Acoustic Symposium

Adler Pelzer Group

20th October 2021

2nd Edition | Online Event

9:00 - 17:00 CET

Welcome to the 2nd Edition of Adler Pelzer Group Acoustic Symposium.

Participate and hear the latest development in automotive acoustics, especially the new approaches needed for optimising acoustics of New Energy Vehicles.

How to master newly appearing noise sources with different focus on some parts for acoustic treatment, e.g., accessories, aero noises, tires, beside of course e-motors.

How new simulation techniques can contribute reaching the target quicker and more efficiently, either at early car architecture stage or at later component optimisation, and open new doors like aeroacoustics.

Which learnings from NEVs help to optimise further the acoustics of ICE's car.

Enlarge your insight on the industry transformation pace by enriching networking opportunities, meeting the experts of automotive acoustics.

Pietro Lardini
CEO

Lino Mondino
CTO

Agenda

Plenary session – 9:00 - 13:00

Pietro Lardini (CEO) Lino Mondino (CTO)	Adler Pelzer Group	Introduction
Paolo Bonfiglio	Materiacustica (I)	New perspectives and challenges into automotive acoustics
Kai Aizawa	Toyota (JPN)	Acoustic Package Consideration using Airborne Noise Analysis Method for Mid Frequency
Kirill Horoshenkov	Sheffield University (UK)	The acoustical properties of air-saturated aerogel powders
François Xavier Becot	Matelys (F)	Micro-Macro approach for poro-elastic material: linking the micro-structure to the performance
Bart Verrecas	Siemens (BE)	Prediction of E-drive unit NVH performance using a mixed hybrid CAE+Test approach
Tim Starkey	University of Exeter (UK)	Acoustic metasurfaces and their application to turbulent flow

Best Practices – 14:00 - 17:00

Yannick Denoual	Renault (F)	Uncertainties in noise regulation and their management in vehicle development process
Aytekin Ozkan	Tofaş (TK)	Determination of a New Set of Sound Quality Metrics for a Better Correlation of Customer Perceptions and Vehicle Level
Marco Tarabra	CNH (I)	Journey on the evolution of tractors, from the origin to digital farming: how noise and vibration performance has developed during the last century in agriculture
Francesco Sini	Ducati (I)	The NVH development process in Ducati Motor Holding: the application on the new Multistrada V4
Lucas Marchesini	MANTA Aircraft (CH)	MANTA ANNx Hybrid eVTOL Air Vehicle How the acoustic aspects enter the equation of aircraft design

Methodologies – 14:00 - 17:00

Edmondo Minisci	Strathclyde University (UK)	Uncertainties treatment for the aeroacoustics analysis of a car vehicle
Stuart Bolton	Purdue University (USA)	The Acoustic Cavity Mode and the Effects of Modal Coupling and Rotation on Force Transmission to the Hub
Steve Fisher	Jaguar Land Rover (UK)	Moving from Structure Borne to Air Borne, can CAE be used to predict this?
Francesco Pompoli	Ferrara University (I)	Modelling of the acoustic properties of mixtures of recycled fibers for automotive applications
Gianmarco Battista	Marche Politechnic University (I)	Advanced 3D acoustic source mapping in automotive wind tunnels

New perspectives and challenges into automotive acoustics

MATERIACUSTICA
RESEARCH AND ENGINEERING IN ACOUSTICS AND VIBRATION

Author: Paolo Bonfiglio – Materiacustica

Although vibro-acoustics optimization is just one of the many criteria involved in the development of a vehicle, it has steadily gained in importance.

Automotive noise is a multidisciplinary problem involving complex phenomena such for instance fluid-structure interactions and psychoacoustics. The problem is also significantly different whether the interior or the exterior noise is investigated. An important issue for vehicle manufacturers is certainly the comfort enhancement, to increase passengers' well-being and reduce in-cabin noise. At the same time, due to regulations devoted to low-to-zero emission strategies automotive manufacturers and suppliers are constantly searching innovative solutions also for exterior noise emission.

Finally, both characteristics need to be designed to maintain and increase the brand identity on the market and to satisfy the increasingly demanding requests of Customers.

All these challenges contribute to the need to develop increasingly efficient NVH solutions and a better understanding of no longer negligible sound sources mechanism, effects, and interactions. As a direct consequent, a lot of effort is required to have more comprehensive experimental investigation tools and robust and fast numerical simulation schemes capable of significantly reducing a vehicle and components development process.

