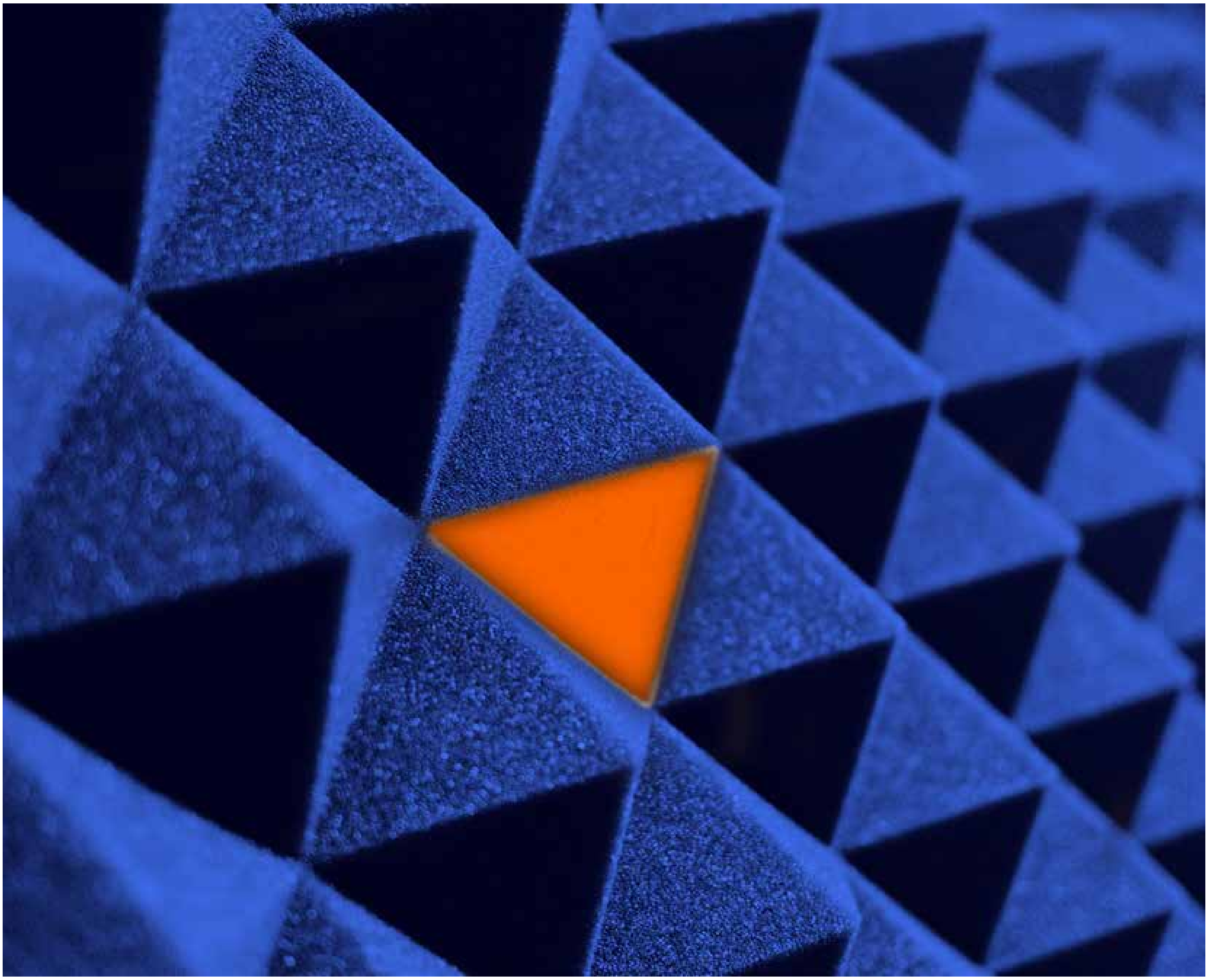
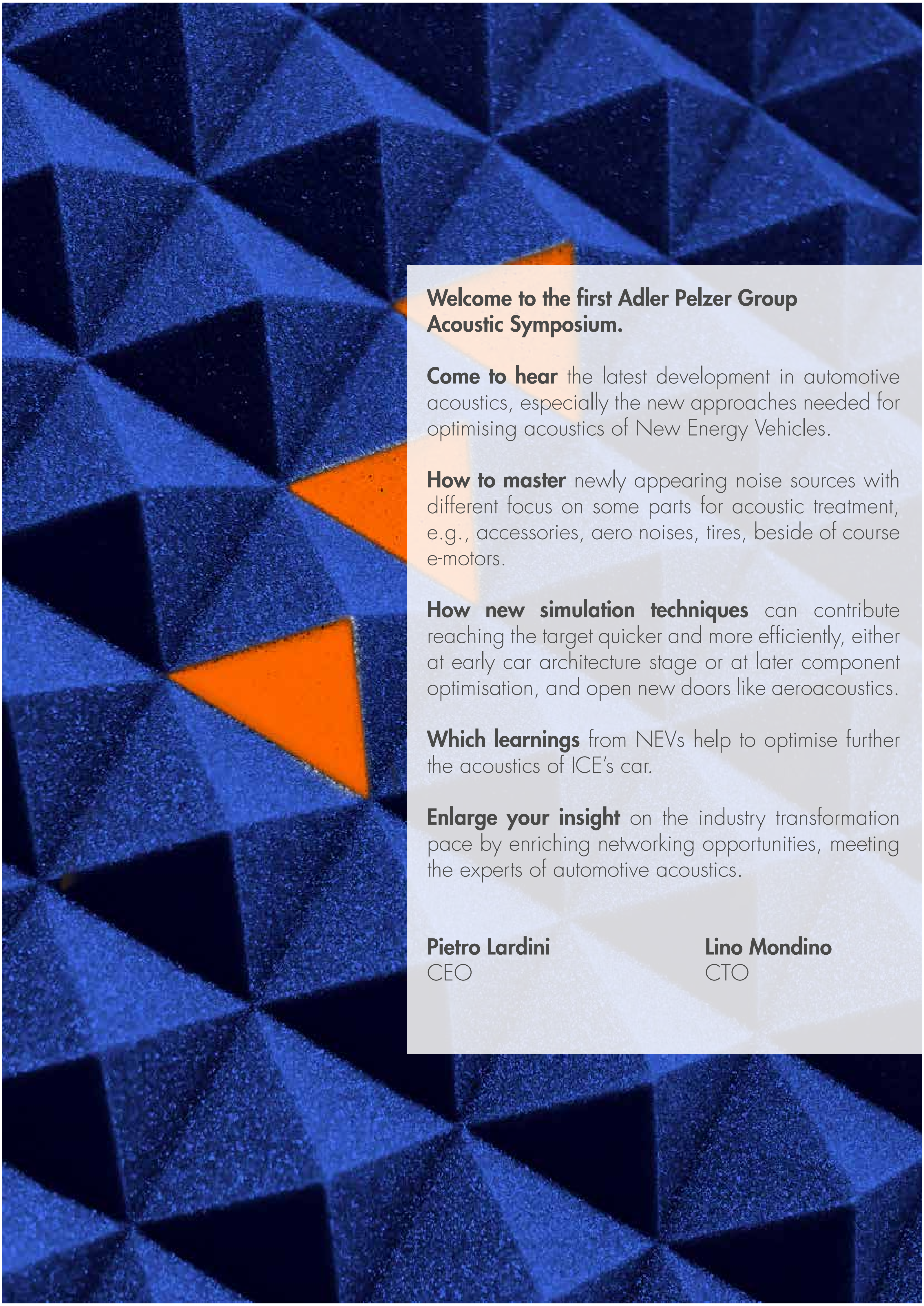


