research project sponsored at Georgia Institute of Technology by Ford Motor Company to study wind noise generation, propagation, control and prediction. Consumers could see the results of this work applied to future automobile design, said Dr. Krishan K. Ahuja, head of the Georgia Tech Research Institute's acoustics branch and a professor in Georgia Tech's School of Aerospace Engineering.

"As the 21st century approaches we will probably start seeing more electric cars," he said. "They will be super-quiet, as far as engine noise is concerned. The key noise will be wind noise, which is the focus of this study."

Researchers led by Ahuja want to develop ways to predict the noise levels drivers hear inside their vehicles while on the road. No way of completely predicting noise inside automobiles has been developed. This is the first study during which a detailed ranking of automobile wind noise sources has been made, Ahuja said.

Noise data was collected in a wind tunnel with the car engine off before the road tests were begun. (Color and B&W Available)

To prepare the car for its 25,000 miles of road study and a myriad of additional tests,

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student team leader Tim Hamel and colleagues Brian Miller and Julia Robinson used clay to mount hearing-aid microphones at 41 locations on the car. The locations were chosen by their potential to be noisy: around the mirrors, near crevices and recesses, around corners and on the underside of the car, for example.

As the car traveled the interstates, data from each microphone was fed separately into tape recorders and an onboard computer. Later, the information was transferred to a lab computer for detailed digital signal processing. This provided a time history of the noise recorded, as well as the frequency content of noise at each of the 41 microphone locations.

The driver of the car also looked a little unusual. He donned a pair of eyeglass frames with a microphone dangling in front of each ear, recording the sound that was reaching him.

Other data was being compiled during the road tests. A wind vane and a wind speed monitor attached to a special frame on the front bumper recorded flow direction and velocity. A bicycle wheel attached to the rear bumper monitored the car's speed using a magnetic pulsing device available at bicycle shops. The data on wind direction and velocity and car speed also was fed into the onboard computer and later analyzed, along with the noise data, as a function of time, Ahuja said. The tests were conducted between 2 and 5 a.m. to avoid noise generated by other traffic.

The road tests were just one in a series of studies that Ahuja and 10 of his students are conducting to help them predict noise levels in automobiles. To predict, they must know the sources of noise, where noise is produced, how the sound propagates from where it is produced to where it is heard, and how to control it.

Prior to the road tests, noise data was collected in a wind tunnel with the car engine off and the vehicle facing at different angles to the wind flow. A mannequin head equipped with eyeglass frames and microphones was used to record noise detected in the front passenger seat on some tests, Ahuja said.

The wind tunnel data will provide a comparison for the road test data, and allow the researchers to rank by decibel level the noise produced by the wind -- excluding other factors such as engine noise -- at the 41 different locations, Ahuja said. Wind tunnel tests also verified that the extra equipment mounted on the car was not increasing the amount of noise the microphones were recording.

Next the researchers studied noise paths in a portable semi-anechoic chamber to find out whether, and at what levels, noises created outside the car entered the driver's area. They sent sound into the car through tubes attached at each of the points where a microphone had been placed, and recorded the noise level that reached a microphone at the driver's location. The semi-anechoic chamber simulated road test conditions.

The bicycle wheel monitored the car's speed. Microphones are visible on the left windows and doors. (Color and B&W Available)

The researchers are making their first attempts at predicting noise generated by flow around the antenna of the car.

"The noise produced by flow around antenna-like bodies has been known for years," Ahuja said. "Our object is to predict the frequency and the amplitude, and we are doing that right now."

Ford is interested in aero-acoustic research for several reasons, says William Quinlan, manager of the company's Aerodynamics Design Engineering Department.

"One of Ford Motor Company's missions is to continually improve our products to meet our customers' needs and expectations," he said. "Our customers expect an overall quality sound when driving our vehicles; this is an area of vehicle engineering that offers the potential to surprise and delight them with a high value product. The work performed at GTRI is forming the building blocks of basic understanding from which we can engineer the improvement of our vehicles' sound quality."

Some unusual, useful developments have come from this study. The researchers developed molded rubber microphone mounts that can be stuck to a vehicle, eliminating the need for drilling holes in its body to position microphones. The mounts are shaped like the clay ones used in the study, but are easier and less messy to use. The researchers also made the semi-anechoic chamber they used by filling inexpensive wire frames with rolls of fiberglass.

Some of the pages and pages of results, which are proprietary, have been analyzed and presented to Ford. More study and analysis lie ahead, Ahuja said. The researchers also will begin studying how much and what frequency of sound is absorbed or deflected by the car before the remaining noise reaches the driver.