ASME
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## 2nd Annual

WRIGHT STATE UNIVERSITY

# Dayton Engineering Sciences Symposium

*October 30, 2006*
*Wright State University*
*Student Union*
*Dayton, OH*

Photograph Courtesy of the WSU High Altitude Balloon Team, 2006

# WELCOME

On behalf of the Organizing Committee, we would like to welcome you to the 2nd Annual Dayton Engineering Sciences Symposium (DESS). Sponsored by the Dayton Section of ASME, the symposium is intended to facilitate communication between members of the regional technical community, and to provide a forum for sharpening technical presentation skills among students, engineers, and scientists.

This year's symposium features 102 presentations, divided among 19 technical sessions spanning a broad range of engineering sciences. In addition to scientific research, the symposium includes special sessions on both Undergraduate Projects and Engineering Education, as well as significant participation from local industry. The symposium will feature Dr. Bor Jang, Dean of the College of Engineering and Computer Science at Wright State University, as its distinguished keynote speaker.

We hope that this symposium will serve to encourage increased participation and cooperation within the Dayton region's professional and student communities. Its success would not have been possible without all of your participation: speakers, session chairs, students, faculty, government and industry representatives, organizing committee, and the ASME Dayton Section Executive Board.

**Nathan Klingbeil and Sivaram Gogineni**
*General Chair and Co-Chair*

## Organizing Committee

**Tim Leger**, Conference Website and Registration Coordinator
**Ramana Grandhi and Mitch Wolff**, Session Chair Coordinators
**Todd Benanzer**, Conference Program Coordinator
**Alysoun Taylor**, Affiliation and Name Tag Coordinator
**Vincent Miller**, Financial Coordinator
**Ruth Sikorski and Alyson Turri**, AFRL Representatives
**Bob Canfield**, AFIT Representative
**Margie Pinnell**, UD Representative
**Bob Chasnov**, Cedarville Representative
**Stephen Balek**, President, ASME Executive Board

## SCHEDULE AT A GLANCE

**Morning:**
Registration and Continental Breakfast: 8:15-9:00 AM

Structures and Solid Mechanics I: 9:00-11:00, E156A
Aerospace Propulsion and Control: 9:00-11:00, E156B
Fluid Mechanics/CFD I: 9:00-11:00, E156C
Design & Optimization I: 9:00-11:00, E157
Heat Transfer and Thermal Sciences: 9:00-11:00, E163A
Industrial and Human Factors I: 9:00-11:00, E163B

Break: 11:00-11:20

**Keynote Address:** 11:20-12:00, Apollo Room

**Lunch:** 12:00-1:00, Apollo Room

**Afternoon:**
Structures and Solid Mechanics II: 1:00-3:00, E156A
Materials I: 1:00-3:00, E156B
Fluid Mechanics/CFD II: 1:00-3:00, E156C
Design & Optimization II: 1:00-3:00 PM, E157
Undergraduate Projects: 1:00-3:00 PM, E163A
Industrial and Human Factors II: 1:00-3:00 PM, E163B

Break: 3:00-3:20

Engineering Education: 3:20-5:00 PM, E156A
Materials II: 3:20-4:40, E156B
Computer Science: 3:20-5:00 PM, E156C
Design & Optimization III: 3:20-4:40 PM, E157
Biomedical Engineering: 3:20-5:20 PM, E163A
Industrial and Human Factors III: 3:20-4:00 PM, E163B
Electronics and Sensors: 4:00-5:20 PM, E163B

# TECHNICAL PROGRAM

## Structures and Solid Mechanics I: 9:00-11:00 AM Room E156A
**Chair:** Rebecca Hoffman, ABAQUS, Inc.

**9:00-9:20**
Vanessa Bond, "Wind Tunnel Testing of Twisted Wing for Longitudinal Control in a Joined Wing Aircraft," Air Force Institute of Technology

**9:20-9:40**
Craig Baudendistel, "Validation of a Dissipated Energy Theory for Fatigue Crack Growth Under Mixed-Mode Loading," Wright State University

