Sound synthesis solutions for new engine combustion strategies.
Vibro-acoustics perception interactions

To reduce fuel consumption, car manufacturers use procedures consisting in strongly modifying combustions in some cylinders, which can be made in some particular running conditions. Such strategies strongly modify engine noise, by increasing irregularities which gives a poorer sound quality. This is particularly noticeable for engines with a low number of cylinders (3 or 4). In order to correct this noise modification, manufacturers think of using sound synthesis solutions : extra sound is emitted through loudspeakers in the cabin. Synchron or asynchron strategies have already been evaluated and proved to be beneficial. This thesis will partly be devoted on improving such techniques of sound synthesis. On the other hand, these engine modifications also modify the vibrations from the engine transmitted to passengers through the chassis. Sound synthesis cannot compensate for these modifications. This could give inconsistencies between auditory and vibration stimuli while such stimuli are usually attributed to a common source (the engine). In some other cases, it has been proved that such stimuli should have a minimum coherence when presented together to a subject (e.g. Kim et al., 2006, measured the maximum acceptable time delay between stimuli). But, as far as we know, no study has yet been conducted in order to evaluate how incoherent stimuli could affect the evaluation of comfort or of the quality of the product.

The work program will include the following steps :

- development of sound synthesis procedures so as to compensate the effect on noise of planned combustion strategies;
- modelization of the effect on vibration in the cabin of these strategies;
- experiments aiming at evaluating the improvement due to sound synthesis. These experiment will be conducted in real cars or in the laboratory, using a test rig which allows to submit the subject to sound and vibration;
- experiments in order to evaluate the minimum coherence needed between sound and vibration, for a given comfort level experienced by subjects.

Sound analysis and synthesis tools already exist at PSA and will be used, by some other ones will have to be developed during the thesis.

This thesis will be co-supervised by PSA Peugeot Citroën and the Acoustics and Vibration Laboratory (INSA-Lyon).

For any question, and for applying, please contact :
Etienne Parizet (etienne.parizet@insa-lyon.fr)
Vincent Roussarie (vincent.roussarie@mpsa.com).