Education

- Degree in Physics at the University of Catania
- European Doctorate in Sound and Vibration Studies (EDSVS) and PhD in Civil Engineering at the University of Ferrara

Career

- Since 2008: partner of Materiacustica srl, spin-off company of The University of Ferrara
- 2007 to 2017: post-doc position at the Engineering Department of the University of Ferrara

Main research activities

- Vibro-acoustics characterization, modelling and optimization of porous and viscoelastic materials and sandwich structures
- Active noise control development
- Advanced NVH testing and signal processing in material characterization and NVH applications

Micro-Macro approach for poro-elastic materials: linking the micro-structure to the performance

Author: François-Xavier Becot – Matelys

The material development research nowadays experiences an exciting technological shift. The recent massive spreading of additive manufacturing techniques and the better monitoring of traditional manufacturing technologies (e.g. foaming, fiberizing, compounding …) give rise to new opportunities for designing tailored micro-structures. This shed new insights into the potential of so-called Micro-Macro approaches.
This terminology comprises a wide range of modeling techniques, which all aim at predicting the macroscopic response of a material from the definition of its micro-structure.

Two routes are possible to obtain the input data related to the micro-structure. One may start from a finely discretized geometry obtained from e.g. X-ray tomography. This has the advantage of requiring little geometry manipulation, 'only' meshing considerations. However, the resulting mesh size may yield prohibitive computational times. Moreover, the identification and the number of parameters governing the response of the material is unclear, which precludes any parametric studies to be carried out. Instead, you may identify an idealized micro-structure in the form of e.g. a Kelvin cell or a cubic centered geometry, which aims at representing the actual micro-structure. Even though, this stage may be delicate for some structures, it yields low computational demands and enables large parametric studies thanks to a limited set of governing parameters.

Once the micro-structure defined, essentially two categories of resolution methods can be found. The first one aims at predicting the field variables, namely the acoustic pressure and velocity. The resulting material properties like the sound absorption or sound transmission are then retrieved from their physical definition. These approaches are quite heavy from a computational point of view and require a new computation for each material thickness and sound excitation condition. Also, the computed material properties are not adapted to consider the material in a multi-layer system. Alternatively, the resolution can target the set of macroscopic parameters, e.g. the open porosity, the air flow resistivity, the tortuosity, the Young's modulus. The material properties are then predicted using some phenomenological predicting model, e.g. JCA or JCAL model, for a set of prescribed thickness, excitation conditions and layer arrangement. This so-called Hybrid approach makes the optimization stage very efficient as it allows a large range of possibilities to be explored.

This talk will discuss these different approaches and report some examples of the Hybrid approach for vibro-acoustic applications. In addition, the prediction of a combined set of acoustic and thermal properties for a multi-layer system will be presented. Finally, it will be shown how this approach can be used to build an accurate prediction model for the acoustic and elastic properties of porous materials under compression.

Education

- PhD at Chalmers Univ. of Technology (Sweden)
- PhD work related to the introduction of the road absorption into the model for exterior tyre noise

Career

- Co-founder and Executive Manager of MATELYS; independent research laboratoty specialist in the characterization and modeling of sound packages
- Co-founder of the triennial cycle of conferences SAPEM
- Vice-Chair of Forum Acusticum 2020

Main research activities

- Characterization techniques for screens, scrims and perforated plates
- Modeling of heterogeneous materials (double porosity, porous composites) using homogenization approaches
- Vice-Chair of Forum Acusticum 2020

The acoustical properties of air-saturated aerogel powders

Authors: Yutong Xue, J. Stuart Bolton, Hasina Begum, Kirill V. Horoshenkov – Sheffield University

The University Of Sheffield.

There is a general lack of understanding of the acoustical behaviour of air-saturated aerogel powders in theaudible frequency range. It is unclear what physical processes control the acoustic absorption and /or attenuation mechanisms in a very light, loose granular mix in which the grain diameter is comparable to a micron.

This work attempts to fit a Biot-type viscoelastic model to predict the absorption coefficient of two aerogel powder mixes with the particle diameter in the range of 1 - 40 microns. it is shown that these materials behave like a highly flexible, viscoelastic layer. It is found that the absorption coefficient for these materials depends strongly on the root mean square pressure in the incident wave. It is also found that the loss coefficient which accounts for the energy dissipation due to vibration of the elastic frame is a key model parameter. The value of this parameter reduces progressively with the frequency and sound pressure.

Other parameters in the adopted Biot-type viscoelastic model, e.g. the storage module of the elastic frame and pore size, are relatively independent of the frequency and amplitude of the incident wave. It is shown that this material can be a very efficient resonance absorber in the low frequency range.

