

Immersive Audio Experiences In The Car

Michael Cousins | Senior Automotive Engineer



MICHAEL COUSINS

2014 | PhD at University of Southampton | “The Diffuse Sound Object” | Modelling the perception of diffuse sound fields for use in object-based audio.

2018 | Postdoc at University of Surrey | S3A project - Future Spatial Audio for an Immersive Listener Experience at Home | Decorrelation algorithms for diffuse sound fields.

2019 | Automotive Engineer | Meridian Audio.

2022 | Senior Automotive Engineer | Meridian Audio

MERIDIAN

- 1977: Meridian M1 | The worlds first active loudspeaker for the home.
- 1989: Meridian D600 | Worlds first digital active loudspeaker for the home.
- 1991: Meridian D6000 | Worlds first DSP digital active loudspeaker.
- 1997: Meridian Lossless Packing | Later licenced to Dolby as Dolby TrueHD
- 2010: McLaren Automotive | Tier 1 supplier for the MP4-12C.
- 2011: Land Rover | Brand partner for Land Rover.
- 2012: 3D Surround System | First 3D surround sound system in a car featured in Range Rover.
- 2020: Human Horizons.
- 2021: Kia.
- 2021: Rivian.
- 2022: Engineered By Meridian.



ENGINEERED BY MERIDIAN

Unified commercial licensing approach via EbM

EbM – Engineered by Meridian

EbM is the new ‘umbrella’ name for our engineering consultancy & licensing activities



Automotive, Consumer Electronics, Airlines & Production Marine

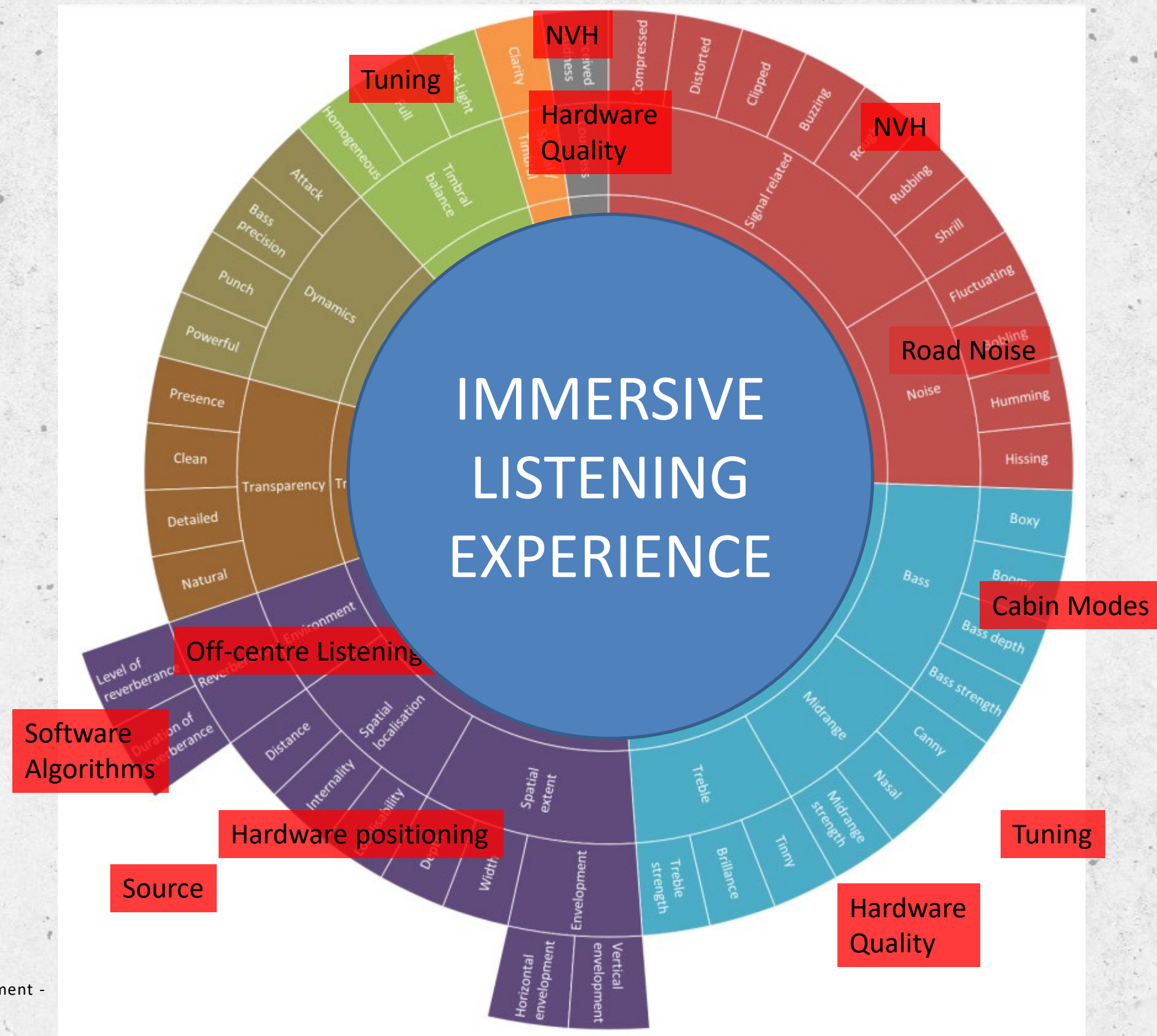
Offering:

- Engineering services and consultancy
- Proprietary DSP technology licenses
- 3rd party technology licenses
- Audio tuning services
- Marketing services and consultancy
- Brand(s) licenses



OVERALL AUDIO QUALITY

- “Overall Audio Quality” has many components.
 - Frequency response
 - Localisation
 - Loudness
 - Noise
 - ...
- Audio system has many variables.
 - Hardware capabilities
 - Hardware positioning
 - Acoustic environment
 - NVH
 - Software algorithms
 - Source
 - Tuning



Zacharov, Nick & Holm Pedersen, Torben & Pike, Chris. (2016). A common lexicon for spatial sound quality assessment - latest developments. 1-6. 10.1109/QoMEX.2016.7498967.

INNOVATION IN AUTOMOTIVE

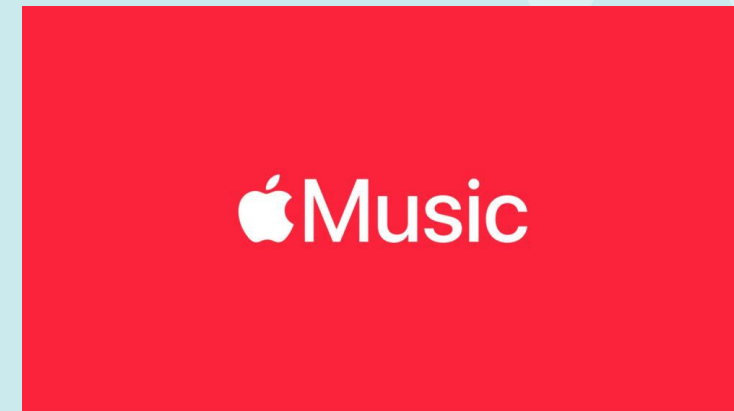
- Immersive Formats.
- Hardware.
- Personalisation/Customisation.
- Simulation.
 - Expectation of system performance.
 - Perceptual Metrics.