Acoustic Symposium
Adler Pelzer Group

18th September 2019
Ruhr-Congress Bochum | Germany



Welcome to the first Adler Pelzer Group Acoustic Symposium.

Come to 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

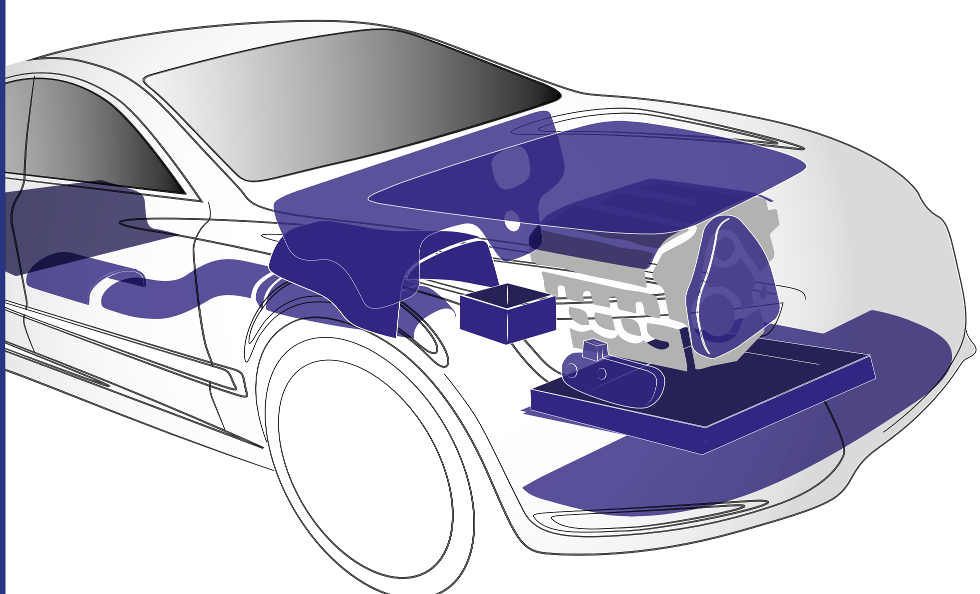
Agenda

9:00-12:30 Morning Session „Plenary"	Pietro Lardini (CEO) Lino Mondino (CTO) **Adler Pelzer Group**	CEO Welcome Symposium Introduction
	Paolo Bonfiglio (Chairman) **Materiacustica (I)**	Acoustic evolution into Automotive Chairman Introduction
	Nicola Prodi **Ferrara University (I)**	A sonic environment for future cabins
	Kirill Horoshenkov **Sheffield University (UK)**	How many materials one needs to predict the acoustical properties of porous material accurately?
		COFFEE BREAK
	François-Xavier Becot **Matelys (F)**	Future stakes of tyre noise
	Luca D\`Alessandro **Phononic Vibes (I)**	Meta-materials for 3D vibration and noise suppression
	Nicos Zafeiropoulos **Silentium (D)**	Active Noise Cancellation for EVs in practice
12:30-14:00		**NETWORKING LUNCH**
Afternoon Session 1 „Best Practices"	Francesco Naclerio **Ferrari (I)**	Final drive noise: experimental and numerical approach to investigate the paths from Gearbox to Cabin
	François Lohr **Michelin (F)**	Tyre-Wheel-Cavity models for vehicle interior noise optimization
		COFFEE BREAK
	Simon Noble **Bentley (UK)**	Integration of airborne acoustic transfer path techniques into digital prototype strategy
	Davide Palmieri **Mc Laren (UK)**	Intake noise refinement for the new McLaren GT
	Thomas Antoine **Renault (F)**	R51 phase 3 regulations – beyond the 7,5 m microphone – a global approach
	Rod Morris-Kirby **Adler Pelzer Group**	Conclusions
17:15		**CLOSE**

