Enabling hardware reduction via immersive N&V driving simulation

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Enabling hardware reduction via immersive N&V driving simulation

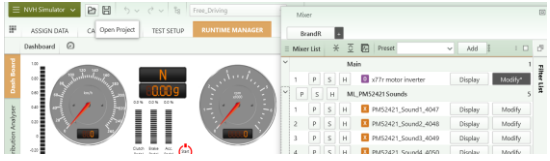
Motivation for hardware reduction

Interactive N&V Simulator

- Why do we need it
- Integration into the VDP

Challenges Looking forward

- Automation
- Immersion



Motivation – Preproduction vehicle development process

Preproduction Components
- Soft (i.e. temporary) tooling
- Labor intensive component assembly (non-productized)

Limited run assembly
- Labor intensive assembly (non-productized)
- Garage work

Physical testing
- Low fidelity parts
- Camo

Scrap and recycle
- Components
- Vehicles

Production Components
- Hard tooling

Production Assembly

Yes, it generates waste but is necessary, right?

Virtual assessments can replace the build and test cycle

Status assessments virtually – Subjective assessments in the Simulator

Very few development vehicles – continued development in the simulator

~ 2 ½ years

Target setting using N&V driving Simulator (no comparable hardware available)

Concept

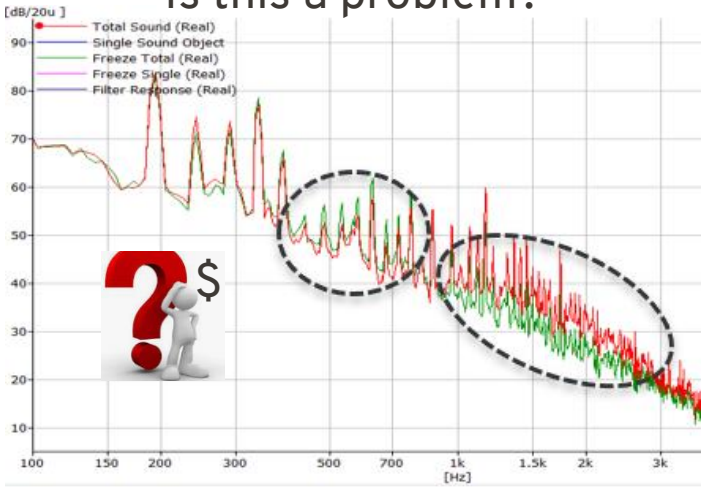
Production

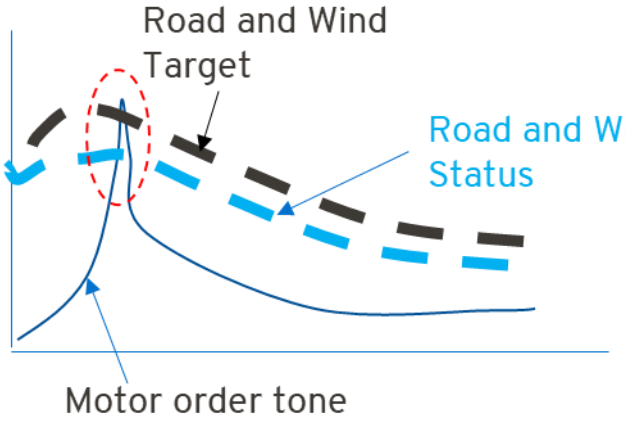
Subjective assessments are necessary

Can't I just use analytical assessments to targets?

- Requirements are typically necessary but not sufficient.
- Is a target exceedance really a problem? How much is it worth?
- Is a solution good enough?
- What about interactions?

Is this a problem?





If road and wind overachieves, we may have a tonal noise problem?