IMMERSIVE FORMATS



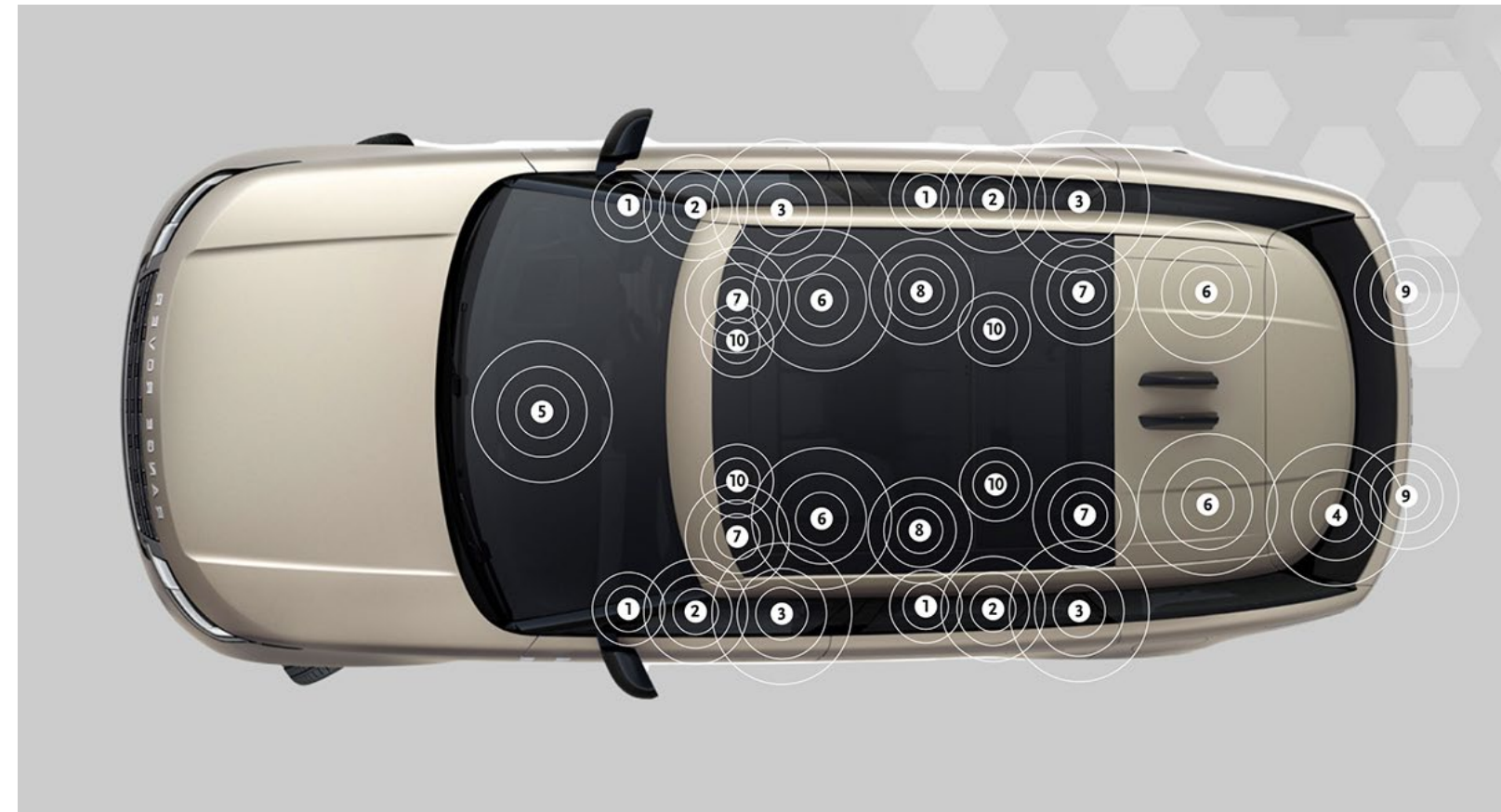
Dolby workshop.

- Bass management.
- Multiple listeners.
- Compatibility with stereo.



HARDWARE

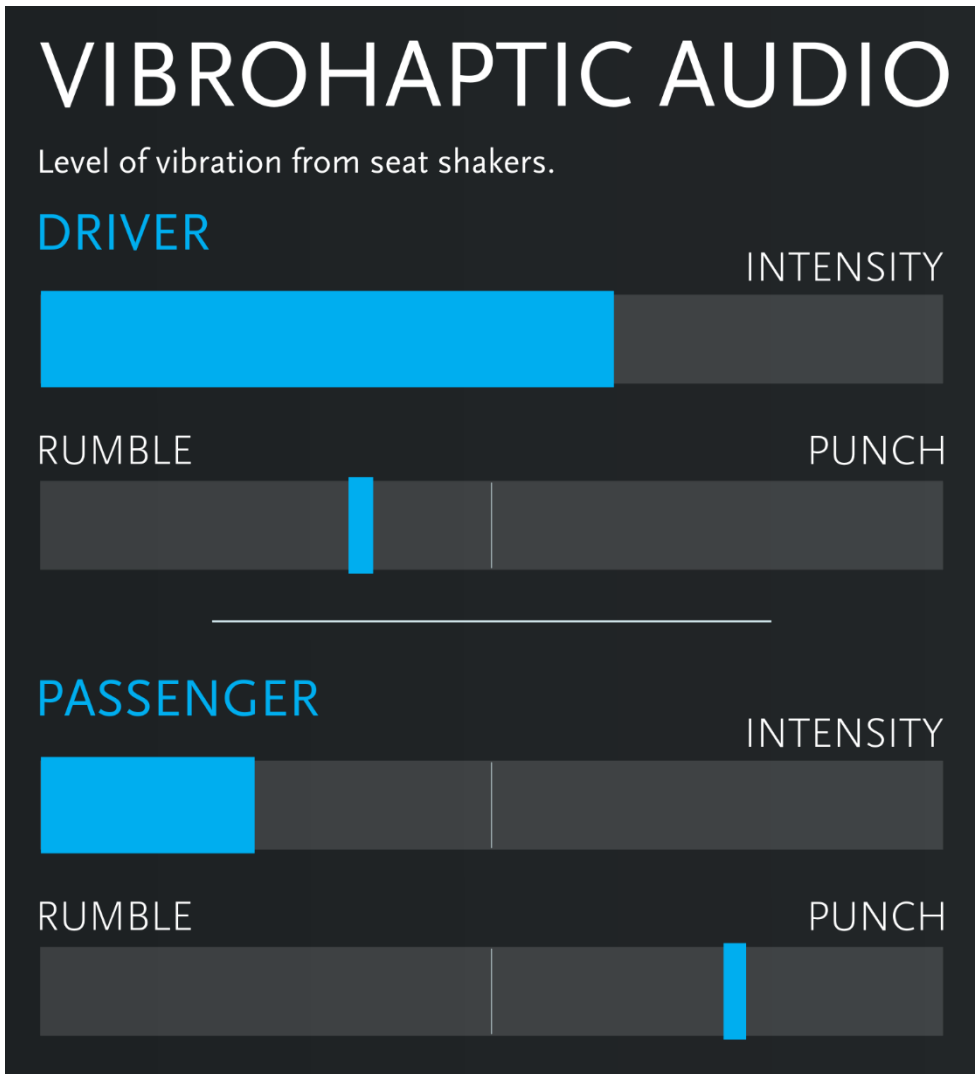
- Heights.
- Headrests.
- Rear Seat Entertainment.
- Seat Shakers.
- Actuators.