**9:40-10:00**
Oleg Shiryayev, "Improved Structural Health Monitoring Using the Randomdec Signatures," Wright State University

**10:00-10:20**
Arif Malik, "Validating a New Approximate Model for Rolling Mill Deflection and Strip Thickness Profile," Wright State University

**10:20-10:40**
Enrique Medina, "Evaluation of a Distributed Sensing System with Simple Bending Beams," Ohio University

**10:40-11:00**
Anusha Anisetti, "Suppressing Structural Response using Piezoelectric Patches," Wright State University

## Aerospace Propulsion and Control: 9:00-11:00 AM Room E156B
**Chair:** Fred Schauer, AFRL/PRTC

**9:00-9:20**
Timothy Helfrich, "Comparison of Fuels for Use in a Pulsed Detonation Engine," Air Force Research Laboratory

**9:20-9:40**
Timothy Helfrich, "Use of Nitromethane to Augment Thrust on a Pulsed Detonation Engine," Air Force Research Laboratory

**9:40-10:00**
Oleg Shiryayev, "Power Extraction From Turbine Engines - Numerical Simulations," Wright State University

**10:00-10:20**
Michael Corbett, “Analysis of Transient Turbine Engine Electrical Power Extraction Using Hardware in the Loop,” PC Krause and Associates, Inc.

**10:20-10:40**
Tony Adami, “Flight Control of Hypersonic Scramjet Vehicles Using a Differential Algebraic Approach,”Ohio University

**10:40-11:00**
Christopher Corbin, “Dynamic Turbine Engine Modeling For Real Time Experimental Investigations,” Wright State University

## <u>Fluid Mechanics/CFD I</u>: 9:00-11:00 AM Room E156C
**Chair:** Kevin Klasing, GE-Aviation

**9:00-9:20**
Roger Kimmel, “FRESH FX Flight 1 Boundary Layer Transition Experiment Design,” Air Force Research Laboratory

**9:20-9:40**
Ryan Schmit, “PIV Seeding Techniques in Large Scale Open Loop Wind Tunnel Facilities,” Air Force Research Laboratory

**9:40-10:00**
Nathan Woods, “Phase Locked Investigation of Separation Control in Low Pressure Turbine Using Pulsed Vortex Generator Jets,” Air Force Research Laboratory

**10:00-10:20**
Cody Rasmussen, “The Least Squares Finite Element Method Applied to Fluid-Structure Interaction Problems,” Air Force Institute of Technology

**10:20-10:40**
Scott Stanfield, “Spatially Resolved Temperatures of a Dielectric Barrier Discharge Using Spectroscopy,” Wright State University

**10:40-11:00**
Veera Venkata Sunil Kumar Vytla, “The Mine Face Ventilation: A Comparison of CFD results against the bench mark experiments for the CFD code validation,” Wright State University

## <u>Design & Optimization I</u>: 9:00-11:00 AM Room E157
**Chair:** Harini Shankar, Delphi

**9:00-9:20**
Darren Holland, “Optimal Tracking Control for a Two Disk Rotating System,” University of Michigan

**9:20-9:40**
Karleine Justice, “Modeling and Simulation of a Micro Turbine Generator to be Coupled with a MCFC for Distributed Generation,” Wright State University

**9:40-10:00**
Hemanth Amarchinta, “Multiattribute Optimization based on Conjoint Analysis,” Wright State University

**10:00-10:20**
Rafael Aleman, “Application of Vehicle Routing and Multiperiod Assignment Problem to UAV Planning,” Wright State University

**10:20-10:40**
Chaitr Hiremath, “Knapsack Problems – Empirical Study and Test Problem Generation,” Wright State University

**10:40-11:00**
Gulshan Singh, “Reliability Based Design, Modelling and Analysis of Unmanned Undersea Vehicle,” Wright State University

## <u>Heat Transfer and Thermal Sciences</u>: 9:00-11:00 AM Room E163A
**Chair:** Kevin Hallinan, University of Dayton

**9:00-9:20**
Hong Yan, “Control of High-Speed Aerodynamic Interaction by Pulsed Energy Deposition,” Wright State University