Driving Simulators are a tool to help get there

Interactive N&V Driving Simulator

- Receives vehicle driving performance data

- Recreates major sound and vibration touch points
  - Order related responses (e.g. drive unit tones)
  - Spectral content (e.g. road & wind)
  - Based on measured or predicted responses

- Provides experience of subjective N&V performance
  - Set Targets
  - Enables content decisions
  - Captures interactions

Streamlined process flow is necessary

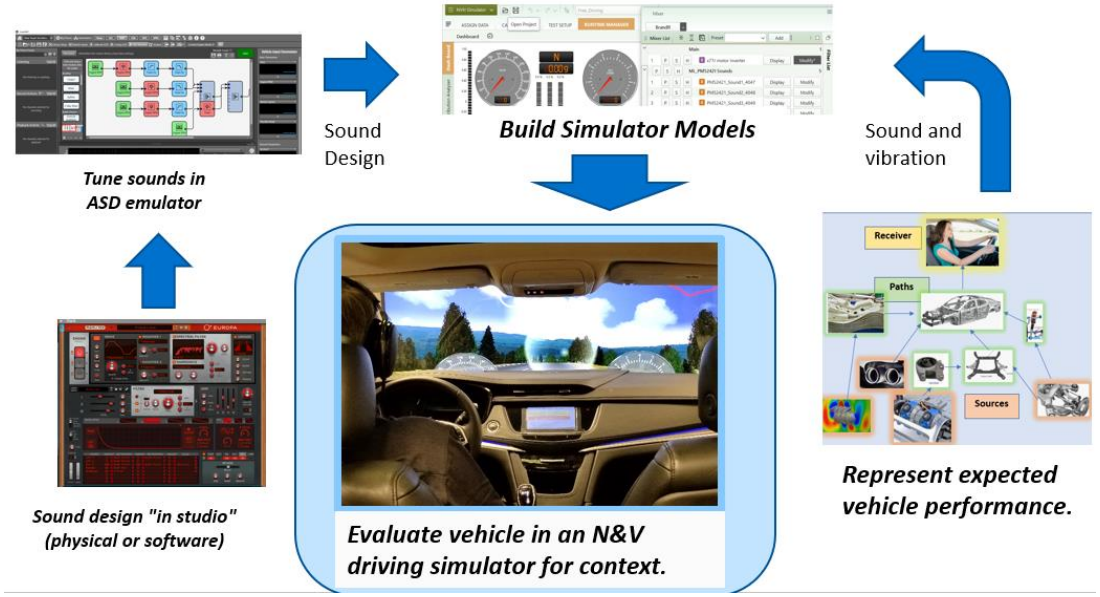
Analytical and Test tools **must** be integrated into the simulation process.

- Minimize data “touches”
- Manage revisions
- Automation enables optimization
- **Manual processing doesn’t scale to real volumes**

Overly simplified example (to make a point):

- 2 pairs of wheels, 2 drive units, 5 components, wind -> **10 “sources”**
- Structure borne and airborne paths
  - 10 * 2 = **20 paths** (ignores # of mounts)
- **5 Operating conditions** and **5 interfaces**

- Iterations per vehicle development cycle:
  - Content Studies: isolated cradle, gear finish, motor design, mounts, etc.
  - Development Gates (i.e. check points)
  - Enhancement/Masking
- Times the number of models and sub-models



“Touches” are inefficient and lead to mistakes – cut&paste model building cannot scale to support a true VDP

Enhanced Realism to enable decisions

A simulation must “feel right” to decide to spend money to fix an issue.

Examples:

- Rear bias road noise
- Mirror whistle
- Sound staging for sound enhancement

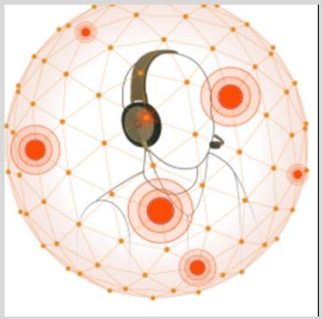
Binaural playback provides a surround effect but falls short of true immersive audio.

Object based audio (OBA) formats such as Atmos or MPEG-H provide a framework for simulating sounds in a 3 dimensional space.

Localized sounds can then be rendered to headsets with tracking or to speaker arrays.

Integrating analytical models with object based audio and vibration in a free driving simulator enables realistic demonstrations

Sound with a location relative to head



e.g. Atmos, MPEG-H, …

Conclusion

Free driving simulators provide an excellent platform for virtual vehicle evaluations.

Integrated CAE tools are necessary for full scale implementation and allow efficient status representations and optimization.

Integrating object-based audio and vibration provides an additional sense of realism to enable decision making.