VIBROHAPTIC AUDIO



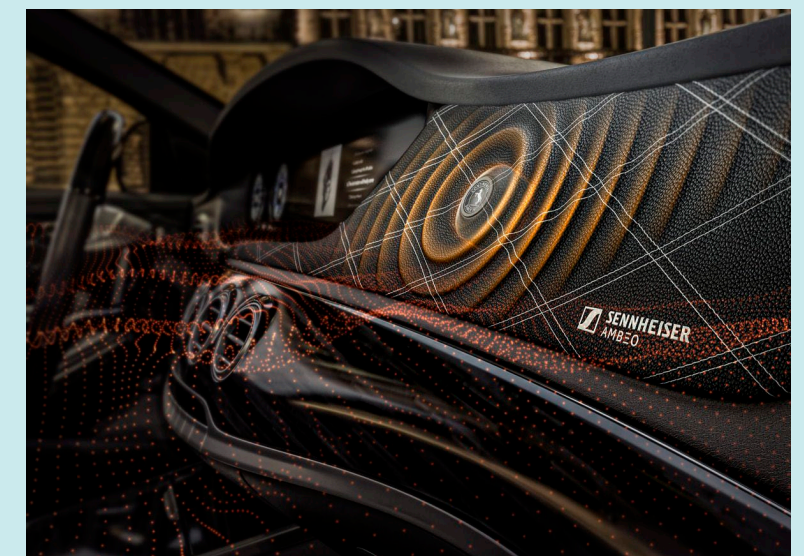
- Seat shakers give tactile feeling of bass.
- Announced in 2023 at CES.
- Rumble/Punch user control.



Aker, S. C., Innes-Brown, H., Faulkner, K. F., Vatti, M., & Marozeau, J. (2022). Effect of audio-tactile congruence on vibrotactile music enhancement. *The Journal of the Acoustical Society of America*, 152(6), 3396. <https://doi.org/10.1121/10.0016444>

ACTUATORS

- LG Display “Thin Actuator Sound Solution”.
- Demo Car at CES 2023.
 - 21 actuators. 3 regular woofers.
- 2.5 mm thick piezoelectric actuators bonded to the vehicle trim, headliner and screens.



PERSONALISATION

User controls that cater for different audio tastes.

- Spatial.
 - Centre image position.
 - Immersion/Sound staging.
- Timbral.
 - Not just Bass/Mid/Treble.
 - Not just 9 bands.
- Tactile.
- Accessibility.
- Personal.
 - Audio Zones.

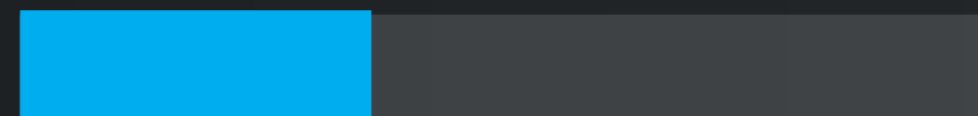
HORIZON

Move the position of the vocal image from the nearside door to the centre of the car



Centre Image: -1

Control the amount of enveloping ambience for a personalised sense of immersion



Immersion: 3

VIBROHAPTIC AUDIO

Level of vibration from seat shakers.

