DEVELOPMENT OF AEROACOUSTIC CFD AT JAGUAR LAND ROVER

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ABSTRACT

Traditionally the wind noise contribution to vehicle noise has been improved by increasing glazing thicknesses, introducing acoustic laminate glazing and improved sealing. These two solutions have significant draw backs as they add weight and cost into a program. Adding weight to the car in any capacity has a detrimental effect on efforts to reduce CO_2 emissions and so must be avoided. This combined with the increasing use of Aluminum instead of Steel in vehicle bodies further reduces the noise attenuation of the vehicle structure. These factors combine to highlight the importance of developing good form related wind noise.

During the last 5 year period the use of CFD for wind noise applications has increased significantly. This presentation will discuss how aeroacoustic CFD was developed for a number of different applications between 2007 and today.

Literature and previous investigation at Jaguar Land Rover (JLR) tells us the major noise contributor to a front occupant outer ear is the noise transmitted through the front side glass. This can then be broken down into two factors, the wall pressure fluctuations on the glass exterior and the transmission of that into the cabin. However this can only be measured experimentally once prototypes have been manufactured, at which point any changes are very difficult and costly. Wall pressure fluctuation can be measured using surface mounted microphones, either on a prototype vehicle or on a full-scale representative aerodynamic property (‘aerobuck’) during development. However these aerobucks are costly to build and can become outdated quickly. Therefore the first Computational Fluid Dynamics (CFD) project was aimed at predicting the wall pressure fluctuations on the front side glass. This method could then be used at every surface release and form change throughout program development. It could be conducted in a timely fashion in order to influence design direction before design freezes and well before the final engineering freeze.

Initial simulations were conducted using Exa's Corporations PowerFLOW suite of tools, a Lattice-Boltzmann code. These used the aeroacoustic best practice set up for front side glass (fsg) wall pressure fluctuations (wpf) and correlated to experimental surface pressure microphone measures. Good correlation was achieved. There are also many advantages to CFD simulation over experimental surface pressure measures. Such as being able to examine volume flow structure and achieve a higher spatial resolution.

It was understood that whilst front side glass contributions are important they are not the complete wind noise story. So we have moved onto looking at windscreen loads, yawed flow simulations and underfloor contributions in order to increase the scope of influence pre final engineering freeze, all of which will be discussed.

Along with aerodynamics and thermal management it has been our strategy to focus on CAE development instead of test based wind tunnel testing. The development of aeroacoustic CFD at JLR over the last 5 years has taken us from virtually no capability to one of the leading European automotive companies.