

Ph.D. Opportunity CIFRE: Characterization of brake squeal instabilities through time domain simulations of a reduced-order nonlinear dynamic system.

Desired start date: planned for 2027

Location: 80 % (Lyon) / 20 % (Stellantis Poissy Green Campus)

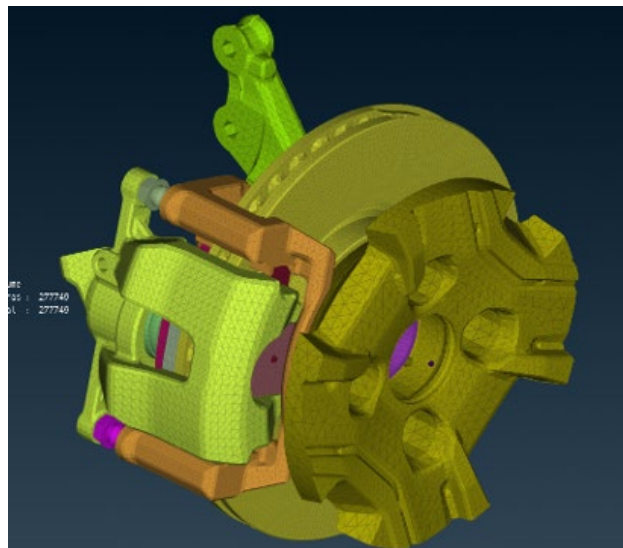
Partners: Stellantis, Université Gustave Eiffel/UMRAE, ECL/LTDS, ENSAM/PIMM, VibTwin

Profile: Final-year engineering student or recent graduate with a Master's degree (Bac+5) in Mechanical Engineering, Applied Mechanics or a related field.

Keywords: Non-linear analysis, model order reduction, parametrization, brake squeal, experimental correlation.

Description:

Brake squeal remains a major challenge in the automotive industry, degrading customer perception of quality. Industrial development is becoming ever more dependent on computational modeling to address design constraints, create digital twins, and explore the potential of artificial intelligence-based approaches. Although such methods are now widely applied to brake design, producing reliable and predictive brake squeal models is still difficult. As Stellantis is considering the development of an upstream predictive tool, major progress is required to characterize brake squeal numerically and experimentally. This tool will be integrated into the DynaFreq suite, developed and maintained by VibTwin and SDTools.



Finite element model of a full Stellantis brake system

The ultimate objective is to develop a simulation methodology capable of delivering meaningful and actionable information for the robust and reliable design of low noise braking systems. Performance should be evaluated through stability maps derived from the system's nonlinear dynamic response [1]. Robustness, in turn, must stem from thorough parameterization, incorporating knowledge of sensitive design features as well as systematic experimental validation. Non-linear analysis can be direct transient [2], [3], or continuation based [4], [5]. Application to industrial models requires model order reduction to attain feasible simulation time [2], [6], [7]. Parametrization requires considering environment and command parameters (such as temperature, applied pressure) as well as design parameters and production variability [8], [9]. The ability to realize non-linear simulations with computation times compatible with large design of experiments is thus critical. Experimental validation must provide the same ability to characterize squeal occurrences as in simulation, and thus account for amplitude and environmental parameters. The HBVSig [9] method enables such characterization with operational shape extraction. This allows to correlate and estimate the system state on the model with expansion techniques such as the MDRE [10].

The thesis goal is to provide reliable numerical parametrized stability maps to qualify brake products as early as possible in the design phase. The first phase will focus on the development of a methodology to realize fast parametrized transient simulations. Non-linear time integration schemes, model reduction and parameter assessment, and implementation will be studied to provide an efficient simulation framework to be integrated in DynaFreq in collaboration with VibTwin. In a second time, the methodology will be applied to an industrial case for which experimental characterization will be carried out by Stellantis, and advanced post-treatments will be required in the thesis work. The work will focus on validating the simulations and updating the model. In the final phase, the validated simulation framework will be used to propose a qualification procedure based on stability maps and brake response feature extraction.

References

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Why apply?

- Work on a challenging and impactful research topic at the intersection of nonlinear dynamics, vibro-acoustics, and automotive engineering.
- Contribute to the development of innovative methodologies for predicting and mitigating brake squeal, a major industrial challenge.
- Benefit from a unique collaboration between Stellantis and leading academic laboratories, combining industrial needs with cutting-edge research.
- Publish scientific results in international conferences and peer-reviewed journals.
- Collaborate with multidisciplinary experts from industry and academia.
- Enhance your career prospects in both research and engineering, within the automotive sector and beyond.

Supervision

Olivier Chiello (Univ Gustave Eiffel/[UMRAE](#)), Jean-Jacques Sinou (ECL/[LTDS](#)), Etienne Balmès (Arts et Métiers/[PIMM](#), [SDTools](#)), Guillaume Vermot des Roches ([VibTwin](#)), Zoran Dimitrijevic ([Stellantis](#))

You can apply for this PhD position by submitting a CV, a cover letter, your transcripts from your master's degree and/or engineering diploma, as well as a list of two or three individuals who can provide recommendations for you, to zoran.dimitrijevic@stellantis.com