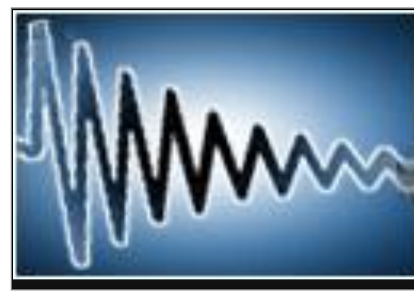
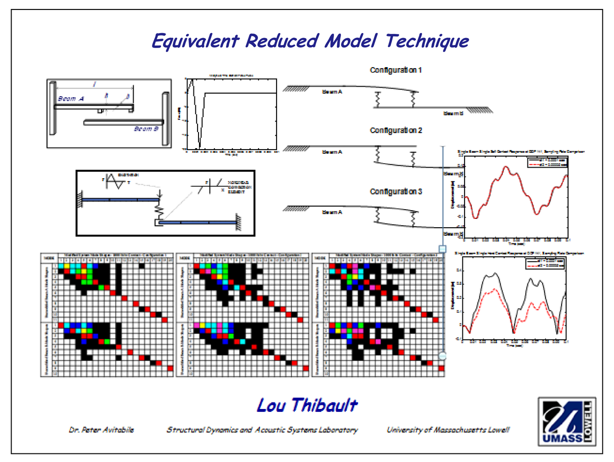


Structural Dynamics and Acoustic Systems Laboratory
University of Massachusetts Lowell

SOME RECENT STUDENT THESIS/RESEARCH/PROJECT WORK IN THE SDASL

MASTER'S RESEARCH - LOU THIBAULT

EQUIVALENT REDUCED MODEL TECHNIQUE DEVELOPMENT FOR NONLNEAR SYSTEM DYNAMIC RESPONSE



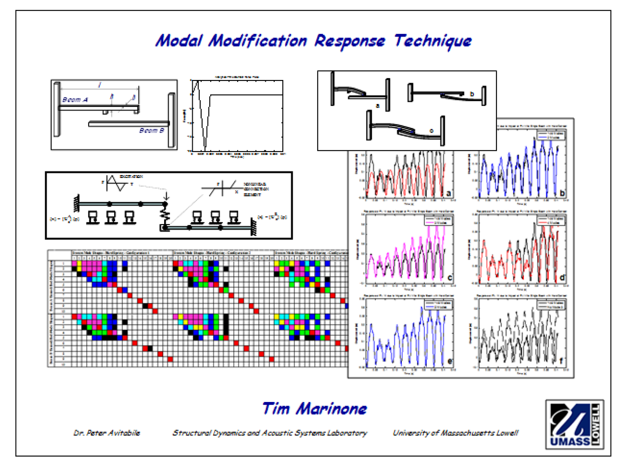
ABSTRACT

The dynamic response of structural systems commonly involves nonlinear effects. Often times, structural systems are made up of several components, whose individual behavior is essentially linear compared to the total assembled system. However, the assembly of linear components using highly nonlinear connection elements or contact regions causes the entire system to become nonlinear. Conventional transient nonlinear integration of the equations of motion can be extremely computationally intensive, especially when the finite element models describing the components are very large and detailed.

In this work, the Equivalent Reduced Model Technique (ERMT) is developed to address complicated nonlinear contact problems. ERMT utilizes a highly accurate model reduction scheme, the System Equivalent Reduction Expansion Process (SEREP). Extremely reduced order models that provide dynamic characteristics of linear components, which are interconnected with highly nonlinear connection elements, are formulated with SEREP for the dynamic response evaluation using direct integration techniques. The full space solution will be compared to the response obtained using drastically reduced models to make evident the usefulness of the technique for a variety of analytical cases.