Agenda

Afternoon Session 2 „Methodologies"

Edmondo Minisci **University of Strathclyde (UK)** Federico Gallizio **OPTIMAD Engineering (I)**	Propagation of boundary and geometrical uncertainties for the aeroacoustics analysis of a side mirror
Mattia Barbarino Gianluca Diodati **CIRA (I)**	Technologies for Noise & Vibration reduction in the Automotive and Aerospace fields: some CIRA experiences
	COFFEE BREAK
Arnaud Caillet **ESI (D)**	Analysis of the challenges of sound package definition for electric vehicles using SEA analysis
Antonello Bianco **Pininfarina (I)**	Beamforming Technique in Pininfarina Wind Tunnel
Francesco Pompoli **Ferrara University (I)**	A new perspective in porous material modelling and optimization for vibro-acoustical applications
Francesco Carlo Tinti **Adler Pelzer Group**	Conclusions
17:15	**CLOSE**



Acoustic evolution into automotive

PAOLO BONFIGLIO | MATERIACUSTICA

The interest in different aspects of the acoustics and in general of the NVH in automotive has always been growing in recent years. In facts, acoustic performances of a car have a strong impact on the driving experience and consequently the quality perception. Due to regulations devoted to low-to-zero emission strategies car manufacturers and suppliers are constantly searching innovative design solutions for NVH comfort both to improve brand identity and lead the market. Innovation must be sought and conceived at different levels and requires contextual acoustic evolution. Surely materials play a predominant role and for this reason it is necessary to improve traditional passive solutions by introducing new concepts of dissipation of mechanical and acoustic energy. Still in the same context, the use of new material concepts (such as metamaterials and locally resonant solutions) opens interesting scenarios to bridge the limits of traditional solutions, especially at low frequencies. Also developing increasingly efficient active approaches for controlling noise and vibrations in cars is no longer an academic proof of concept but is becoming a reality in various automotive applications and for several sources of disturbance.

Furthermore, the growing demand to move towards New Energy Vehicles requires a greater understanding of sound sources mechanism, effects and interactions (for example, tyre noise, rolling noise, wind noise and electromagnetic noise) which until now have had a secondary role if compared with ICE's cars. The development of innovative solutions in automotive also requires innovation. On the one hand the complexity of the interaction of different sources and on the other the need to have increasingly smart and efficient solutions lead to the need to have more global experimental investigation tools and reliable numerical simulation schemes capable of significantly reducing a car's development process.

Finally, the concept of sound quality also requires innovation. An assessment in terms of objective disturbance or subjective pleasure during the driving experience is no longer sufficient. The concept of automobile itself is moving towards a scenario that requires that a vehicle is also suitable for working and co-working activities and therefore an environment in which excellent sound quality is mandatory and closely linked to concepts of efficiency and proactivity.

PAOLO BONFIGLIO

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.

Author and co-author of around 130 contributions on journal papers, conferences and seminars.

A sonic environment for future car cabins

NICOLA PRODI | FERRARA UNIVERSITY

Research in the last decades has achieved a remarkable decrement of vehicle interior noise, and a substantial improvement in this respect is in progress due to electrification. The more this process advances the more the internal cabin noise can be designed with features that meet customers' expectations and needs.

In the next generation of connected and autonomous vehicles the operational possibilities of the passengers will be increasingly detached from the functioning of the vehicle itself, and their cognitive capacities will be released to focus on other tasks, either leisure ones or related to work. A new challenge is thus posed to the design of the interior soundscape of car cabins.

In fact a target soundscape shall not just avoid the negative noise issues that cause annoyance and interfere with speech reception, but shall be tailored to the passengers' tasks and possibly contribute as much as possible to their positive deployment. In order for this challenges to be tackled the traditional concepts of sound quality and speech intelligibility need extensions. In particular a framework has to be developed where a fully binaural approach is considered and great emphasis is given on the cognitive issues raised when the soundscape is affecting auditory and non-auditory tasks.

NICOLA PRODI

Education

Degree in Physics at the University of Bologna.

PhD at the University of Ferrara.

Career

Associate Professor at the Department of Engineering at the University of Ferrara (Advanced Mechanics Lab).

Several national research projects funded by the National Research Council of Italy (CNR), by the Italian Ministries for Scientific Research (MIUR) and Economic Development (MISE), by INAIL-ISPESL (Italian Workers' Compensation Authority), by the Emilia-Romagna Region and by various firms and private Institutions.

Research works within projects funded by the European Commission.

Main research activities

Acoustics including theory and experiment of sound in rooms, acoustical properties of materials, virtual acoustics and sound intensity.

Fellow of the Acoustical Association of Italy (AIA) and associate member of the Acoustical Society of America (ASA).

