COE CST Third Annual Technical Meeting: Nonlinear Structural Models Task 293

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and
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Overview

- Team Members
- Task Objective
- Research Methodology
- Results to Date
- Next Steps
- Contact Information

Team Members

- **PIs:** Dr. A. Keith Miller, Associate Professor of Mechanical Engineering, NMT

  Dr. Warren Ostergren, Associate Professor & Chair of Mechanical Engineering, NMT
- **Students**: Mr. Joshua Mendoza, MS MENG (May 2013), Mr. Lance Hernandez, BS MENG (May 2014)
- **Research Partners:** Sandia National Laboratories
- **Industry Partners:** United Launch Alliance, Ball Aerospace

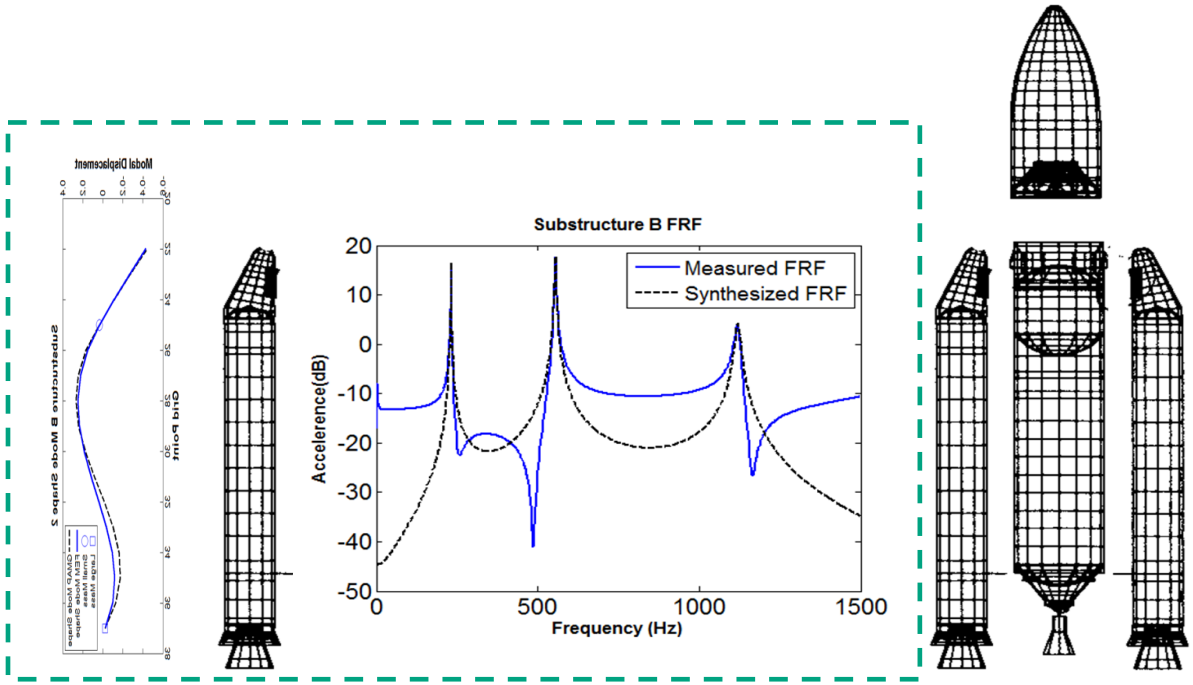
Task Objective

Develop computational tools that improve the capability to determine the performance and safety margins of commercial space vehicles. The focus is to construct non-linear system-level models. The models are constructed by computationally combining reduced-order finite element models of substructure components directly with experimentally-derived modal substructure components.