MASTER'S RESEARCH - TIM MARINONE

MODAL MODIFICATION RESPONSE TECHNIQUE DEVELOPMENT FOR NONLNEAR SYSTEM DYNAMIC RESPONSE



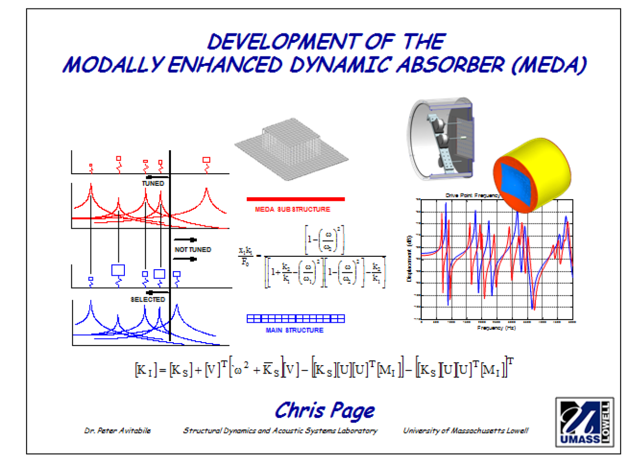
ABSTRACT

Generally, structural systems contain nonlinear characteristics in many cases. These nonlinear systems require significant computational resources for solution of the equations of motion. Much of the model, however, is linear where the nonlinearity results from discrete local elements connecting different components together. Using a component mode synthesis approach, a nonlinear model can be developed by interconnecting these linear components with highly nonlinear connection elements.

The approach presented in this work, the Modal Modification Response Technique (MMRT), is a very efficient technique that has been created to address this specific class of nonlinear problem. By utilizing a Structural Dynamics Modification (SDM) approach in conjunction with mode superposition, a significantly smaller set of matrices are required for use in the direct integration of the equations of motion. The approach will be compared to traditional analytical approaches to make evident the usefulness of the technique for a variety of test cases.

MASTER'S THESIS - CHRIS PAGE

MODALLY ENHANCED DYNAMIC ABSORBER - MEDA



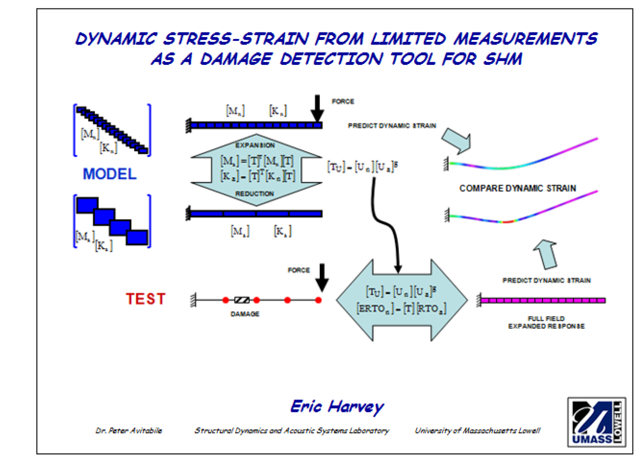
ABSTRACT

Often structure borne noise has a deleterious effect on both the performance and aesthetics of many commercial and military systems. Noise issues can be dealt with many ways through the incorporation of active, semi-active and passive solutions. A common passive approach to solving structural vibration problems is to use a tuned vibration absorber. Tuned absorbers are generally used to affect a single undesirable resonance at a time. In order to affect multiple resonances multiple tuned absorbers are typically required, causing the design and implementation to be prohibitively difficult.

This paper develops the concept of a Modally Enhanced Dynamic Absorber (MEDA) that can be used for the suppression of multiple structural resonances. The MEDA is an auxiliary substructure designed to achieve a multi-resonance tuned absorber effect. Modal characteristics derived from a primary structure are used as design targets for the MEDA substructure. Preliminary analytical studies have been undertaken to demonstrate the MEDA concept on simple structures. The results show that the MEDA concept is a viable approach to detune multiple modes simultaneously.