Education

- MEng in Electro-Acoustics and Ultrasonic Engineering for Radioengineering, Electronics and Automatics at Moscow University
- PhD in Computational and Experimental Acoustics at the University of Bradford

Career

- Since 2013: Personal Chair at the University of Sheffield
- Research assistant and professor at the University of Bradford
- Founder of Acoutechs Limited (2000) and Acoustic Sensing Technology Limited (2009), University spin-off companies

Main research activities

- Novel sensors for water industry, novel acoustic materials and physical acoustics
- Noise control, audio-visual interactions and design of nature-inspired noise control solutions
- Member of the EPSRC-sponsored Pennine Water Group at Sheffield, Chairman of the Research Coordination Committee of the Institute of Acoustics, member of the EPSRC Peer Review College, member of the Editorial Board of the Journal of the Acoustical Society of America (JASA)
- Author and co-author of 3 books, over 180 journal and conference papers, and 10 patents/p

Uncertainties in noise regulation and their management in vehicle development process

Author: Yannick Denoual – Renault

Regulations addressing the noise emissions of road transport vehicles are becoming utterly stringent on vehicle design. Those regulations generally describe a measurement method, the calculation of a noise emission indicator and impose limits to it. With these limits becoming more severe over the years, it is crucial to consider uncertainties in the development process, to guarantee the compliance of the final product.

On the regulation side, the UN-ECE Informal Working Group on Measurement Uncertainties has produced an extensive study of the sources of uncertainties. For some of them, methods can be proposed to lower their impact. For the other, a revised tolerance is proposed.

On the vehicle development side, EOMs must consider uncertainties in their development process, to guarantee that each produced vehicle is compliant to the regulation. The starting point is to set the development target.

This target considers the regulation limit itself, and the uncertainty margin to consider, to set the actual development target to the new designed vehicle.

The next stages consist in cascading targets to each component and build a prediction of the achieved noise level. Numerical tools are used for the prediction of component noise emissions and for the synthesis of the final pass-by noise level prediction. These numerical tools are constantly improved to offer a better predictivity. But the result they deliver will always have to be considered within uncertainty margin. A stochastic tool for pass-by noise synthesis is presented, that helps asserting prediction uncertainties.

Education

- PhD in Structural Dynamics at ISMCM Paris
- MSc in Mechanical Engineering at ISMCM-CESTI Paris

Career

- Since 2014: Pass-by Noise Engineer, Renault-Nissan-Mitsubishi
- 1995 – 2014: Acoustic Engineer

Main research activities

- Advanced methodologies for vibration, acoustics, fluid-borne noises

Uncertainties treatment for the aeroacoustics analysis of a car vehicle

Authors: Angela Scardigli, Giacomo Uffreduzzi, Federico Gallizio – Optimad engineering S.r.l
Edmondo Minisci – Intelligent Computational Engineering Laboratory, University of Strathclyde

Uncertainty in the design and operation of engineering systems may arise from various sources. The uncertainties in physical properties of materials and inevitable randomness in boundary conditions and geometries, as well as physical models uncertainties, are a few examples of such uncertainties that can significantly restrict the reliability of deterministic analyses and designs. For a reliable analysis and design process based on computational fluid dynamics (CFD) simulations, including computational aeroacoustics (CAA), all sources of uncertainty must be considered in the analysis and design process. However, CAA analyses requires exceptionally fine 3D computational meshes, very small time-step, and (usually) high-dimensional stochastic space, bringing to very high, and up to now prohibitive, computational costs.

In the literature, various techniques have been proposed for uncertainty quantification (UQ). The Monte Carlo (MC) approach is widely used for UQ given its conceptual simplicity, but, unfortunately, the conventional MC methods converge slowly and often require a large number of samples to achieve reasonable accuracy and thus are impractical for problems with a large number of uncertainties, and/or very high computational costs. During the last decades, some other more efficient UQ approaches have been developed, with some of them being intrusive and others non-intrusive.
The intrusive approaches involve some modifications of the implemented code, while non-intrusive methods consider the models as black-box and sample it through the use of meta-modelling techniques.
In some previous works, a non-intrusive approach for probabilistic propagation of boundary and geometrical uncertainties for the aeroacoustics analysis was presented. Obtained results were used to detail some approaches giving statistical similitude between uncertain numerical performance of a car side mirror and (synthetic) uncertain experimental data, with the general aim of demonstrating how the appropriate handling of involved uncertainties can bring to a better understanding of experimental and numerical modelling and testing, and, consequently, more efficient acoustic design processes. The previous works considered realistic, but only synthetic experimental data.

In this work, the previously developed methods and techniques will be used to properly treat some of the uncertainties affecting the usual coupled experimental/numerical aeroacoustic analysis process for a real life Super Sport Utility Vehicle, comparing actual test data to numerical simulation results.