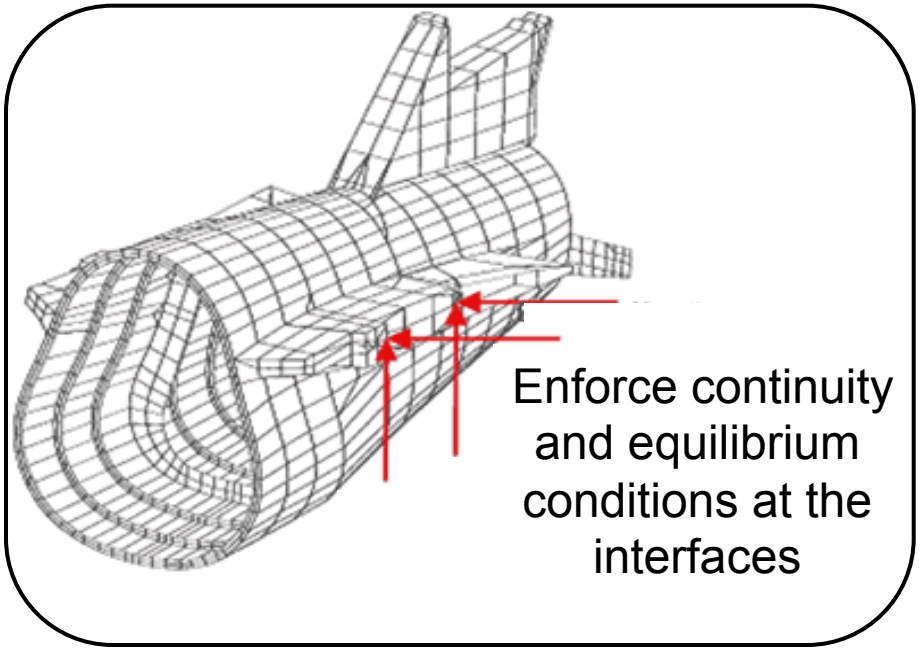
SUBSTRUCTURING

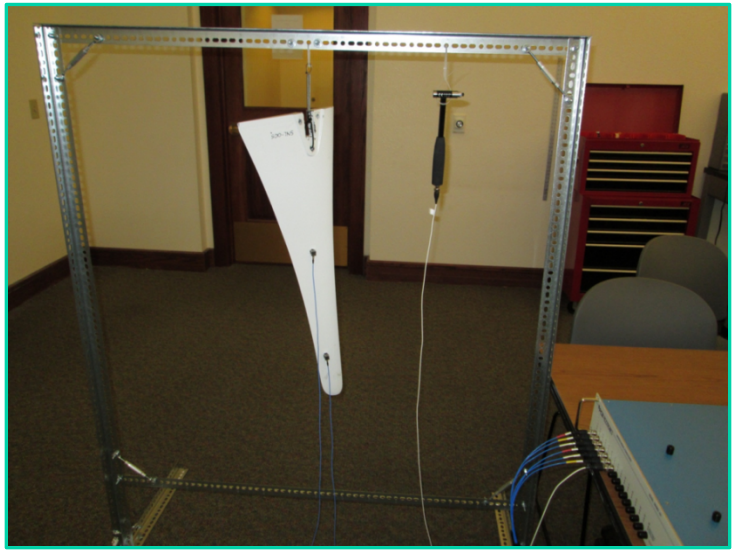
Research Methodology

Develop system-level non-linear structural dynamic models by computationally coupling FEA and experimentally derived components.



Produce reduced-order models of each substructure

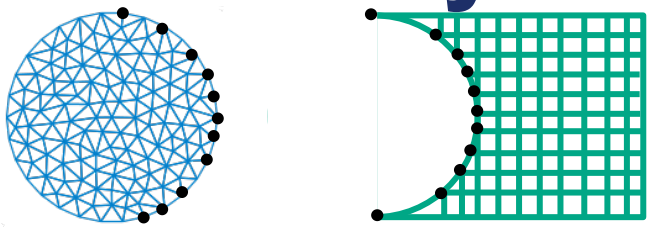




Fixed interface FEA "testing"

Free interface modal "analysis"

Static Augmentation Modes for Improved Accuracy



$$[\mathbf{T}]_1 = [\mathbf{\Phi}]_k + [\mathbf{\Phi}]_{static} = \begin{bmatrix} \phi_{11} & \cdots & \phi_{1k} \\ \phi_{21} & \cdots & \phi_{2k} \\ \vdots & \ddots & \vdots \\ \phi_{n-11} & \cdots & \phi_{n-1k} \\ \phi_{n1} & \vdots & \phi_{nk} \end{bmatrix} + \begin{bmatrix} g_{11} & g_{12} & \cdots & g_{1b} \\ g_{21} & g_{22} & \cdots & g_{2b} \\ \vdots & \vdots & \ddots & \vdots \\ g_{n-11} & g_{n-12} & \cdots & g_{n-1b} \\ g_{n1} & g_{n2} & \cdots & g_{nb} \end{bmatrix}_{static}$$

Fixed Interface Boundary Nodes

- Constraint Modes
  Craig-Bampton
- Attachment Modes
  MacNeil-Coppolino

Free Interface Boundary Nodes

- Inertia-Relief Modes
  Benfield-Hruda
- Residual Modes
  Martinez-Miller-Carne

Results to Date

Developed Matlab™ based modal parameter extraction algorithms based on rational fraction polynomials and global RFP Method