How many parameters one needs to predict the acoustical properties of porous media accurately?

KIRILL HOROSHENKOV | SHEFFIELD UNIVERSITY

There are many theoretical and empirical models to predict the acoustical properties of porous media. These models require a range of non-acoustical parameters few of which are directly measurable. Therefore, there is often a question: which model shall we use?

This paper presents theoretical and experimental evidence that the acoustical impedance of a broad range of granular media, fibrous media and foams can be predicted through the knowledge of the porosity, median pore size and standard deviation in the pore size only. These three parameters are easy to measure directly and non-acoustically.

This paper also explains that there are clear inter-relations between some commonly used intrinsic parameters of porous media such as tortuosity, permeabilities, characteristic lengths and statistical parameters of pore size distribution such as median pore size and standard deviation in pore size. The proposed model can be attractive to use beyond acoustics (e.g. in areas of chemical, process and material engineering) because it paves the way for an easier inversion of key morphological characteristics of porous media from acoustical data which are relatively easy to obtain through a standard impedance tube experiment.

KIRILL HOROSHENKOV

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) and Journal of Applied Acoustics.

Author and co-author of 3 books, over 180 journal and conference papers, and 10 patents/p.

Future stakes of tyre noise

FRANÇOIS-XAVIER BECOT | MATELYS

This talk aims at presenting the evolution and the future stakes of tyre noise, which is expected to become the main dominant noise source for automotive.

While major modifications of the power unit have been conducted in the past years, tyre noise characteristics has little changed over the same period. The situation is forced to change now, driven by an ever increasing demand for interior noise reduction as well as recent modifications in the standardized evaluation of pass-by noise.

Results from EcOBEx, a French research collaborative project aiming at reducing pass-by noise, will be presented so as to illustrate these trends. The main conclusion of this work is that the tyre noise is now masking the gain brought by new sound packages and new architecture in the engine bay.

The presentation will recall the main tyre noise generation mechanisms and present recent innovations for controlling them. The main routes for reducing the tyre noise emission will be discussed including the effects of the modifications of the road surface and the latest efforts for modifying the tyre itself.

FRANÇOIS-XAVIER BECOT

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 – Research Lab; independent research laboratoty specialist in the characterization and modeling of sound packages.

Co-founder of the triennial cycle of conferences SAPEM (Symposium on the Acoustics of Poro-Elastic Materials).

Vice-chair of the next edition of Forum Acusticum (April 2020 in Lyon-France).

Main research activities

Characterization techniques for screens, scrims and perforated plates.

Modeling of heterogeneous materials (double porosity, porous composites) using homogenization approaches.

Meta-materials for 3D vibration and noise suppression

LUCA D'ALESSANDRO | PHONONIC VIBES

Periodic structures find numerous applications in physics and engineering domains due to their peculiar properties in wave guiding and filtering. A major example in the electromagnetic field is represented by photonic crystals, while their counterparts for acoustic and elastic waves are the so-called phononic crystals.

Focusing on elastic periodic structures, the frequency range of applications is wide: from extremely high frequencies, i.e. THz region for heat transmission, to few Hz in the seismic metamaterials domain, often taking the most from locally resonant mechanisms.

Among the others, the bandgap (i.e. the frequency range of prevented wave transmission) is one of the most investigated properties: a wide and complete bandgap is generally beneficial to guarantee robust wave attenuation around a certain frequency. In many cases, a complete bandgap is obtained by a periodic arrangement of two or more materials , but significant results can also be achieved for a single material, among which the one endowed with a very large complete bandgap that the authors show in a previous work.

In general, periodic structures endowed with bandgap exhibit attenuation in the transmission spectrum of the finite structure in correspondence of the bandgap frequency range. Conversely, the design presented in this work is such that the transmission spectrum of the finite structure is typical of a low-pass mechanical filter: the attenuation starts in correspondence of the bandgap bottom limit, and it proceeds beyond the bandgaps top limits, merging the subsequent bandgaps. The bandgaps merging is confirmed by both numerical calculations and experimental tests on a finite prototype.

Additionally, a comparison with a prototype of a homogeneous solid cube of the same material, production process and dimensions is carried out to highlight the differences between the proposed design and the bulk material.

LUCA D'ALESSANDRO

Education

PhD with Honors in Structural Engineering at Politecnico di Milano.

Semester at MIT Boston, working on meta-materials for vibration control.

Career

Contract Professor of the course «Structures» at Politecnico di Milano.

Main research activities

Meta-materials and optimization of phononic crystals for noise and vibrations isolation and absorption.

Active Noise Cancellation for EVs in practice

NICOS ZAFEIROPOULOS | SILENTIUM

In the near future, many commercial vehicles will be equipped with automotive broadband active noise cancellation systems. At the same time, the transition from ICE vehicles to EVs is influencing the way that NVH requirements for vehicle development are defined. Additionally, modern applications that create a personalized and connected life in-cabin environment are strongly influencing the NVH developments for EVs. This creates the necessity for more advanced active NVH technologies that can support modern NVH requirements.

In this presentation, the advances of broadband active noise cancellation for EVs will be introduced. In particular, the integration of advanced active NVH technologies in vehicles and the corresponding performance in EVs will be presented.

NICOS ZAFEIROPOULOS

Education

PhD in the area of Active Road Noise Cancellation at University of Salford.

MSc in Acoustics at the Technical University of Denmark.