MASTER'S THESIS - ERIC HARVEY

DYNAMIC STRAIN DETERMINATION FROM LIMITED MEASUREMENTS FOR STRUCTURAL HEALTH MONITORING APPLICATIONS



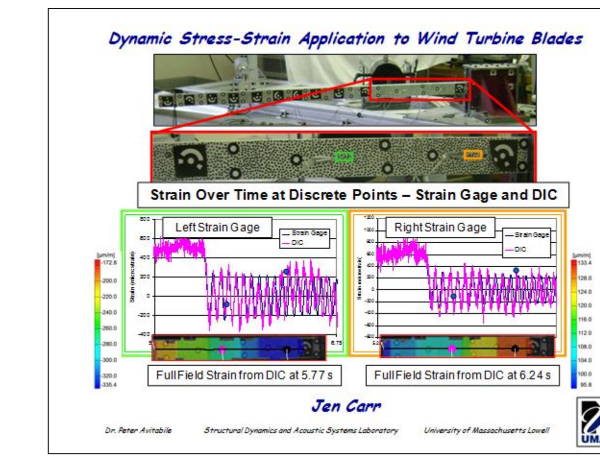
ABSTRACT

Complex composite structures, that are subjected to appreciable externally induced loading, will fatigue and fail over time. For many structures, imminent failure and loss of structural integrity is not externally apparent. Typical failure occurs at the interfaces between the structure's surface and internal ribs or stiffening members. Conventional approaches for proper validation of full-scale exterior dynamic behavior of numerical models require a significant number of measurement points; unfortunately, interior dynamic response due to time-varying loads is not currently predictable from measured data.

The current research focuses on the global and local interior and exterior member dynamic interactions to understand the possible loss of structural integrity and fatigue failure of complex composite structures. Using some newly developed dynamic stress-strain modeling approaches from limited sets of measured locations, identification of stress-strain distributions will be used as a damage detection tool for structural health monitoring assessment.

MASTER'S THESIS - JENNIFER CARR

DYNAMIC STRESS-STRAIN PREDICTION FROM MEASURED DATA FOR WIND TURBINE APPLICATIONS



ABSTRACT

Often times, wind turbine blades are subjected to static and dynamic testing to identify the performance levels that can be achieved for a particular configuration. Many times only a handful of strain gages are deployed to capture that information.

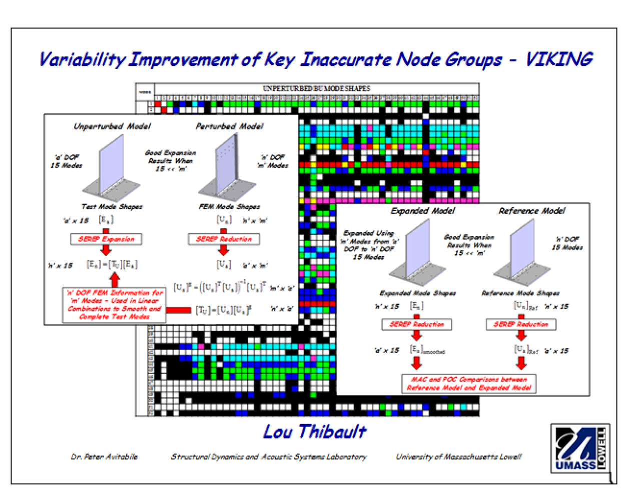
The first part presents the static strain measurements and calibration of the system overall. The strain distribution obtained by using digital image correlation (DIC) along the length of the beam is compared to discrete strain gage measurements and with a finite element model. The second part presents DIC techniques to identify the full-field stress-strain on the turbine blade during dynamic testing. Comparison of the full-field stress-strain and the conventional strain gages are presented to show the usefulness of the image correlation approaches.

Hardware and software tools employed

MATLAB · Polytec · Spectral Dynamics · The Modal Shop Inc. · FEMAP · LMS · PCB PIEZOTRONICS · FEMtools · Vibrant Technology, Inc. · Trilion Optical Test Systems