**9:20-9:40**
Shadab Shaikh, “Thermal Conductivity Improvement in Carbon Nanoparticle Doped PAO-Oil: An Experimental and Theoretical Study,” University of Dayton

**9:40-10:00**
Carlos Gutierrez, “Dynamic Simulation of Turbine Engine Used with a Molten Carbonate Fuel Cell for Power Generation ,” Wright State University

**10:00-10:20**
Robin McCarty, “Experimental Verification of Source Temperature Modulation via a Thermal Switch in Thermoelectric Energy Harvesting,” Univeristy of Dayton

**10:20-10:40**
Sukesh Roy, “Femtosecond CARS Measurement of Gas-Phase Temperatures from Frequency-Spread Dephasing of the Raman Coherence,” Innovative Scientific Solutions, Inc.

**10:40-11:00**
Sukesh Roy, "Application of Electronic-Resonance-Enhanced Coherent Anti-Stokes Raman Scattering Spectroscopy for Minor Species Detection in Reacting Flows," Innovative Scientific Solutions, Inc.

## Industrial and Human Factors I: 9:00-11:00 AM Room E163B

**Chair:** Scott Fleming, AFRL/HEPA

**9:00-9:20**
Hrishikesh Karvir, "Power Spectrum Weighted Edge Analysis for Target Detection in Images," Wright State University

**9:20-9:40**
Christina Schrider, "Histogram-based Template Matching for Object Detection in Images with Varying Contrast," Wright State University

**9:40-10:00**
Mary Fendley, "Cognitive Biases and Heuristics in Human Decision Making in Complex, Dynamic Environments," Wright State University

**10:00-10:20**
Vikrant Chopra, "Agent-based modeling - A growing technique for modeling complex systems," Wright State University

**10:20-10:40**
Suman Niranjan, "Analysis for Base-Stock Levels in Multi-Echelon Inventory Systems with Random Capacity and Intermediary Product Demand," Wright State University

**10:40-11:00**
Sriram Mahadevan, "Visualization Methods and User Interface Design Guidelines for Rapid Decision Making in Multi-Task, Complex Environments," Wright State University

## Break: 11:00-11:20

## Keynote Address: 11:20 AM - 12:00 PM, Apollo Room

**Speaker:** Dr. Bor Jang
Dean, College of Engineering and Computer Science (CECS), Wright State University

"Engineering Education and Research in Dayton/Ohio: Challenges and Opportunities"

Speaker Bio: Dr. Bor Jang joined WSU as Dean of CECS in July of 2005. He had previously served as Chair of Mechanical Engineering at North Dakota State University, and as a distinguished faculty member at Auburn University. He is the author of more than 150 peer reviewed articles, and 63 patents issued or currently pending in the areas of nanotechnology and advanced materials development.

**<u>Lunch</u>: 12:00-1:00 PM, Apollo Room**

## <u>Structures and Solid Mechanics II</u>: 1:00-3:00 PM Room E156A
**Chair:** Doug Young, ABAQUS, Inc.

**1:00-1:20**
Steven Page, "Investigation into Bolted Joint Dynamics," Wright State University

**1:20-1:40**
Christine Esperanza, "Investigation of Vibrational Behavior Control Using Magneto-Rheological Fluids," Wright State University

**1:40-2:00**
James Rodriguez, "Integrated Stuctural Health Monitoring Systems," Air Force Institute of Technology

**2:00-2:20**
Reid Larson, "Analysis of Functionally Graded Circular Plates Subject to a Low-Velocity Impact Event," Air Force Institute of Technology

**2:20-2:40**
Inseok Park, "Analysis of Functionally Graded Plates with FEM," Wright State University

**2:40-3:00**
Mohammad Almajali, "Effect of Phase Difference Between Axial and Contact Loads on Fretting Fatigue Behavior of Titanium Alloy Ti-6Al-4V,"

## <u>Materials I</u>: 1:00-3:00 PM Room E156B
**Chair:** Tony Corvo, AVETeC

**1:00-1:20**
Emily Fehrman, "Optical Dispersion and Residual Stress of Sputtered Germanium Thin Films for IR Applications," University of Dayton