Career

Since 2007 working in the area of active noise cancellation both for commercial products and research projects.

Main research activities

Development of active noise cancellation headphones for military applications.

Algorithm development for core road noise cancellation technology.

Final Drive Noise: experimental and numerical approach to investigate the paths from Gearbox to Cabin

FRANCESCO NACLERIO | FERRARI

Transmission noise are often characterized by high frequency harmonics and a way of propagation that can be structural, airborne or either of them. To understand the nature of the phenomena some advanced test techniques such as Transfer Path Analysis with Active Side Excitation and Mount Stiffness Method were used.

Once the vibro-acoustic paths were described the focus moved to the mitigation of the noise at the receiver, this time with a numeric approach.
The structure borne contribution was controlled improving the dynamic stiffness at the body side, whereas the airborne contribution was tackled with a technique called Equivalent Radiated Power (ERP). The approach allowed the optimization of the NVH performance of the area surrounding the Gearbox mounts without any significant weight penalty.

FRANCESCO NACLERIO

Education

MA in Mechanical Engineering, major in Ground Vehicles at Politecnico di Milano.

BA in Mechanical Engineering at Politecnico di Milano.

Career

2016 – current:
Senior NVH Engineer, Ferrari.

2014 – 2016:
NVH Engineer, McLaren.

2013 – 2014:
NVH Engineer, Bentley Motors.

Main research activities

Exhaust-Intake and Structure Borne Road Noise, ride comfort and sound quality.

NVH performance for the front engine platform, from concept to production.

Creation and Development of virtual models in B&K NVH vehicle simulator environment.

Tyre-Wheel-Cavity models for vehicle interior noise optimization

FRANÇOIS LOHR | MICHELIN

Customers' expectations concerning noise and comfort inside a vehicle are getting higher, as an image of the quality of the vehicle. Due to optimization of engine noise during the past years, the contribution of tyre road noise to interior noise has increased. The road noise performance is mainly due to the vibrations coming from the tyres and going inside the car through wheels and frame. Thus, it depends on the coupling between the tyres and the vehicle, to avoid bad filtering or mode resonance.

One of the current challenges in automotive world is to switch practices from measurement and physical design loops to virtual ones, to quickly try more solutions in a cost efficient way. For the optimization of interior noise, finite elements modeling is technically adequate, because of the frequency range involved (up to 500Hz). However, because of computation time, complexity of FEM to build and to use, and confidentiality, complete tyre FE models are not appropriate for vehicle interior noise simulation.

Sub-structuration modeling appears therefore since many years as the best option to conciliate precision of finite elements models, computation time and confidentiality. Michelin developed a full chain of tyre model creation, including the wheel and the cavity, in order to create relevant models for car makers in their interior noise simulations. The good quality of the simulation is validated by comparison to on-drum measurements.

FRANÇOIS LOHR

Education

Graduate Engineer in Automobile and rail transport sector at ENSTA ParisTech.

Master 2 (M2) in Advanced Structural Calculation Techniques at École Normale Superieure de Cachan.

Career

2018 – current:
Technical Manager NVH Tire Performance, Michelin.

2012 – 2018:
Modeling expert NVH Performance, Michelin.

Main research activities

Improvement of tyre noise and comfort by appropriate simulation tools and measurement methods.

Integration of airborne acoustic transfer path techniques into a digital prototype strategy

SIMON NOBLE | BENTLEY

Simulation tools are increasingly being used in the automotive industry; the field of acoustics is no exception. In order to use any simulation tools effectively it is vital that accurate physical test data for model inputs and correlation exercises is provided. Once adequate correlation has been achieved, a desirable output from any acoustic digital prototype, is to support the subjective assessment of a product at the concept phase. This is prior to physical vehicle availability and maximum ecological validity is the objective.

The acoustic transfer path of airborne noise from external source to receiver inside the vehicle cabin is an important piece of input data. Issues with repeatability and a lack of understanding regarding the various sources, can lead to poor model inputs and hence a potential for erroneous conclusions during the early stages of vehicle development.

This paper investigates several key areas surrounding the measurement, simulation and application of airborne transfer paths from sources to receiver positions. The validity and pitfalls associated with physical testing are investigated. An existing statistical energy analysis (SEA) model is correlated with measured data to ensure its validity. The simulated airborne transfer functions are integrated into a full vehicle simulator model with existing sources and structure borne paths in order to auralise the output. How the above findings would be implemented into future product development cycles is demonstrated.

A conclusion is drawn as to the validity of reciprocity of an automotive product and its dependence on acoustic path complexity. Test equipment locations that are critical for ensuring test repeatability are identified. The ability to auralise with confidence simulated airborne transfer function data provides a powerful tool. This will enable business decisions on target setting, vehicle packaging, material selections and noise countermeasures prior to physical vehicle availability. Thus supporting a front loaded digital prototype project strategy.

SIMON NOBLE

Education

MSc with Merit in Acoustics with Audio Applications at Salford University.

BEng (Hons) in Automotive Engineering at University of Hertfordshire.

Career

2007 – current:
Lead Acoustic Engineer
(including 2 year graduate theme),
Bentley Motors Ltd.

2005 – 2006
Placement year,
Nissan Technical Centre Europe.

Main research activities

Airborne road noise, cabin isolation and digital prototyping strategy for owned atributes.

Target setting and development through entire project timeline from concept to production.