VIKING - LOU THIBAULT

Variability Improvement of Key Inaccurate Node Groups



ABSTRACT

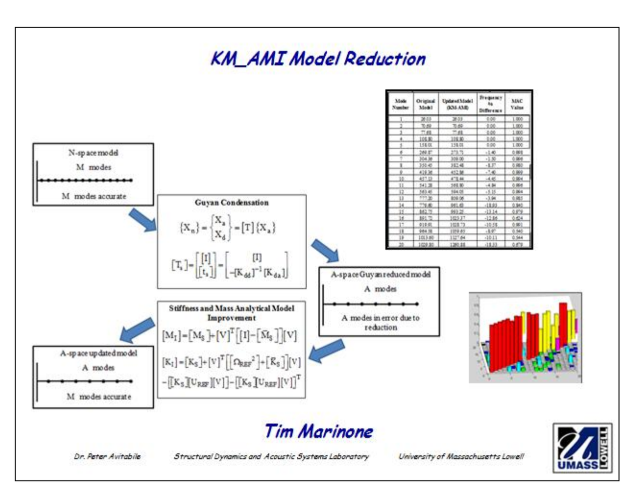
Expansion processes have been used for modal correction studies for some time now. In general, the expansion process was believed to be most accurate when there was a fairly good correlation between the analytical and experimental mode for which expansion was to be performed. If the correlation was not reasonably good then the expansion process would be tainted by the lack of adequate correlation. In essence this is similar to any least squares minimization approach that is used to expand and complete data.

However, some recent work suggests that using many shape expansion functions simultaneously may have some merit as an expansion process. Using many shapes simultaneously is a very good alternate approach and overcomes the requirement of having well correlated modes for the expansion process.

As such, a new approach for expansion called the Variability Improvement of Key Inaccurate Node Groups (VIKING) has been developed and used in a variety of applications including expansion of measured data sets. The basis of the approach is described in this work. Several test cases are studied to show the usefulness of the technique in a variety of applications.

KM_AMI MODEL REDUCTION - TIM MARINONE

Development of a new reduced order model approach



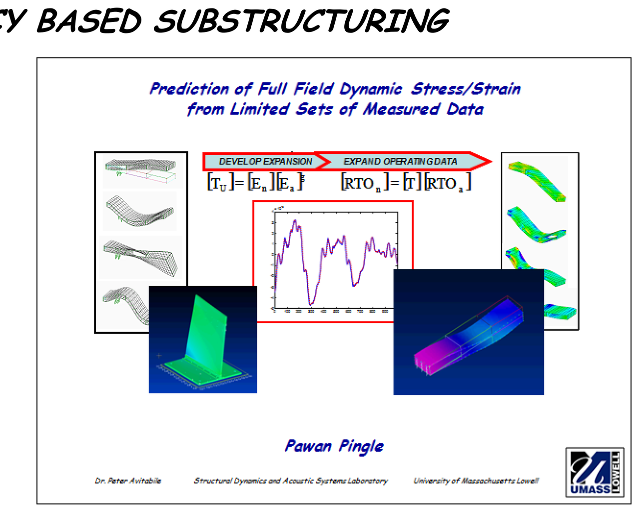
ABSTRACT

Model reduction has been performed for several decades as an approach to allow for correlation of an analytical model to experimental data at a reduced number of points. Traditional reduction techniques have utilized static equations in order to obtain the transformation matrix while more recent techniques have utilized the mode shapes of the model.

This work presents an alternate methodology to model reduction using a traditional reduction technique to reduce the model and then improving the reduced model with the model mode shapes and frequencies from the full space finite element model. An analytical study on a cantilevered beam and general plate type structure shows that this approach contains advantages from both types of reduction techniques while minimizing the limitations.

PHD DISSERTATION - PAWAN PINGLE

INVESTIGATION ON EXPERIMENTAL ISSUES RELATED TO FREQUENCY RESPONSE FUNCTION MEASUREMENTS FOR FREQUENCY BASED SUBSTRUCTURING



ABSTRACT

Dynamic stress-strain predictions are important to determine the overall fatigue usage of structures. Usually finite element models are developed along with some estimation or approximation of the actual loading conditions that are often difficult to identify or predict rendering these models to have questionable accuracy.

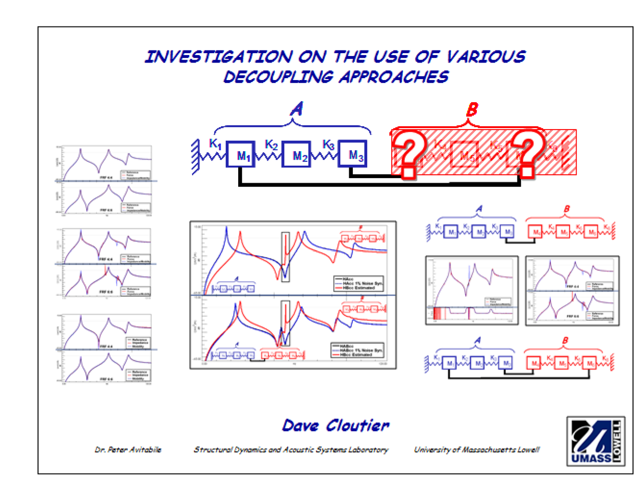
A dynamic expansion technique in conjunction with the finite element model of the system has been successfully applied using limited sets of measured data that enable the prediction of the full field dynamic stress-strain. The measured data is expanded throughout the full field and then used in the finite element stress recovery process to predict dynamic stress-strain due to dynamic events. The solution procedure does not require the identification of loads or boundary conditions which is often the hardest part of the conventional approaches used.