Education

- PhD in Aerospace Engineering at Politecnico di Torino
- MSc in Aerospace Engineering at Politecnico di Torino

Career

- Founder member and former general manager of OPTIMAD Engineering S.r.l., spin-off of Politecnico di Torino
- Director of the Intelligent Computational Engineering (ICE) Laboratory
- Senior Lecturer (Associate Professor) at the Department of Aerospace and Mechanical Engineering of University of Strathclyde

Main research activities

- Numerical optimisation, uncertainty treatment, and machine learning for the design of engineering systems and planning of operations in areas such as aerospace, automotive, renewable energy, and health care
- Over 80 high quality publications on aerospace engineering and sciences, wind turbines and energy systems analysis and design, and computational intelligence

Modelling of the acoustic properties of mixtures of recycled fibers for automotive applications

Università degli Studi di Ferrara

Author: Francesco Pompoli – Ferrara University

Fibrous materials for automotive applications are constituted from mixtures of recycled fibers of different nature which are bonded together and compacted with a wide variability of density and thickness.

The acoustic modelling of these materials is of significant importance for the simulation of the acoustic performance of the final component and is usually carried out by performing experimental tests on a considerable number of samples with different density and extrapolating specific analytical relationships for a defined mixture of fibers.

Education

- PhD in Technical Physics
- MSc in Mechanical Engineering

Career

- Researcher of Applied Acoustics at the Department of Engineering at University of Ferrara
- Co-founder of Materiacustica srl, spin-off company of University of Ferrara

Main research activities

- Sound propagation in poroelastic materials and noise control

Acoustic Package Consideration using Airborne Noise Analysis Method for Mid Frequency

TOYOTA

Author: Kai Aizawa – Toyota

Electlification could increase the demand to reduce the noise at mid frequency. Usually, the mid frequency airborne noise analysis is time consuming to solve the structure-acoustic coupling using Finite Element Analysis (FEM). A new simulation method will be proposed to improve the efficiency based on the concept of Transfer Path Analysis (TPA) and Equivalent Radiation Power (ERP).

A new metric will be proposed by applying ERP to simulate the sound radiation from body panel.Also, the acoustic package is acting to reduce the sound radiation from body panel, and its effect is considered based on Transfer Matrix Method (TMM). By combining the FEM solution of body structure with a new ERP and acoustic package noise reduction from TMM, the method reduces the computation time at least by 75% with high reproductivity of the test result within +/- 2dB accuracy.

This presentation concludes how we can reduce the noise at mid frequency both by body panel itself and by acoustic package based on the method proposed.

Supporting Information

The similar topic will be presented in Japanese Society for Automotive Engineer (JSAE) spring conference in May 2021 from myself. The presentation contents will be updated to fit the purpose and background of APG conference (focusing more on acoustic package than the methodology itself). Because the upcoming presentation in JSAE will be written and presented only in Japanese, the methodology itself will be presented world-wide for for the first time at your conference.

Education

- MSc in Mechanical Engineering at Chuo University, Tokyo
- BSc in Mechanical Engineering at Chuo University, Tokyo
- 2013: Research scholar at the University of Massachusetts Lowell
- 2014: Research scholar at KU Leuven

Career

- Since 2021: Enigineer in NVH Development, Toyota (Japan)
- 2019 – 2020: Trainee in NVH, Toyota (USA)
- 2015 – 2020: Enigineer in NVH Research, Toyota (Japan)

Main research activities

- Engine, tyre and wind noise performance development using Statistical Energy Analysis, Transfer Matrix Method, and Finite Element Analysis (and optimization method development combined with Genetic Algorithm) in advanced R&D divisions
- Author and co-author of various publications

Determination of a New Set of Sound Quality Metrics for a Better Correlation of Customer Perceptions and Vehicle Level NVH Tests

TOFAŞ
TÜRK OTOMOBİL FABRİKASI A.Ş.

Author: Aytekin Ozkan – Tofaş

The acoustic comfort level in a vehicle's passenger compartment has become directly effective on customers' preferences. Understanding the customers' expectations regarding acoustic comfort level has become a fundamental sales volume issue. However, traditional measurement parameters are not enough to identify the acoustic comfort level perceived by customers. Therefore, it is essential to reveal customer perceptions better to guarantee customer satisfaction in the early design phase.

In this study, new sound quality parameters (SQP) were defined with a much higher correlation with subjective perceptions. Five different maneuvers were determined to simulate the customers' driving conditions.

Interior sound levels of six cars were measured objectively and evaluated individually by fifty jurors subjectively, both on the road and in listening room conditions. Expert evaluations were also performed on the same conditions. Correlation analyses were made using the objective and subjective data sets to determine highly correlated psychoacoustic parameters. Upon obtaining a well-correlated data set, the regression analysis was performed to define new sound quality parameters, which eventually demonstrate the acoustic comfort level in terms of customer perceptions. The validity of the new parameters was also verified by conducting further tests on over 100 vehicles.