**1:20-1:40**
James Dahlman, "On the Oxidation Properties of CaBMGs," Air Force Research Laboratory

**1:40-2:00**
Nathan Klingbeil, "Effect of Beam Width on Melt Pool Geometry and Microstructure in Laser-Based Manufacturing Processes," Wright State University

**2:00-2:20**
Bryan Debelak, "A Nanocomposite As A New Concept To Overcome The Current Polymer Limitations," University of Dayton

**2:20-2:40**
Carl Hager, "The Use of CrCN, TiAlN, Ni, and CuNiIn Coatings for Gross Slip Fretting Wear Amelioration at Ti6Al4V Interfaces," Wright State University

**2:40-3:00**
Alicia Drain, "Investigation of Conductive Materials for Lightning Strike Protection," Air Force Research Laboratory

## Fluid Mechanics/CFD II: 1:00-3:00 PM Room E156C

**Chair:** Shiva Prasad, Emerson Climate

**1:00-1:20**
Mark McQuilling, "Influence of Loading Distribution on Low-Pressure Turbine Aerodynamic Performance," Wright State University

**1:20-1:40**
Haibo Dong, "Analysis of Swimming and Flying in Nature Using an Immersed Boundary Method," Wright State University

**1:40-2:00**
Matthew Dillsaver, "Extending Missile Range Using Alternative Wings," Air Force Institute of Technology

**2:00-2:20**
Roger Kimmel, "Analysis on the Instantaneous and Phase Averaged Velocity Distributions from the Flow Fields Generated by Dielectric Barrier Discharges (DBD)," Air Force Research Laboratory

**2:20-2:40**
Michael Maddux, "Using In-Situ Error Tracking For Mode Selection in Proper Orthogonal Decomposition Reduced Order Modelling," Wright State University

**2:40-3:00**
Sukesh Roy, "H2O and CO2 Concentration Measurements Using a Diode-Laser-Based Optical Parametric Oscillator at 2750 nm," Innovative Scientific Solutions, Inc.

## Design & Optimization II: 1:00-3:00 PM Room E157

**Chair:** Steve Petrof, Delphi

**1:00-1:20**
Zhesheng Jiang, "Trajectory Generation on Approach and Landing for RLVs Using Motion Primitives and Neighboring Optimal Control," University of Dayton

**1:20-1:40**
Hai Jiang, "Design a Novel Microstrip Leaky Wave Antenna with High Bandwidth," University of Dayton

**1:40-2:00**
Todd Benanzer, "Unmanned Undersea Vehicle Structural Optimization," Wright State University

**2:00-2:20**
Timothy Jorris, "2-D Trajectory Optimization Satisfying Waypoints and No-Fly Zone Constraints," Air Force Institute of Technology

**2:20-2:40**
Randy Tobe, "Design a Thermal Protection System to Enable Effective Structural Health Monitoring," Wright State University

**2:40-3:00**
Taiwo Ogunjobi, "Computational Study of Optimal Magnetic Circuit Configurations for an Ion Engine," Wright State University

## Undergraduate Projects: 1:00-3:00 PM Room E163A

**Chair:** Tommy Baudendistel, PC Krause & Associates

**1:00-1:20**
Michael Corbett, Jessica Williams, and John Holtkamp, "Design of a High Altitude Balloon Payload," Wright State University

**1:20-1:40**
Michael Pirnia, Amanda Wilcox, and Ankush Mittal, "All-Limb Powered Vehicle Design," Wright State University

**1:40-2:00**
William Bennett, Tye Gietzen, and Adrienne Schaab, "Design of Remote Controlled Aircraft For Entry in SAE AeroDesign Micro Class Competition," Wright State University

**2:00-2:20**
Charles Phelps (WSU), Carl Druffner (UD), Glen Perram (AFIT), "Optical Analysis of the Emissive Plume Structure During Pulsed Laser Deposition of YBCO"

