An Overview of COMET® Software

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1.0 INTRODUCTION

Increased customer demands for quieter products as well as government restrictions and environmental concerns have created a need for cost effective noise prediction methods. While analytical methods are mostly applicable for simple problems and experimental methods require the need to build costly and time consuming prototypes, numerical (or computational) methods not only permits the simulation of complex problems but they also allow the evaluation of the acoustical performance at the early stage of design process. Further, numerical methods allow the evaluation of many and major design iterations rapidly as well as permit the evaluation of optimal solution satisfying many design criteria. As a result a product's time to market is minimized and the cost is reduced.

In a broader sense, numerical methods can be grouped into two categories: differential or domain methods and integral or surface methods. Among the differential methods, finite element method is the most popular and versatile method and among the integral methods, boundary element is the widely used technique. The method that is most suitable for a given situation is based on the problem type. For example, modal analysis and modeling of inhomogeneous and thin structures are easily handled by the finite element method. On the other hand, boundary element method is well suited for the analysis of radiation problems as well as the modeling of half-plane and acoustic sources.

COMET is a computational simulation tool based on finite element and boundary element methods that models sound propagation in fluid, structural and elastic porous domains. COMET software consists of a graphical user interface called COMET/Vision® and a family of solvers grouped under COMET/Acoustics®. The modules of COMET are schematically depicted in figure 1.

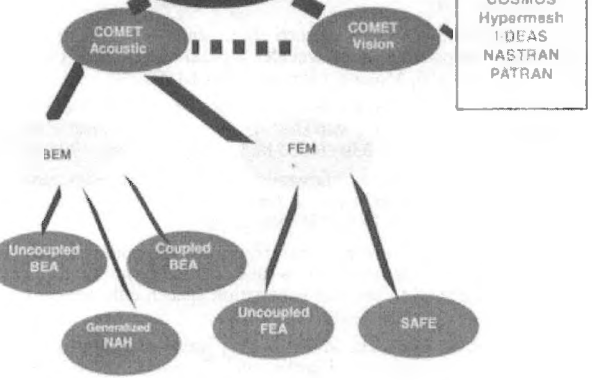

Fig 1. Schematic representation of COMET modules

A typical analysis in COMET involves the creation of a mesh that represents the geometry of the problem and the imposition of loading (boundary condition). Both of these informations are generated by using third party software. This information is imported into COMET using the COMET/Vision.

2.0 COMET Modules

2.1 Graphical User Interface – COMET/Vision

COMET/Vision is an easy to use pre- and post-processor that is designed to work the way engineers intuitively think about acoustic problems. It is tightly integrated with CAD/CAM packages such as I-DEAS®, Hypermesh® and PATRAN® as well as with structural vibration CAE software programs such as ABAQUS™, ANSYS®, COSMOS® and NASTRAN®.

2.2 Uncoupled BEA

This module is used to solve uncoupled acoustic problems. In a vibration induced noise analysis, this implies that the analysis considers the effect of vibration on the sound field and assumes that the effect of the sound field on the vibration is negligible. The solution is based on the boundary element method. Boundary element method requires the modeling of the surface of the acoustic domain and as a result the modeling (mesh generation) effort is minimal. Additionally the method satisfies the radiation condition of exterior problems, hence does not require any additional tedious modeling techniques. Analyses available in the module are frequency response, transient response and normal mode response. In addition to predicting sound field the module is effective for the treatment of a wide class of problems:

- Sensitivity analysis: Provides the effect on the sound field due to change in surface velocity. Together with structural sensitivity it provides information as to how structural changes affect the acoustical performance.
- Panel Acoustic Contribution Analysis (PACA): Provides a systematic process for the identification of areas of noise contribution and associated design modification.
- Multi-fluid Analysis: Allows the accurate modeling of piecewise homogeneous acoustic domains. This includes the modeling of bulk complex material properties.
- Mean-Flow analysis: Incorporates the effect of mean flow on wave propagation.
- Enhanced Rayleigh Integral analysis: Allows the evaluation of radiated sound field rapidly during design iteration.

These solutions are further enhanced by the use of nonlinear matrix interpolation technique for multi-frequency acoustic analysis and procedures that eliminate the irregular, non-unique behavior of exterior solutions.

2.3 Coupled BEA

In situations where the effect of the acoustics on structural vibration is not negligible one needs to use this module in which the structural response based on finite element method is coupled with the boundary element method based acoustic response. This module is also used to perform reverberant field analysis. Further, the analyses described in the previous sub-section are all available in this module.

2.4 Uncoupled FEA

Finite element method requires the modeling of the acoustic domain and thus the modeling effort is substantial compared to the boundary element method modeling requirement. On the other hand the method is well suited for the analysis of thin and inhomogeneous domains. This module can be used to perform both frequency response and normal mode analyses.

2.5 SAFE – Structural Acoustic Foam Engineering

SAFE module can be used to analyze and optimize sound in elastic-porous (e.g. foam), solid and fluid domains. Unlike approximate solution tools that have been used for the modeling of foam type materials, SAFE is based on rigorous physical and mathematical principles. SAFE is a powerful tool for the analysis of noise controls treatments such as glass fiber, mineral wool and thinsulate. Typical applications include, vehicle sound insulation, mufflers and ducts, headliners, seats, carpets, trim lining and enclosure liners. The development of SAFE module was partially funded by NASA.

2.6 Generalized NAH (Nearfield Acoustical Holography)

Noise prediction analysis requires knowledge of the noise sources. However, evaluation of noise sources is difficult when there are multiple sources and the interaction among them is complex. Holography is an inverse solution technology in which one can identify and rank sources using near field sound measurement. Conventional holography is applicable for simple geometry such as planar, cylindrical or spherical surfaces. COMET/NAH allows source identification in complex structures based on measurements taken using flexible non-planar layout. This module can be used to identify noise sources that are coherent, incoherent or partially coherent. The development of COMET/NAH is partially supported by an ongoing research program funded by NASA.

3.0 APPLICATION AREAS

COMET has been used to solve a wide class of acoustic problems in many industries [1-11]. Application areas of COMET include:

Automotive: Prediction of vehicle passby noise, component (e.g. manifold, air cleaner, engine, engine cover) sound radiation analysis, analysis of sound transfer through porous seat design, engine sound quality analysis, interior noise analysis, analysis of silencer performance, optimization of material properties, noise source identification in power plant.

Aerospace: Reverberant (diffuse) field analysis, determination of structural response of payloads during launch, prediction and optimization of interior aircraft noise, noise source identification in the interior of aircraft.

Consumer Products: Characterization of acoustical absorption properties of multi-layer material, prediction of noise transmitted through foam barriers, noise performance analysis of computer disk drive.

Construction Equipment: Analysis of the effect of sound absorbing material on engine noise, prediction of noise contribution from systems components, optimization of engine cover to minimize noise emission, interior cab acoustics, mount optimization.

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