Education

- MSc in Mechanical Engineering (area of interest: Control Actuation System Design)

Career

- Twenty-three years of experience on NVH at Tofaş, a joint venture of Stellantis group: management of NVH and Soft trim design groups; currently working as NVH technical lead
- Previously worked as a control system engineer in the defense industry

Main research activities

- Besides all kinds of vehicle leven NVH activities, Sound Quality is the primary area of interest

Journey on the evolution of tractors, from the origin to digital farming: how noise and vibration performance has developed during the last century in agriculture

Author: Marco Tarabra – CNH

Journey on the evolution of tractors, from the origin to digital farming: how noise and vibration performance has developed during the last century in agriculture

Education

- Master in Marketing and Communication at Rome Business School
- BSc in Applied Physics, Acoustics and Applied Science

Career

- Since 2021: Global NVH Manager for CNH tractors, CNH
- Owns a patent on sound quality component design
- Since 2012 working in vehicle acoustics for prestigious brands, such us Bentley Motors Limited and Ferrari (sound quality, vehicle refinement, ride comfort)
- Worked in base diesel engine NVH development from 2001 until 2012 (FIAT-GM Powertrain, then FPT, then General Motors – Italy and US based)

Main research activities

- Engine design NVH guidelines
- Modern measurement methodology application
- Simulation model correlation
- Acoustic drivable models to enhance sound quality and road noise performance
- Transfer Path Analysis application to vehicle development
- Talent acquisition and nurturing approach

Advanced 3D acoustic source mapping in automotive wind tunnels

Authors: Gianmarco Battista, Milena Martarelli, Paolo Castellini – Marche Polytechnic University
Paolo Chiarotti – Polytechnic University of Milan

Acoustic source localisation and quantification with microphone arrays in automotive wind tunnel applications is a powerful tool to detect the root causes of (aero)acoustic noise. In this work, three-dimensional acoustic mapping application on full size car in Pininfarina wind tunnel is presented.

The common realisation of acoustic mapping techniques involves a planar microphone array and a mapping algorithm to estimate source powers on a target plane positioned near the object of interest. In most cases, this choice represents an oversimplification of the problem that produces misleading results in terms of both localisation and quantification of acoustic sources. In fact, the real acoustic sources do not necessarily lie on the mapping plane. Moreover, the car model in the test section produces noise sources on each side, therefore, a single planar array has only a partial vision of the acoustic scene.

For these reasons, it is useful to extend the region of interest to a volume that is likely to contain all acoustic sources to map and use multiple microphone arrays to have a more comprehensive view of acoustic sources. Despite the increase of experimental setup and problem complexity, results in such applications greatly benefit of volumetric maps with multiple planar arrays.

All three microphone arrays available on different sides of the test section are used and both state-of-the-art mapping methods and advanced techniques tailored for 3D applications are applied. The combination of these factors makes it possible to get source maps with fine spatial accuracy and high dynamic range and to deal with high level of background noise common in this kind of test setup.

Education

- European PhD in Industrial Engineering at Polytechnic University of Marche
- MSc in Mechanical Enigneering at Polytechnic University of Marche
- BSc in Management Engineering at Polytechnic University of Marche

Career

- Since 2021: Postdoctoral Research Assistant at Polytechnic University of Marche – Department of Industrial Engineering and Mathematical Sciences
- 2020: NVH and Sound Performance Engineer, Ferrari
- 2018 – 2019: Postdoctoral Research Assistant at Polytechnic University of Marche – Department of Industrial Engineering and Mathematical Sciences

Main research activities

- Mechanical measurement systems and algorithm for data processing
- NVH sound quality analysis and sound design
- Noise and vibration measurements based on array of sensors

Acoustic metasurfaces and their application to turbulent flow

Author: Tim A. Starkey – University of Exeter

The use of surface structures can have a significant impact on the pressure fluctuations that manifest above them. Acoustic metamaterials that comprise structured surfaces have been designed to influence the acoustic pressure field for a variety of applications such as acoustic filtering, focusing, and absorption, whilst in the aerodynamics of turbulent boundary layer flows, surface treatments can cause significant changes to the sound generated from, and pressure fluctuations present within, the flow.
So, the question arises, can we apply acoustic metamaterial concepts as a strategy to influence a turbulent flow?

In principle, metasurfaces used to control acoustic fields should also respond to evanescent pressure fluctuations generated by turbulence. However, interfacing a metasurface and boundary layer poses some challenges, not least in the large disparity between acoustic and flow scales at low Mach number, and the need to avoid metasurface configurations that generate drag or other undesirable flow effects.