Presented at 1st IMAC Conference, Orlando, FL — November, 1982

PARAMETER ESTIMATION FROM FREQUENCY RESPONSE MEASUREMENTS USING RATIONAL FRACTION POLYNOMIALS

Mark H. Richardson & David L. Formenti
Structural Measurement Systems, Inc.
San Jose, California

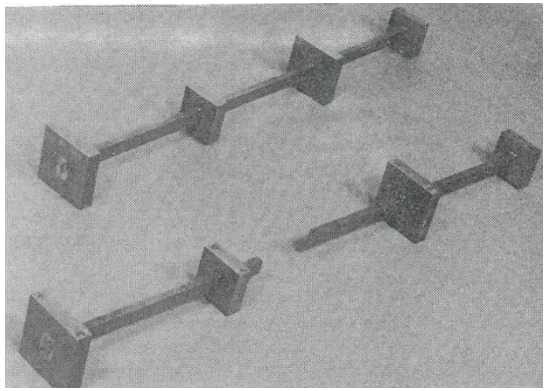
Presented at 3RD IMAC Conference, Orlando, FL — January, 1985

Global Curve Fitting of Frequency Response Measurements using the Rational Fraction Polynomial Method

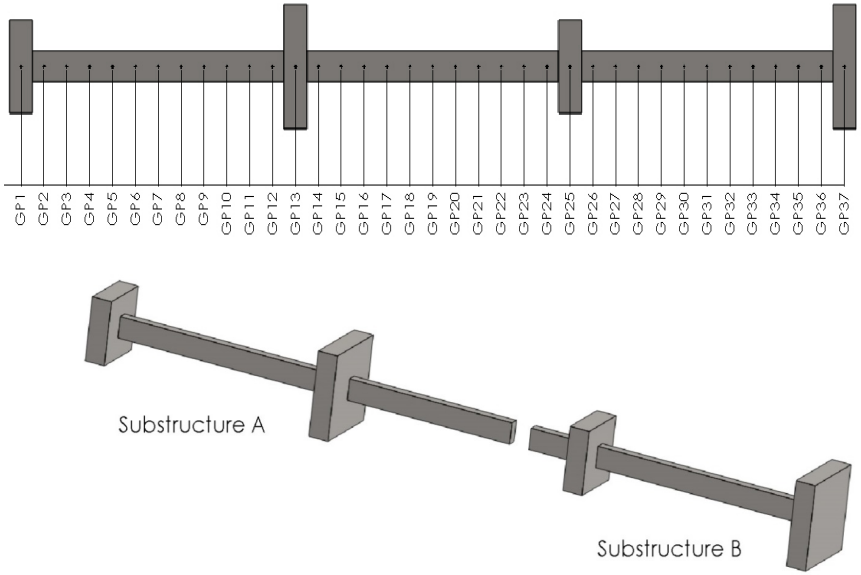
by
Mark H. Richardson and David L. Formenti
Structural Measurement Systems
San Jose, California