DRIVER

INTENSITY



RUMBLE

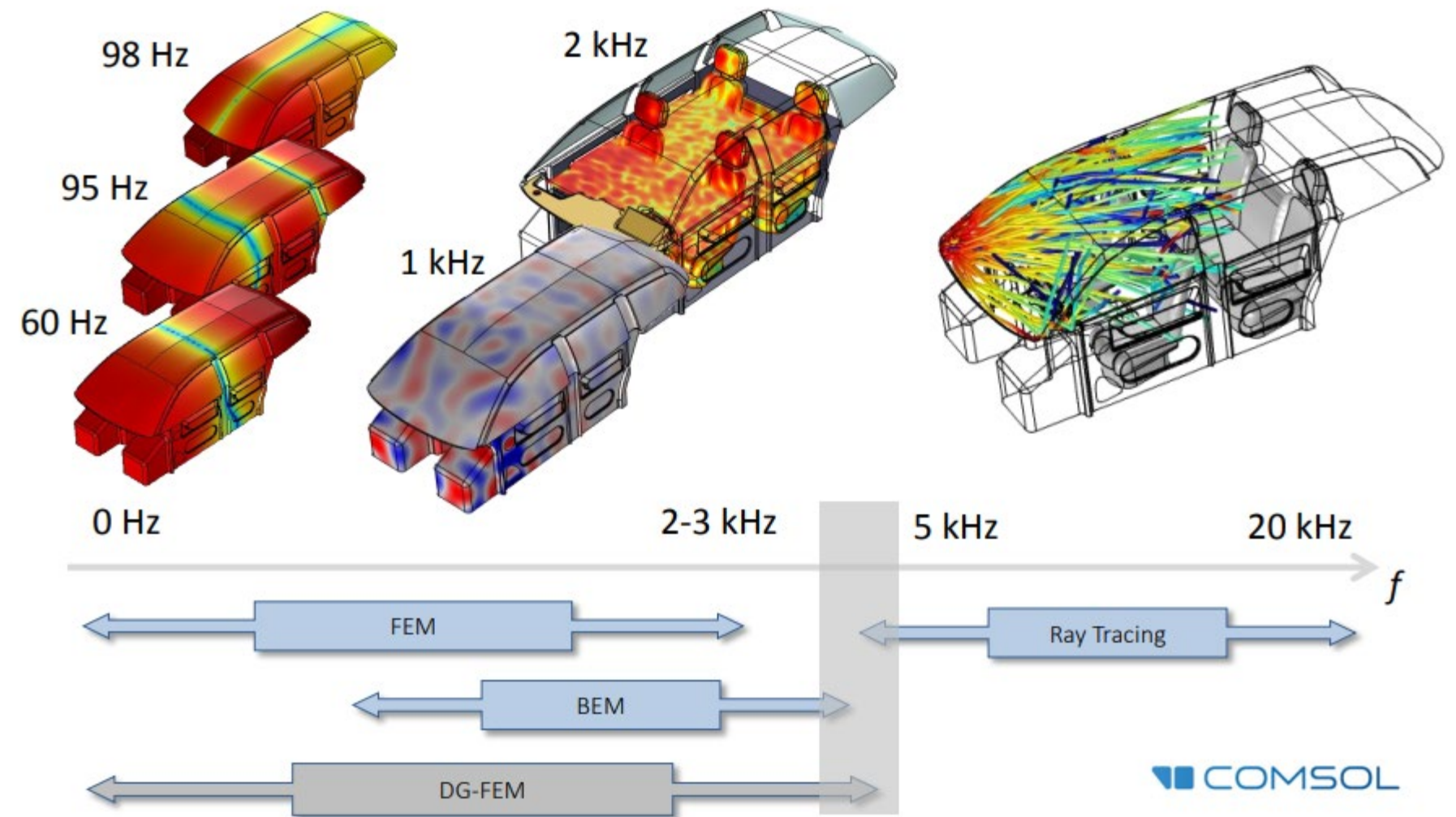
PUNCH



SIMULATION

- Computational analysis of the vehicle.
- Simulation of the result of tuning.
- Auralisation.
- Identification of risks.

The right tool for the right job!



PERCEPTUAL METRICS

Predicting human responses to aspects of the sound system:

- “Focus”: The degree to which the vocal is central and pinpoint accurate.
- Localisation: Direction of the sound to calculate soundstage width/accuracy.
 - Reflective cabin.
 - Upmixed content using multiple speakers.
 - Precedence effect.
- Impression of bass including the tactile element.

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