In this talk I will discuss our recent work on acoustic surface waves and the strategy developed with collaborators at Virginia Tech, that interfaces a cavity-type metasurface with a turbulent flow using a hydrodynamically smooth but acoustically transparent membrane. Our experiments demonstrate the excitation of a bound acoustic mode using the stochastic near-field pressure fluctuations of a turbulent flow. The tested metasurfaces demonstrate a route for acoustic surface mode dispersions with reduced phase velocities to match to the convective velocity of the turbulent structures.

We view this as an important first step in interfacing flows and metamaterials, with potential applications to the control of flow generated edge noise or energy harvesting.

Education

- PhD „Investigation of bio-inspired phononic sensors“ at University of Exteter
- 1st Class BSc in Mathematics/ Physics at University of Exteter

Career

- Since 2016: Research Fellow in the field of acoustic metamaterials at University of Exeter
- 2015 – 2016: Systems Engineer in underwater acoustics, Thales Underwater Systems
- 2014 – 2015: Assistant Research Fellow at University of Exeter

Main research activities

- Acoustic metamaterials, fluid flow and phononics

The Acoustic Cavity Mode and the Effects of Modal Coupling and Rotation on Force Transmission to the Hub

Author: J. Stuart Bolton – Ray W. Herrick Laboratories, Purdue University

Concerns about tire noise radiation arise partly from city traffic planning, environmental protection and pedestrian safety standpoints, while from the vehicle passengers‘ perspective, noise transmitted to the vehicle interior is more important.

It is the latter concern that is addressed in this presentation. In particular, a tire's internal, acoustical cavity resonance contributes significantly to tire-related structure-borne noise near 200 Hz, and it can easily be perceived by passengers. That acoustic mode can be suppressed by adding an absorptive lining to the tire's interior. However, apart from the additional cost and weight of such tires, there are concerns with durability, and there is also an increased complexity when repairing them because of the need to avoid damaging the absorptive lining. In that light, modifying the design of the tire-rim and suspension system to decrease the cavity noise influence without the addition of sound absorbing material has a clear benefit.

To that end, fully-coupled, structural-acoustic finite element tire models have been developed to study the force transmission to the hub, and how the force transmission is affected by the coupling of the acoustic mode with circumferential structural modes of the treadband. In the case of a static, loaded tire, for example simulation results have indicated that when the frequency of the vertical cavity mode matches with an odd-numbered, circumferential flexural mode of the treadband, the vibration levels transmitted from the tire to the hub and hence the vehicle's suspension increase significantly. This situation is further complicated by effects of rotation which cause the modal frequency splits due to loading to increase with increasing speed, thus altering the modal coupling.

These effects will be demonstrated in this presentation and compared with experimental results. Ultimately, if these coupling effects are clearly understood, it may be possible to to minimize the coupling between the acoustic and structural modes in specific speed ranges by altering structureal mode locations through the adjustment of tire stiffness properties, for example, hence eliminating the need for the insertion of absorptive materials within the tire.

Education

- PhD at Southampton University's Institute of Sound and Vibration Research
- MSc at Southampton University's Institute of Sound and Vibration Research
- Undergraduate Degree (BSc) ind Mechanical Engineering at University of Toronto

Career

- Since 1984: Professor of Mechanical Engineering at Ray W. Herrick Laboratories, Purdue University

Main research activities

- Maintenance of an active research program in Noise Control and related disciplines, such as Acoustical Materials, Sound Field Visualization, and Acoustical and Structural Wave Propagation, particularly in the context of tire noise and vibration
- Fellow of both the Acoustical Society of America and the Institute of Noise Control Engineering
- Awards: Institute of Noise Control Engineering's Outstanding Educator Award (1999); Distinguished Noise Control Engineer Award (2014); ASME Per Brüel Gold Medal in Acoustics and Noise Control (2020)

Prediction of E-drive unit NVH performance using a mixed hybrid CAE+Test approach

SIEMENS

Author: Bart Verrecas – Siemens

The transition towards electrified vehicles comes with specific challenges for NVH engineering. Unlike what was intuitively expected, NVH engineering of those vehicles requires a lot of effort overall. Not only does the electrified powertrain still contribute to the vehicle interior noise, more attention on for example wind and road noise, HVAC noise, … is of key importance. At the same time, vehicles need to be developed ever faster and lengthy physical prototype iterations are no longer an option.

To address these challenges, engineering methods need to be implemented that allow the evaluation of full vehicle NVH performance as early as possible. The use of full vehicle simulation models plays a crucial role in this. At the same time, once physical components are available, test data can be used to further improve the simulation accuracy.

More and more, hybrid approaches that combine test and simulation need to be applied.
But how to make those worlds work together in a synergetic way?