Method yields either real, normal modal data or complex modal data

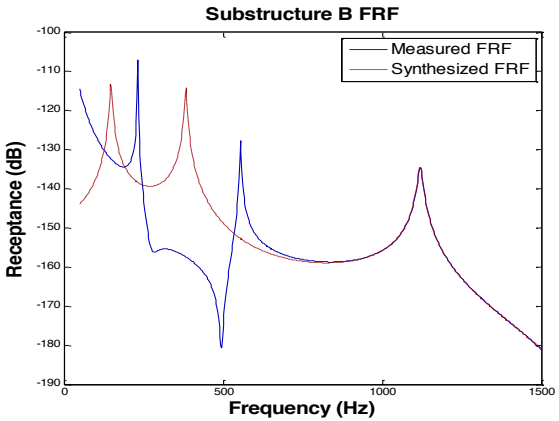
Results to Date



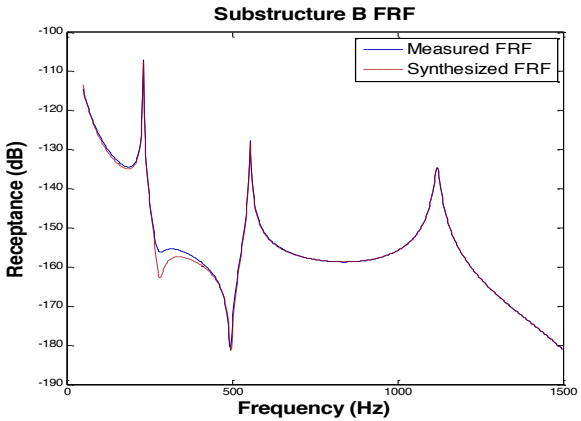
Muli-component test beam



Codes written by Josh Mendoza, 2012 - 2013

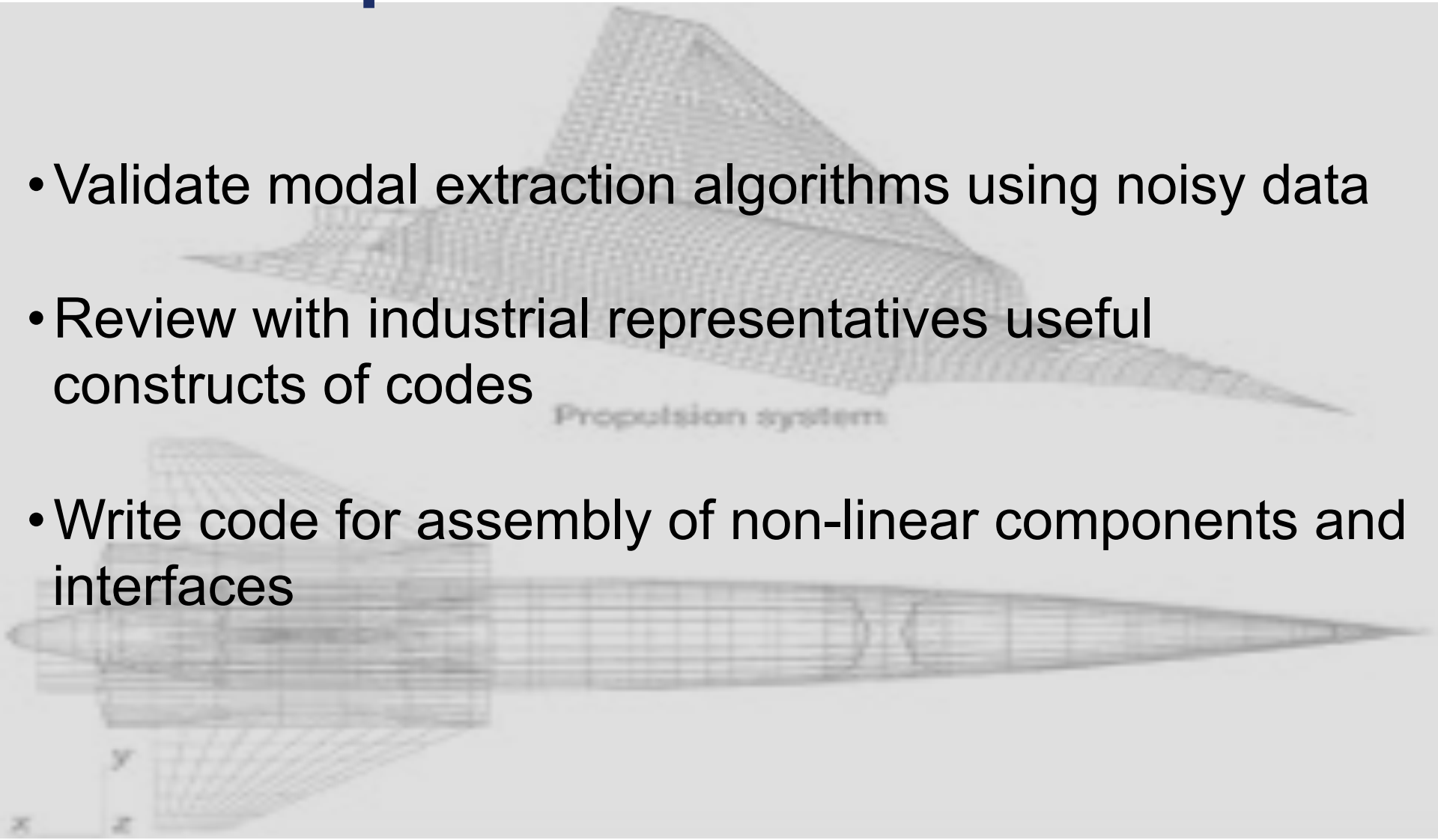


FRF Fitting with zero computational modes



FRF Fitting with two computational modes

Next Steps:



- Validate modal extraction algorithms using noisy data
- Review with industrial representatives useful constructs of codes
- Write code for assembly of non-linear components and interfaces

Contact Information

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