A clear audio alternative:

Using a windshield for sound

Generations of driving audiophiles have invested considerable time and money turning passenger cabins into rolling sound stages.

The results can be spectacular, but this additional hardware can inflict a high cost; not just the price tag for equipment, but compromises to interior design, an increase in vehicle weight and significantly increased power consumption — so much so that a second battery must sometimes be installed.

Now a clear alternative to this approach might be right in front of drivers everywhere: the windshield. According to Colin Novak, a professor in the University of Windsor's Department of Mechanical, Automotive, and Materials Engineering, this all too familiar sheet of glass could take the place of an installed speaker. Vibrations that move the material no more than a fraction of a millimetre make the structure capable of transmitting specific ranges of sound.

"If you think of a conventional speaker, the bigger the diameter of the speaker, the lower the frequency it's capable of going," he explains. For this reason, the windshield could take the place of a regular subwoofer, which can often be large enough to affect seating arrangements and limit the available space in the trunk of a vehicle. Depending on the vehicle model, it can also reduce a vehicle's weight by up to 20 pounds thus increasing the vehicle's fuel efficiency. This approach would also consume less electricity than a typical on-board sound system.

Canadian automotive parts giant Magna recently acquired the rights to this technology, and is collaborating with Dr. Novak and his AUTO21 project team, to prepare the product for the high-end automobile market.

Dr. Novak and his colleagues are currently working with a prototype installed in a vehicle, which they are using to fine-tune the windshield's available frequencies according to the acoustic features of the cabin.

"Every car is unique," says Dr. Novak, referring to the fact that the pattern of three-dimensional sound waves can be affected by the contours of the roof, seat backs, and even the people riding there.

The vibration of the windshield is made possible by mechanically attaching it only along the roof line, leaving the other three edges free to move. Along the bottom edge are two piezoelectric crystals, actuators about a third of a metre long. Flush to the glass, these devices exert a force perpendicular to the window surface, based on the input signal from the rest of the sound system.

Among the foremost technical hurdles facing the researchers is the sensitivity of these actuators, which function much like intricate springs.

"They have their own set of mechanical characteristics or natural frequencies," says Dr. Novak, describing the challenge of setting an operating range for these actuators which is at a considerable remove from these natural modes.

The University of Windsor's Centre for Engineering Innovation represents a strategic site for such ambitious efforts to balance the technical demands of machinery with the psychological perception of the resulting audio. This new facility has been outfitted by the Danish firm Brüel & Kjær for just this kind of noise, vibration, harshness (NVH), and sound quality analysis.

"We have a full NVH program including a lot of application experience and theoretical knowledge," says Dr. Novak. "So, for us, working with pioneers in the field of sound and vibration means that we are at the forefront of technology."

For just this reason, he adds, the prospect of adding an entirely new function to the windshield makes for an enticing research undertaking. "This is like a whole new frontier that we're able to play with now, improving the acoustics within the vehicle."

In addition to those from the University of Windsor, additional researchers from McGill University, the University of Calgary and the University of Waterloo contribute to the project.

"Every car is unique," says Dr. Novak, referring to the fact that the pattern of three-dimensional sound waves can be affected by the contours of the roof, seat backs, and even the people riding there.

Left: Dr. Colin Novak of the University of Windsor is leading a team to develop a windshield that can take the place of a subwoofer in an audio system.