Both analytical simulations of measured data and actual measured data are used to demonstrate the proposed approach. The cases studied show very good results overall.

The technique provides a significant departure from the conventional approach and provides accurate data for the identification of full field dynamic stress-strain.

MASTER'S THESIS - DAVE CLOUTIER

INVESTIGATION OF VARIOUS SYSTEM MODEL DECOUPLING TECHNIQUES



ABSTRACT

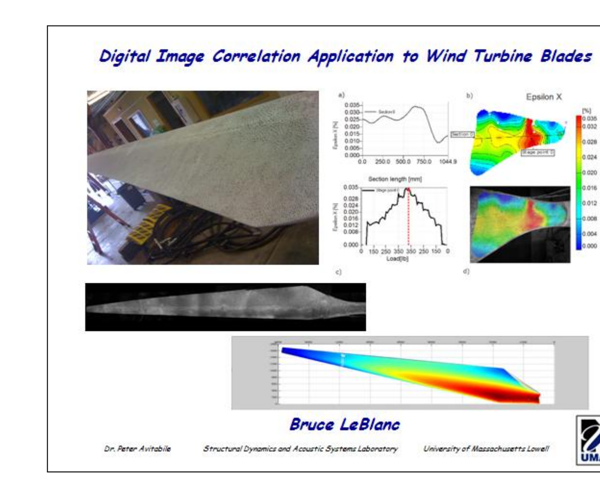
Substructuring assembly methods along with component decoupling methodologies allow for detailed assessment of structural systems. Substructure assembly methods have been used for many years and are more thoroughly understood. However, component disassembly techniques are relatively newer and are currently the focus of much research.

Component information is important for the understanding of cascaded system characteristics. Often times a system response needs to be improved through the modification or replacement of one or more component representations. When these individual components are unknown, system decoupling approaches can be implemented to identify component characteristics from system response.

System decoupling can be performed in several ways. Several approaches are considered for the evaluation of component decoupling from the system using frequency response functions. While several techniques currently exist, an alternate technique is presented in this work which decouples using the force required to constrain two components of a system. This technique is compared to the Mobility, Impedance, and Inverse Frequency Based Substructuring and several models are studied to better understand the strengths and weaknesses of each of the techniques. Several issues related to noise, truncation, and rotational DOF are addressed on analytical and experimental structures; however, further work is recommended on revised test structure.

MASTER'S THESIS - BRUCE LEBLANC

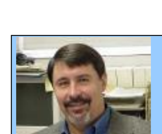
NON DESTRUCTIVE INSPECTION OF WIND TURBINE BLADES WITH 3D DIGITAL IMAGE CORRELATION



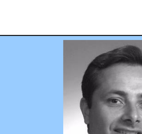
Sandia National Laboratories · NREL National Renewable Energy Laboratory · tpi

ABSTRACT

Growing demand and deployment of wind power has led to a significant increase in the number of wind-turbine blades manufactured globally. As the physical size and number of turbines deployed grows, the probability of manufacturing defects being present in composite turbine blade fleets also increases. As both capital blade costs and operational and maintenance costs increase for larger turbine systems, the need for large-scale inspection and monitoring of the state of structural health of turbine blades during manufacturing and operation increases. One method for locating and quantifying manufacturing defects, while also allowing for the in-situ measurement of the structural health of blades, is three-dimensional digital image correlation (3D DIC). Several tests were performed on composite coupon specimens, including quasi-static and fatigue, to demonstrate the ability of the technique to measure strain and detect manufacturing defects in a non-destructive way. A nine-meter CX-100 composite turbine blade platform was used to extract full-field displacement and strain measurements across an entire blade surface using 3D DIC in order to identify defects within the blade. Post-processing of the data using a stitching technique enables the shape and curvature of the entire blade to be observed for a large-scale wind turbine blade. The overall results indicate the measurement approach can clearly identify failure locations, discontinuities in the blade curvature under load, and manufacturing defects, therefore demonstrating the great potential of the optical measurement technique and its capability for use in the wind industry for large-area inspection.