Intake Noise refinement for the new McLaren GT

DAVIDE PALMIERI | MCLAREN

Countermeasures to achieve a GT vehicle acoustic comfort without affecting the sportiveness of the brand.

This year McLaren automotive presented a new concept of GT vehicle, the McLaren GT. To develop a sport car with a GT behavior, variety of challenges have been faced, especially in terms of acoustic refinements. On one hand a sport car must be engaging, characterized by distinctive sound. On the other hand, a GT car must be characterized by acoustic comfort. Several systems have been optimized to improve the Cabin sound quality. In particular, the intake system, due to high flow rate required by the powerful V8 engine, and due to strictly packaging limitations, produces high rush noise audible by both driver and passenger. Focus of this work are the countermeasures developed, together with the Adler Pelzer Group team, in order to reduce the unpleasant noise without affecting the vehicle sportiveness behavior.

DAVIDE PALMIERI

Education

PhD in Mechanics of Vibrating Systems at Politecnico di Bari.

Master Degree in Mechanical Engineering at Politecnico di Bari.

Career

2017 – current:
Senior NVH Engineer,
McLaren Automotive Ltd.

2016 – 2017:
Powertrain NVH Engineer,
Maserati S.p.A.

Main research activities

Experimental/numerical characterization and validation of NVH attributes for the entire vehicle, main focus on body structure and chassis components.

Definition of roadmaps and targets for McLaren projects.

R51 phase 3 regulations – beyond the 7,5m microphone – a global approach

THOMAS ANTOINE | RENAULT

Major car manufacturers are preparing to meet the next step of pass by noise regulation, with a first phase next year, lowering the Lurban regulation level to 70dB and further down to 68 dB in 2024. This call for a number of countermeasures coming with their engineering challenges (cost, space claim, weight increase, tyre tradeoffs) to ensure the compliance.

The aim of this talk is to open the debate on a more global level, and try to analyze what could be the final impact of those efforts.

The spirit of pass -by noise regulations is ultimately to reduce citizen noise exposure in the environment, particularly in cities. The 2002/49/CE directive, enforced since the early 2000s, calls for each major city to issue a noise exposure mitigation plan. This plan is based on a model of the environment and an idealization of the sound sources to issue night and day averaged equivalent levels used to assess the noise doses at each location.

It is interesting to understand how those maps, and therefore the decisions taken from them will evolve as car manufacturers reduce the Lurban to the requested values.

Simultenaously, the rise of smart cities and big data will very probably empower citizen to measure in real time harmful environmental parameters:
air pollution, electromagnetic pollution and noise. For noise, a number of monitoring efforts are already in place and the unleashed technologies allows no for automatic source localization and classification, driving to more objective and "real time" annoyance or exposure analysis. Big data, smartphone apps, connected cheap sensors allow now anyone to be aware of the "real life" exposure in cities where the urban "soundscape" is starting to get more and more meaning and attention, as some cities even start to talk about sound quality rather than only noise levels.

How can we make sure that those three axis – source regulations, environmental noise regulation, and the spread of objective and real life exposure assessment – are perfectly aligned and that our efforts are indeed beneficial for the citizen?

THOMAS ANTOINE

Education

Mechanical Engineering at INSA Lyon.

Mechanical and Production Technology at Belfort University.

Career

2018 – current:
Expert Leader NVH Technologies, Renault.

Various positions in engine software and hardware development as well as component synthesis and project management for all spark ignited engines worldwide, Renault.

Various positions in NVH Engineering at 01dB Metravib, Caterpilar, AERO STYL and Intermedics Orthopedics Inc.

Main research activities

Predictive maintenance, environmental noise and vibration control.

NVH advanced engineering.

Propagation of boundary and geometrical uncertainties for the aeroacoustics analysis of a side mirror

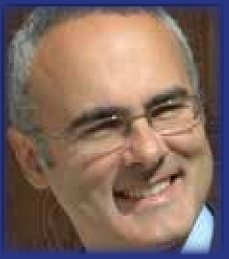
EDMONDO MINISCI | UNIVERSITY OF STRATHCLYDE

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.

EDMONDO MINISCI



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 the Politecnico di Torino.

Director of the Intelligent Computational Engineering (ICE) Laboratory.

Senior Lecturer (Associate Professor) at the Department of Aerospace and Mechanical Engineering of the 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.

FEDERICO GALLIZIO | OPTIMAD ENGINEERING

Aeroacoustics has received great attention in the last years, due to the ever stricter noise regulations, and increased computational capabilities. However, despite the stochastic nature of most aeroacoustics systems and models, non-deterministic investigations in regards to computational aeroacoustics are limited. In this contribution, some non-intrusive approaches for probabilistic and imprecise probability propagation of uncertainties are presented through the use a simple automotive test case, considering boundary and geometrical uncertainties for the aeroacoustics analysis of a side mirror. Obtained results are then used to detail some approaches giving statistical similitude between uncertain numerical performance and (synthetic) uncertain experimental data.

FEDERICO GALLIZIO

Education

PhD in Fluid Mechanics at Politecnico di Torino/ Institut de Mathématiques Appliquées de Bordaux.

MSc in Aeronautics and Aerospace Engineering at Politecnico di Torino.

Career

Co-founder and owner of OPTIMAD Engineering S.r.l., spin-off of the Politecnico di Torino.

2010:
Research fellowship at the Politecnico di Torino, co-advised by CIRA.