In this presentation, a methodology is introduced that allows the assessment of NVH performance of virtual vehicle assemblies built up from separate sub-system and modular component models coming from either test or simulation. Besides explaining the overall concept, the presentation will put this into practice with a special focus on the noise prediction of an electric drive unit. An approach to create a CAE- or test-based simulation model of an E-drive unit and vehicle body is explained, followed by how those models can be used to predict the assembled vehicle's NVH performance. Also insight is given in how to use this to assess the impact of design changes on NVH performance.

Education

- MSc in Mechanical Engineering/ Mechatronics at KU Leuven

Career

- Since 2018: Business Development Team Manager Automotive NVH and Durability Testing, Siemens
- 2008 –2010: Application Engineer Test, LMS
- 2005 –2008: Customer Services Engineer Test, LMS

Main research activities

- New technologies in the field of NVH or Durability testing, such as component based TPA, MBST, Pass-by noise testing and active sound design

The NVH development process in Ducati Motor Holding: the application on the new Multistrada V4

Author: Francesco Sini – Ducati

Over the last decade the demand regarding the NVH performances of the motorcycle are steadily increasing.This is due not only to comply with the stringent noise emission limits set by the regulations but also due to the everincreasing needs of the customer.

The presentation will report some NVH activity done during the development of the new Multistrada V4 that have improved the noise emission and the vibro-acoustic comfort of the motorcycle.

Education

- MSc in Mechanical Engineering at Polytechnic University of Turin

Career

- Since 2013: Testing Manager, Ducati
- 2007 – 2013: Senior NVH Engineer, Fiat
- 2001 – 2007: NVH CAE Engineer

Main research activities

- Evaluation of NVH and acoustic performance, especially in the field of pass-by-noise
- Virtual Analysis (SEA and FE method) of the airborne acoustic performances of materials, insulation components and vehicles
- SEA (Statistical Energy Analysis) model definition and relative experimental campaign for various vehicles

Moving from Structure Borne to Air Borne, can CAE be used to predict this?

Author: Stephen A. Fisher – Jaguar Land Rover

Finite Element Analysis (FEA) has been well established for the investigation in the noise within the vehicle due to the structure borne noise path and has prove n itselfto be quite successful in helping control the design of the vehicle structure. But due to the limitations of FEA it is not real practical to use to predict noise at high frequencies, above 500Hz. Within this region the noise entering the vehicle is dominated by the air borne paths and the treatments used are not "FEA friendly", being very limp and having many modes.

So a different method is needed to look at the higher frequencies. Statistical Energy Analysis (SEA) is a method which has been identified for the investigation of noise at higher frequencies and offers an ability to assess the sound package used within a vehicle. But SEA is a totally different method for assessing noise than FEA, so can it give good prediction of noise?

Through extensive testing on two different types of vehicles this presentation will show how the ability of SEA to predict the noise around the outside and inside of the vehicle and we will see how the effect of a design change can be predicted.

To build a SEA is not as easy as a FEA model, several special consideration have to be taken into account so not invalidating the assumptions of SEA. Also there is the need of a deep knowledge of the vehicle being modelled and the potential paths that the noise can take. In the presentation I will try and highlight some of these points.

Education

- 1st Class BSc in Aeronautical Engineering from City University, London

Career

- Currently Technical Specialist, Body Noise and Vibration at Jaguar Land Rover
- Technical Specialist in Computer Aided Engineering (CAE) at Jaguar Land Rover
- Graduate Engineer in the Advanced Engineering Group (AEG) of Jaguar Cars

Main research activities

- Development of new CAE methods to help develop the refinement of future vehicles while reducing weight and CO_2 impact
- Statistical Energy Analysis (SEA) methods to study high frequency air borne noise within the vehicle
- Vibro-acoustic finite element analysis (FEA) methods to predict the noise within the vehicle
- Co-author on a patent for a bonnet system that reduced injuries in pedestrian impacts

MANTA ANNx Hybrid eVTOL Air Vehicle
How the acoustic aspects enter the equation of aircraft design

Authors: Lucas Marchesini – MANTA Aircraft

Manta Aircraft is developing a vertical take-off and landing (VTOL) multi-purpose platform for electric and hybrid-electric flying vehicles for the Advanced Air Mobility (AAM) sector.
The AAM is bringing air transportation to the doorsteps and in the cities, to offer point-to-point air travel, drastically cutting the commuting times.

To allow for dense flight operations in urban areas, an aspect of great importance is the acoustic impact of the vehicles. This aspect is faced by the companies developing the new eVTOLs studying different solutions for the propulsion system, the main source of noise, in terms of type andarrangement.

The analysis of the sources of noise and its propagation, leads to the optimization of the related components like propellers, fans, exhausts, with an impact on their aerodynamic performance, requiring advanced analytical methods and experimental testing.
Manta Aircraft presents the path to optimization of its vehicles, through trade offs between the several contrasting requirements about aerodynamic performance, noise generation, safety and operability.