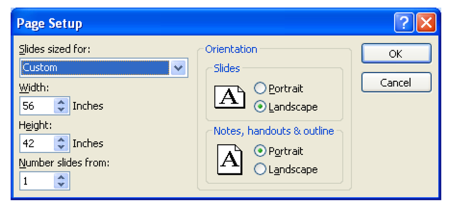
Structural Dynamics and Acoustic Systems Laboratory



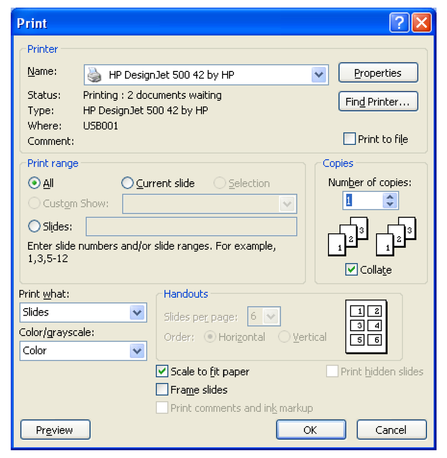
Dr. Peter Avitabile 978-934-3176 *peter_avitabile@uml.edu*

http://sdasl.uml.edu/

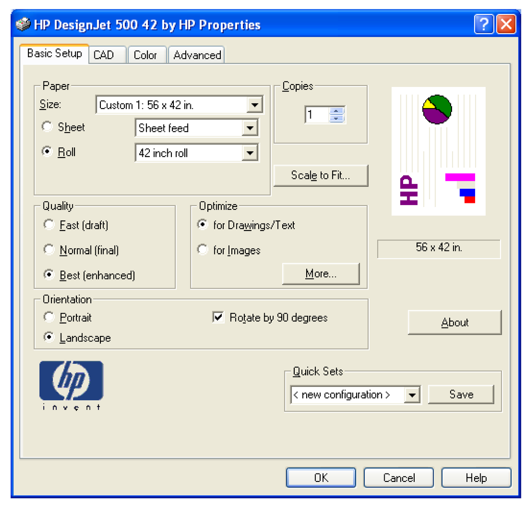
Dr. Chris Niezrecki 978-934-2963 *christopher_niezrecki@uml.edu*



Page setup – 56 x 42 (width of roll paper)



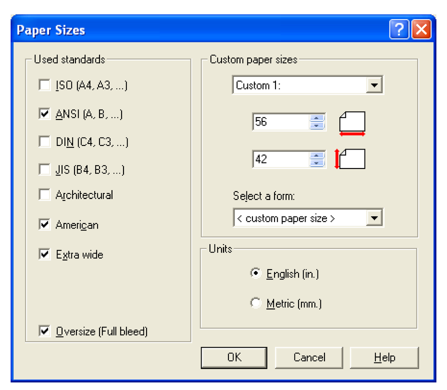
HP designjet 500 42



Properties

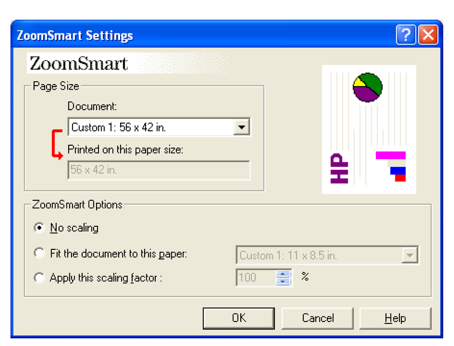
Set up custom 56x42 inch size

Set Landscape and Rotate by 90 degrees



Select <edit paper list>

Enter size 56x42 as shown



Scale to Fit

Select Custom 56x42