2004/2005:
Research fellowship at the Politecnico di Torino, working on flow control for bluff bodies by means of passive techniques and on the implementation of a Newton-Krylov-Schwarz method for Euler equations.

Main research activities

External aerodynamics, internal flows, thermal comfort, combustion and detailed kinetics, turbo-machinery, wind-engineering, fluid-structure interaction.

Technologies for Noise & Vibration reduction in the Automotive and Aerospace field: some CIRA experiences

MATTIA BARBARINO, GIANLUCA DIODATI | CIRA

Along with the road transport, the air transport is an essential element of today's global society. With 2.8 billion passengers yearly and $539 billion of world gross domestic product (GDP) generated per year, aviation brings people and cultures together and significantly contributes to the economic growth. Due to the continuous and steady growth of air traffic, the aircraft manufacturers pose a growing interest to environmental issues (like pollution and noise impact) and passengers comfort. Aircraft noise reduction is, thus, one of the priority challenges for manufacturers to address from one side the European Commission target of reducing the noise up to 65% within 2050 (Flightpath 2050 vision and ACARE Strategic Research and Innovation Agenda) and on the other side to increase their competitiveness on the market by providing a high-level of passengers well-being.

To reach challenging noise reduction and comfort targets, several technological solutions need to be deployed and working both at source level and on the propagation path. The effectiveness of the combined use of several technologies can be realized through a multi-objective design and optimization approach at cabin level that also takes into account for psychoacoustic criteria.

From an experimental point of view, automotive pass-by noise and aircraft flight-over tests can be used to evaluate the benefit of different strategies to reduce the environmental acoustic footprint of both car and aircraft and to give insights on how the exterior noise can be reduced. These kind of tests are complex and require the fulfilment of several different standards with regard to the physical track layout, measurement systems, data acquisition, triggering, processing and analysis. CIRA numerical and experimental experiences on these topics, both in the automotive and aeronautical field, will be presented.

MATTIA BARBARINO

Education

PhD Mechanical Systems Engineering at Università degli Studi di Napoli.

Mechanical Engineering at Università degli Studi di Napoli.

Career

2015 – current:
Head of Computational Acoustics Lab at CIRA.

2007– 2015:
Aerospace Research Engineer at CIRA.

Main research activities

CAA software development and numerical simulation.

Aircraft/rotorcraft noise prediction and reduction.

GIANLUCA DIODATI

Education

PhD Theoretical and Applied Mechanics.

Mechanical Engineering at Università degli Studi di Napoli.

Career

2003 – current:
Researcher in the Vibroacoustics Lab at CIRA.

Main research activities

Vibroacoustic tests, phased array antennas, finite element simulations of vibrations and interior acoustic fields and signal processing.

Analysis of the challenges of sound package definition for electric vehicles using SEA analysis

ARNAUD CAILLET | ESI

The emergence of Electric Vehicles as the vanguard of vehicle development has brought with it new challenges for the design of the Sound Package. Foremost amongst these is the replacement of the masking effect of the Internal Combustion Engine by electric motors and powertrains of far different spectral content and excitation levels. Changes to construction and inclusion of the battery also affect the remaining classical sources (road noise, aero-acoustic noise, etc).

This presentation will illustrate how, for typical airborne and structure borne load cases, the sound package design is affected by the conversion of classical internal combustion engine vehicle to an electric vehicle. This analysis will be conducted using the SEA (statistical energy analysis) simulation method. SEA is a powerful method which can be used in the early development phase of Vehicle Development Programmes and the model further refined as the definition of the vehicle evolves. With the help of the SEA, the effect of the new vehicle construction on the main transfer paths will be compared. Suggestions for an optimized sound package will be provided.

ARNAUD CAILLET

Education

MSc in Mechanical Engineering with vibro-acoustics specialization at Université de Technologie de Compiegne and at Université de Sherbrooke.

Career

2014 – current:
Team leader for the vibro-acoustics department at ESI GmbH.

2011 – 2014:
Vibro-acoustics project engineer on-site at Audi.

2008 – 2011:
Vibro-acoustics project engineer, working on several projects at ESI GmbH.

Main research activities

Virbro-acoustics.

SEA, FEM, BEM methods for the automotive, marine and aerospace industry.

Beamforming Technique in Pininfarina Wind Tunnel

ANTONELLO BIANCO | PININFARINA

Wind noise is one of the top problems most commonly experienced by vehicle owner especially when the car speed is high and air surrounding vehicle is disturbed by front grid, wipers, a-pillar, RVM , etc.

In this situation , noise inside cabin is a sum of noise produced by these exterior noise source, pressure fluctuation due to turbulent flow, and cavity noise due to a seals leakage. In Pininfarina wind tunnel, different techniques are used to understand and individualize different components of total interior noise. In particular , Beamforming technique is used to understand, where are the exterior noise sources, and Coherent Beamforming, if and how these sources influence acoustic field inside cabin.

Beamforming is a signal processing technique that is utilized for locating sound sources using a microphone array. There are many different algorithms used for that, but all compute map of the amplitude and position of acoustic sources in a given measurement area. Furthermore, Coherent Beamforming uses microphones (or acoustic dummy) inside the car to calculate the Coherent Power Spectrum used to understand the contribution of every source to the total noise perceived inside the cabin.

Here it will be shown a case study and an application of DAS (Delay and Sum) and CPS (Coherent Power Spectrum) in Pininfarina Wind Tunnel.

ANTONELLO BIANCO

Education

Technical Diploma in Scientific Software Development.