Education

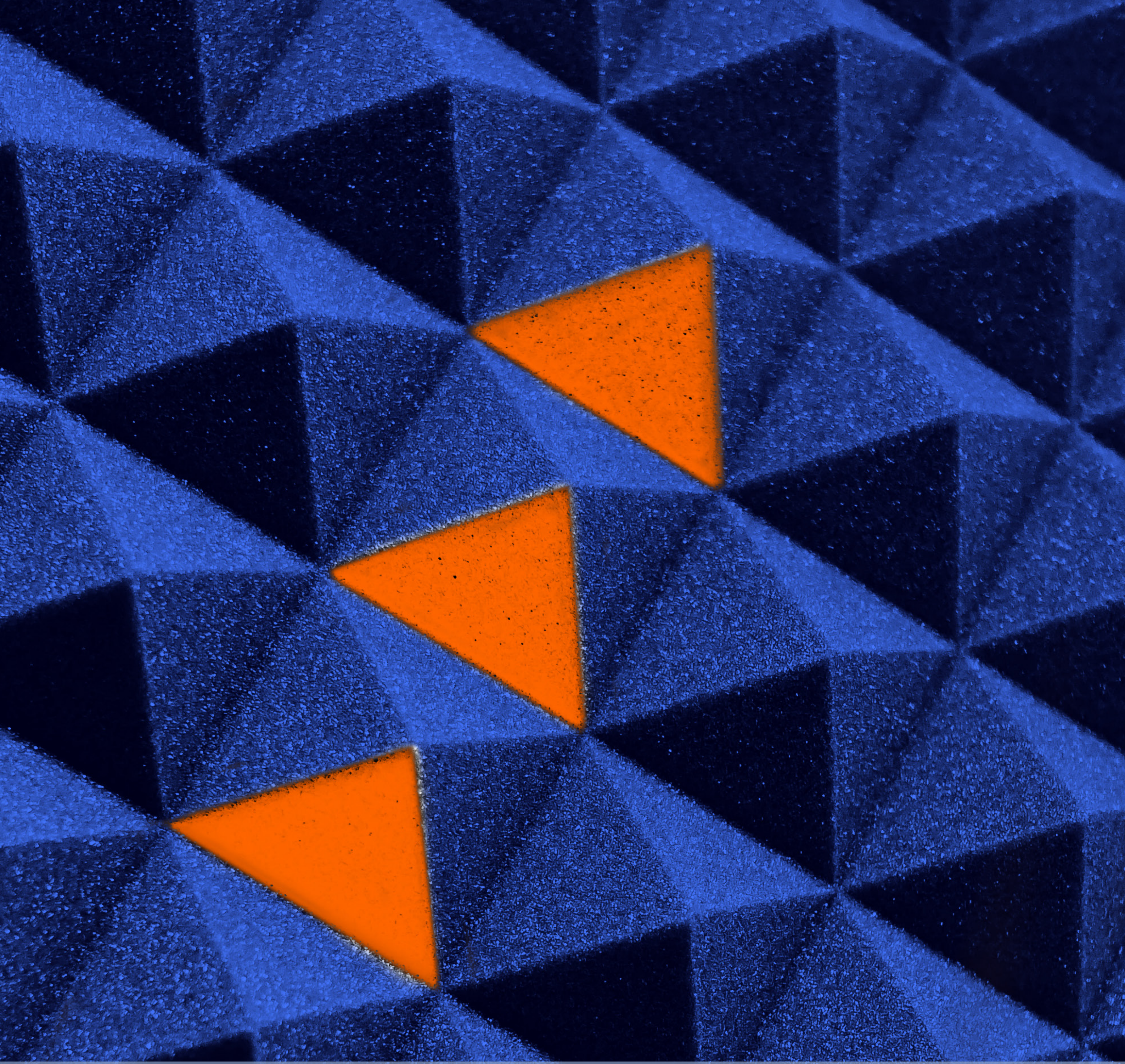
- Master of Business Administration at SDA Bocconi School of Management, Milan
- MSc in Aeronautical Engineering at Polytechnic University of Milan

Career

- Since 2019: Co-Founder, CEO & CTO, MANTA Aircraft SA
- 2007 – 2019: Various positions in several industries with a common ground, the forefront of technology: Formula 1 and other motorsports, simulation, semiconductors, electronics, medical devices, scientific software, blockchain; co-founder in several startups thereof
- 1996 – 2000: Flight Simulation Office Manager, Pilatus Aircraft Ltd

Main research activities

- Design & Engineering of aircraft systems and aerodynamics
- Research & development
- Project Management



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