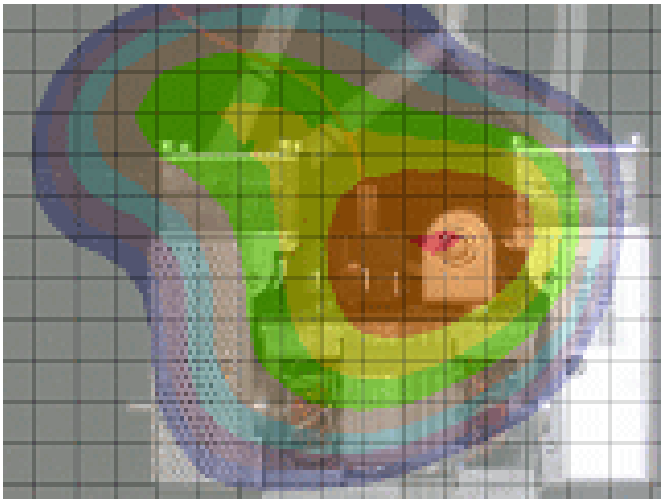
THE CENTER FOR
PROFESSIONAL STUDIES



Acoustic Simulation

Acoustic simulation solutions cover routine applications, such as structural noise radiation and cavity field simulations, and address specific acoustic engineering issues, like engine run-ups, flow-induced noise, aero-acoustic noise or random acoustic loading. They allow to:

- Gain full insight into acoustic problems
- Accurately and quickly predict design change effects
- Minimize the cost and weight of sound treatment
- Reduce noise levels and incorporate desirable sound before prototype testing

In this course you will be trained on every aspect of the acoustic calculation process.

- First, the basic theory of Boundary Element Methods (BEM), Finite Element Methods (FEM) and Acoustic Transfer Vectors (ATV). You will learn to ready a mesh for an acoustical simulation.

- Next, participants will focus on setting up an analysis for interior acoustics, calculate noise radiation, and include fluid-structure interaction in your simulation.

- Lastly, participants will be shown how to run the model and interpret output results on LMS software products. A thorough understanding of what these results mean and how to use them to improve the product design will be discussed.

THE CENTER FOR PROFESSIONAL STUDIES

Course Syllabus

I IDENTIFYING INFORMATION

Course:	Acoustic Simulation
Prerequisite:	Computer Aided Engineering (CAE)
Time Frame:	40 total contact hours
Instructor:	A senior technical specialist with LMS International PhD in Mechanical Engineering 5 years of experience with LMS software 5 years of applicable industrial experience
Phone:	(248) 952-5664
E-mail:	caesupport.us@lmsintl.com

II REFERENCE MATERIALS

1. LMS software usage documentation

III COURSE GOALS AND OBJECTIVES

1. Introduce the basic theory of Boundary Element Methods (BEM) and Finite Element Methods (FEM)
2. Introduce the Fast Multi-Pole BEM, Perfectly Matched Layer (PML) and ATV methods
3. Ready a mesh for an acoustical simulation
4. Set up an analysis for interior/exterior acoustics
5. Calculate and visualize noise radiation
6. Introduce some advanced acoustic methods

IV METHODOLOGY

This course will demonstrate how to simulate interior, exterior and coupled acoustical cases using various methods like Finite Elements (FEM), Boundary Element (BEM) and ATV solvers and how to prepare a mesh for the acoustical simulation. Each module will introduce new materials that the student will be allowed to experience for himself with the associate In-class Tutorials.

Lectures

Each detailed subject will be presented in a lecture format outlining the theory and standardized accepted methodology. A printed copy of the lecture material will be provided for the student's personal in-class use and as a reference material.

Specific Industry Examples

Real life examples will be covered that explain the application of the theory to various industries such as automotive, aerospace, home appliance. This will give the students a clear understanding of how and why these techniques are utilized in different industries and the value they add to acoustic enhancement.

In-Class Assignments

The student will conduct several hands-on tutorials to reinforce the theoretical concepts. These tutorials will increase in complexity as the students further develop their skills.

V COURSE OUTLINE & ASSIGNMENTS

Module 1 – An Introduction to the software interface

Software Infrustructure
Introduction to User Interface
In-class Tutorial – User Interface
In-class Tutorial – Mesh Grouping
In-class Tutorial – Mesh Mapping

Module 2 – Boundary Element Model (BEM) Application

Numerical Acoustics
Boundary Element conventional approach – The Equations
BEM Application
Fast Multi-pole Method (FMM) and Parallel computations
In-class Tutorial – Multiple Load Cases Analysis
In-class Tutorial – BEM Acoustics – Sound Radiation of a Valve-cover
In-class Tutorial – Sound Power Calculation of a Refrigerator Compressor
In-class Tutorial – Transmission Loss of a Perforated Muffler
In-class Tutorial – Sound Radiation of a Turbocharger using FMM

Module 3 – Finite Element Model (FEM) Application

Finite Element Approach – The Equations
FEM application
Fast Trim Applications
Perfectly matched layer (PML)
In-class – Tutorial – Cavity Modes in a Compressor
In-class – Tutorial – Sound Radiation of a Turbocharger using PML
In-class – Tutorial – Transmission Loss of a Perforated Muffler
In-class – Tutorial – Air Intake Manifold
In-class – Tutorial – Trim modeling of a Car interior

Module 4 – ATV, PACA BEM and MACA BEM Applications

Acoustic Transfer Function (ATV) Application
Panel Contribution Analysis (PACA) BEM Application
MACA BEM Application
Equations and Application
In-class Tutorial – BEM PACA Analysis of a Full Vehicle
In-class Tutorial – Engine Acoustic Radiation on V6 with MATV
In-class Tutorial – FEM PACA Analysis of a Car Interior
In-class Tutorial – BEM ATV FRF Synthesis

Module 5 - Coupled Vibro-acoustic Analysis

- Coupled Vibro-acoustic Theory – The Equations
- Coupled Model Application
- In-class Tutorial – BEM Coupled Harmonic – Loudspeakers
- In-class Tutorial – BEM/FEM Coupled – Full Vehicle
- In-class Tutorial – BEM Transmission Loss Analysis of a Dash Board
- In-class Tutorial – FEM Fast Trim

Module 6 – Pre-Acoustics Analysis

- Introduction to Pre-Acoustics
- Mesh Coarsening
- Cavity Meshing
- In-class Tutorial – Mesh Coarsening of a V6 Engine
- In-class Tutorial – Cavity Meshing

Module 7 – Aero-Acoustics

- Distributed Dipoles
- Distributed Quadrupoles
- Fan Sources
- Lighthill Stress Tensor Analysis
- CGNS Import
- Dipole Condensation
- Conservative Mapping
- In-class Tutorial – Aero-acoustic Analysis of a Side Mirror
- In-class Tutorial – HVAC Aero-acoustic Analysis
- In-class Tutorial – Fan Noise Analysis

Module 8 – Random Acoustics

- Auto/cross Power Spectra
- Corcos Model
- Iterative SVD Solver
- Principal Component Analysis
- Modal based Random Post-Processing
- In-class Tutorial – PSD loading on Windshield
- In-class Tutorial – Wind noise analysis

Module 9 – MATV Sensitivity Analysis

- Nastran Sensitivity Analysis
- Modal Based Forced Response and Sensitivity
- MATV Response and Sensitivity Analysis
- In-class Tutorial – MATV Based Sensitivity Analysis of a Valve-cover

Module 10 – Inverse Numerical Acoustics

L-curve Regularization
Inverse Numerical Acoustics Solution
In-class Tutorial – Vibration prediction on a V6 Engine