Career

1985 – current:
Software Developer Manager,
Technical Manager,
Aero Acoustic Testing Manager at Pininfarina.

Main research activities

Software development in steady and unsteady field.

Aeroacoustic Measurement and Research.

Measurement techniques.

A new perspective in porous material modelling and optimization for vibro-acoustical applications

FRANCESCO POMPOLI | FERRARA UNIVERSITY

Porous materials for acoustical applications have been extensively studied over the past years. A considerable number of experimental tests have been carried out as a function of fiber geometrical characteristics (as for example overall density, fiber diameter and density, open porosity, etc…) in order to determine analytical formulations for the prediction of physical parameters, primarily the airflow resistivity. Due to the increase of computational capabilities micro-to-macro structure approach is object of current researches in order to determine transport and acoustic properties starting from certain arrangement of fiber in space.

Almost all researches assume fiber having the same radius with regular or random position within a representative volume of material. To this end the aim of the present presentation is to provide a revision of existing analytical formulations of non-acoustical parameters for two-dimensional structures having random positioning in space and symmetric and asymmetric distribution of radii. Proposed formulations will be compared with existing models and finite element simulations.

FRANCESCO POMPOLI

Education

PhD in Technical Physics.

MSc in Mechanical Engineering.

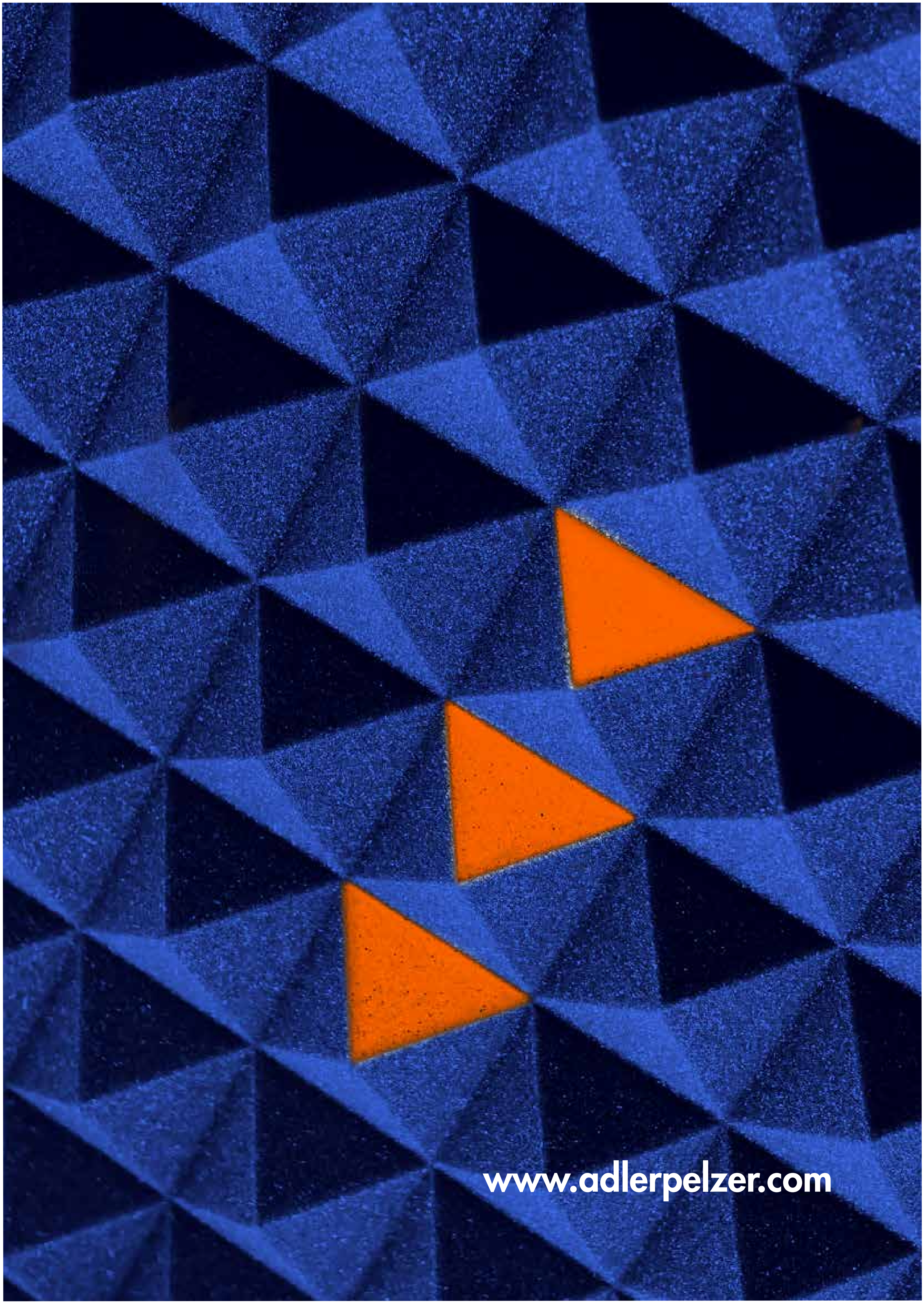
Career

Researcher of Applied Acoustics at the Department of Engineering at the University of Ferrara.

Co-founder of Materiacustica srl, spin-off company of The University of Ferrara.

Main research activities

Sound propagation in poroelastic materials and noise control.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