RAD)))OPT
Radiated Noise Optimization

CDH

REDUCED SOUND EMISSION FROM POWERTRAIN COMPONENTS USING CDH/RADOPT (RADIATED NOISE OPTIMIZATION)

What is CDH / RADOPT?

CDH/RADOPT is a unique new technique that combines the boundary element method (BEM) with the finite element method (FEM) and design optimization to minimize noise radiated from vibrating structures. CDH/RADOPT utilizes the concept of acoustic transfer functions (ATVs) between the velocity of the radiating surface and the sound pressure at a point in the acoustic field around the structure. The ATVs are calculated once only in an initial BEM step. By integrating the pre-calculated ATVs into the structural model as a constraint relationship, the sound pressure at any position in the acoustic domain can be obtained as an output quantity in the FEM calculation. This makes it possible to use the standard structural optimization tools available in FEM software packages such as Nastran and CDH/VAO to minimize the radiated noise.

Implementation

The procedure for CDH/RADOPT can be divided into two relatively independent phases.

Phase I – Calculation of ATVs
The radiating surfaces of the structural system should be identified in a first step and a BEM model for the exterior problem created. This requires a minimum of meshing work. CDH/BEM, a dedicated boundary element program for ATVs which is fully integrated into CDH/VAO, can then be used to generate the ATVs. CDH/BEM includes a mapping procedure allowing an ATV calculated from the BEM mesh to be mapped back to the original structural FE mesh. The mapping procedure in Phase I is an important step since it makes the design optimization in Phase II possible.
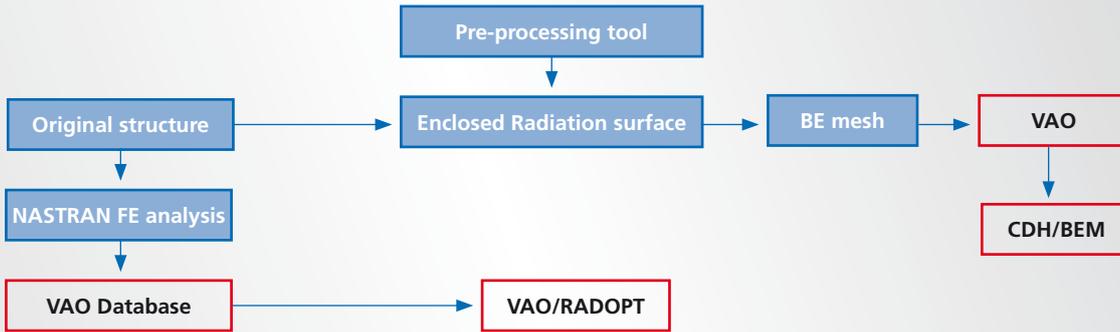
Phase II – Design optimization
At user option, either CDH/VAO or Nastran (SOL 200) can then be used to perform structural design optimization. Both approaches use the beta-method for structural optimization. This method is widely in for structural problems. The objective of the optimization is formulated to minimize the sound pressure at a number of field points simultaneously. A large number of the design variables can be selected since the optimization is performed on the full structural FE system which contains more detail than the BEM model. In Phase II, CDH/RADOPT allows the use of the established techniques for interior NVH optimization to be applied to the exterior noise optimization.
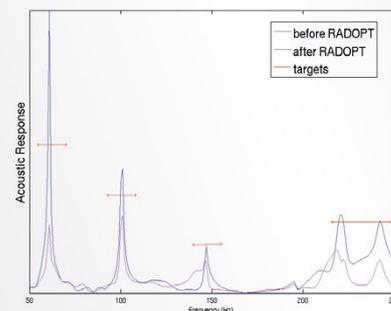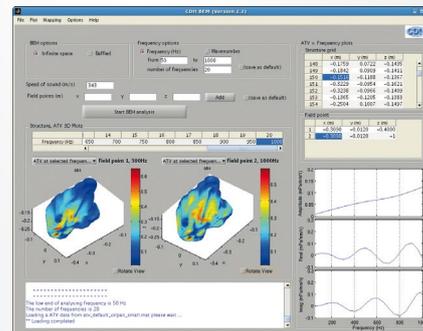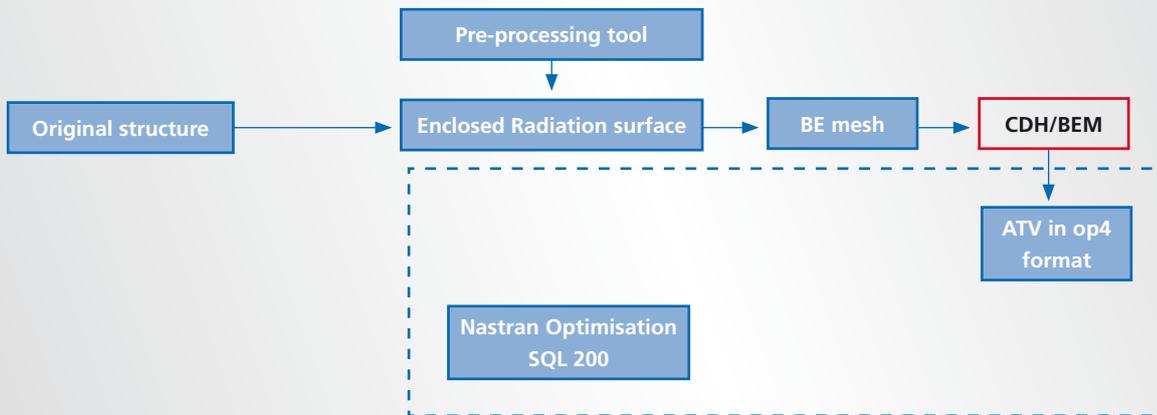
Workflow

Radiated noise optimization using CDH/VAO

```
                          Pre-processing tool
                                  │
                                  ▼
Original structure ──────► Enclosed Radiation surface ──► BE mesh ──► VAO
       │                                                                │
       ▼                                                                ▼
NASTRAN FE analysis                                                 CDH/BEM
       │
       ▼
  VAO Database ──────────────► VAO/RADOPT
```

Radiated noise optimization using NASTRAN

```
                          Pre-processing tool
                                  │
                                  ▼
Original structure ──────► Enclosed Radiation surface ──► BE mesh ──► CDH/BEM
                                                                          │
                            ┌─────────────────────────────────────┐      ▼
                            │                              ATV in op4    │
                            │                                format       │
                            │                                            │
                            │    Nastran Optimisation                    │
                            │    SQL 200                                 │
                            └─────────────────────────────────────┘
```

Features

- Fully compatible with Nastran
- Efficient BEM solver for ATV calculation
- Unique and efficient ATV mapping technique to handle large models

Summary

The design optimization of finite element structural models has been widely used in the NVH design of automotive structures. Common uses of such tools include the minimization of the tactile vibration of vehicle body structures and minimization of interior acoustic responses. CDH/RADOPT has been developed to allow minimization of the noise generated by powertrain components such as gearbox and engines at the early design stage. The CDH/RADOPT procedure is easy to use for engineers familiar with standard structural optimization.

Software-Hardware Support

Supported Software:
MSC.NASTRAN
Simcenter Nastran
CDH/VAO

Supported Hardware:
Linux64 (x86_64)

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