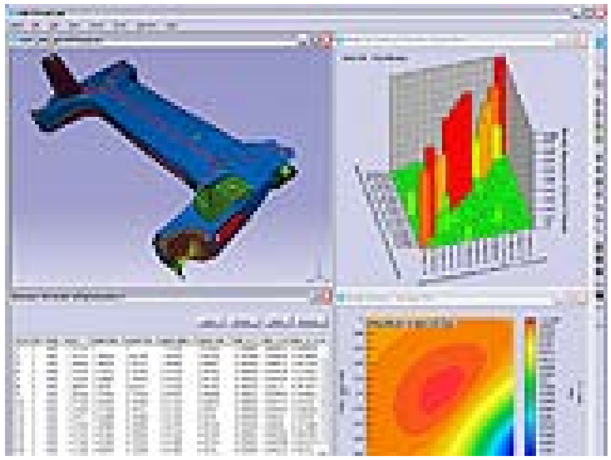
THE CENTER FOR
PROFESSIONAL STUDIES



Numerical Optimization Methods for Correlation and Updating

Today, many analysts wish to improve their structural dynamic models using measured experimental modal data. The first step in this process is to correlate the analytical and experimental models followed by sensitivity and updating processes.

This course is focused towards understanding the steps needed in order to perform a correlation study and introducing some techniques and methodologies for updating a finite element model using experimental data. It is intended for engineers working in the field of analytical and experimental modal analysis who have the need to correlate and update models.

- First, the basics of design of experiments, numerical optimization and design for six sigma methods. These methods will be used to setup a local or global numerical optimization problem and evaluate the optimization results.

- Next, participants will focus on the optimization methods learned will be applied to correlate and update a CAE model based on results of an experimental modal analysis.

- 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.

Course Syllabus

I IDENTIFYING INFORMATION

Course: Numerical Optimization Methods for Correlation and Updating
Prerequisites: Computer Aided Engineering (CAE), Experimental Modal Analysis
Time Frame: 40 total contact hours
Instructor: A technical specialist with LMS International
BS in Mechanical Engineering
5 years of experience with LMS software and hardware
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. Receive an introduction to design of experiments, numerical optimization and design for six sigma methods.
2. At the conclusion of the class, you will be able to use Optimus to define and execute an Analysis Flow chart, select the appropriate Design of Experiment and Response Surface Method, analyze Response Surface Models, setup a local or global numerical optimization problem and evaluate the optimization results as well as check the robustness of your design.
3. Present in detail the different methodologies available for correlating a CAE model to an experimental modal analysis.
4. Understand the sensitivity of your mode shapes and frequencies to the design inputs and update the CAE model using this understanding and the optimization methods introduced in this course.

IV METHODOLOGY

This course is an introduction to different design of experiments, numerical optimization and design for six sigma methods. These methods are then used in to correlate and update a finite element model using results from an experimental modal analysis. Each module will introduce new material 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 the improvement of the CAE model.

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 Optimization

Introduction to Optimization
Design Inputs and Outputs
Process Integration
In-class Tutorial – Process Integration

Module 2 – Design of Experiments

Theoretical Background
Terminology
Objectives
The Different Designs
Defining a DOE
In-class Tutorial – Design of Experiments

Module 3 – Response Surface Modeling

Theoretical Background
Overview of Response Surface Models
In-class Tutorial – Response Surface Modeling

Module 4 – Optimization Methods

Concepts
Gradient Based
Evolution Based
Discrete Optimization
Random Optimization
User Define Optimization
Defining an Optimization
In-class Tutorial – Optimization

Module 5 – Design for Six Sigma – Robustness & Reliability

Robustness
Reliability
Monte Carlo Analysis
First Order Second Moment (FOSM)
First Order and Second Order Reliability Method (FORM / SORM)
In-class Tutorial – Robustness & Reliability

Module 6 – Task List

Task List Definition
Executing multiple Design of Experiments, Optimization and design for Six Sigma methods as a Single Process
In-class Tutorial – Task list

Module 7 – Introduction to Correlation

Correlation Concepts
Inherent Problems
Driving MSC NASTRAN
In-class Tutorial – Basic Concepts
In-class Tutorial – MSC NASTRAN Normal Modes Solution

Module 8 – Pre-Test Techniques: Using CAE modes to Improve Experimental Modal Analysis Results

Selecting an initial node set for an experimental modal analysis
Maximum Off-Diagonal Modal Assurance Criterion (MODMAC)
Driving Point Residues
Export final geometry for experimental modal analysis
In-class Tutorial – Pre-Test

Module 9 – Correlation Methods

Geometric Correlation
Modal Assurance Criterion (MAC)
MAC Contribution
Orthogonality
MAC Sensitivity
FRF Assurance Criterion (FRAC)
In-class Tutorial – Correlation

Module 10 – Sensitivity and Updating

Sensitivity Analysis via NASTRAN solution 200
Updating via optimization techniques
In-class Tutorial – Sensitivity
In-class Tutorial – Correlation and Updating
In-class Tutorial – Correlation Review