**2:20-2:40**
Mark Arlinghaus and Arunesh Roy, "Raider Rover: DGPS Guided Autonomous Lawnmower," Wright State University

**2:40-3:00**
Jacob Hause, "University of Cincinnati BEARSat Program," University of Cincinnati

**Industrial and Human Factors II: 1:00-3:00 PM Room E163B**
**Chair:** Allen Revels, AVETeC

**1:00-1:20**
Justin Estepp, "Functional Near-Infrared (fNIR) Techniques for Operator Functional State Assessment," Wright State University

**1:20-1:40**
Rachel Kinsler, "Multiple-task Perception Information Processing by the Human Operator," Wright State University

**1:40-2:00**
Vishnu Kesaraju, "Development of Simulation Environment by Integrating Process and Event Driven Approaches," Wright State University

**2:00-2:20**
Priya Ganapathy, "A Novel ROC Approach For Performance Evaluation Of Target Detection Algorithms," Wright State University

**2:20-2:40**
Kristie Nemeth, "Multimedia Job Performance Aid for the Flightline," University of Dayton Research Institute

**2:40-3:00**
Kristie Nemeth, "Assembly Toys Used To Simulate Maintenance Activity," University of Dayton Research Institute

**Break: 3:00-3:20 PM**

**Engineering Education: 3:20-5:00 PM Room E156A**
**Chair:** Margie Pinnell, University of Dayton

**3:20-3:40**
Nathan Klingbeil, "The Wright State Model for Engineering Mathematics Education," Wright State University

**3:40-4:00**
Carol Buechler, "Why Does Website Accessibility Matter?" Buechler Computers and Engineers

**4:00-4:20**
Matthew Urbaniak, "University of Cincinnati ICARUS BaLLOONS, Past Present, and Future," University of Cincinnati

**4:20-4:40**
Nicholas Hoffman, "A Unique Approach To Service Learning: The ETHOS Program At The University Of Dayton," University of Dayton

**4:40-5:00**
Jeff Shortt, "Faculty Course Assessment as a part of the Accreditation Board of Engineering and Technology (ABET) Accreditation Process for the Cedarville University Engineering Department," Cedarville University

## <u>Materials II</u>: 3:20-4:40 PM Room E156B
**Chair:** Jeff Dalton, AVETeC

**3:20-3:40**
Christine Pastor, "Kinematically Designed Flexible Skins for Morphing Aircraft," University of Dayton

**3:40-4:00**
Balakrishna Cherukuri, "Heat Treatment and Processing of Boron Modified Beta-Titanium Alloys," Wright State University

**4:00-4:20**
Shad Reed, "Strain Dependent Material Properties of Had Coatings," Air Force Institute of Technology

**4:20-4:40**
Christin Grabinski, "Biocompatibility of Carbon Nanomaterials," University of Dayton

## <u>Computer Science</u>: 3:20-5:00 PM Room E156C
**Chair:** Dean Christolear, Behr Dayton Thermal Products

**3:20-3:40**
Fei Wang, "Dynamically Building Inter-connections Between On-chip IP Cores,"

**3:40-4:00**
Justin Teller, "The Morphable Nanoprocessor Architecture: Reconfiguration at Runtime," The Ohio State University

**4:00-4:20**
Chandrashekara Hassan Raju, "Analysis Of Large Scale Image Data Using Out-Of-Core Rendering Techniques," Wright State University

**4:20-4:40**
Jian Zhu, "Security and Access Control in Collaboration Systems: Challenges and Future Direction"

**4:40-5:00**
Sanjay Boddhu, "CTRNN-EH Controllers: Implications towards building Artificial Nervous System for Biomimetic Micro Air Vehicle," Wright State University.

**<u>Design & Optimization III</u>: 3:20-4:40 PM Room E157**
**Chair:** Kirk Procuniar, Honda

**3:20-3:40**
James Westfall, "Multi-Disciplinary Optimization of a Distributed Actuation System in a Flexible Morphing Wing," Air Force Institute of Technology

**3:40-4:00**
Alan Jennings, "Path Planning Algorithm Creation -Discussion Of Principles," University of Dayton

**4:00-4:20**
Josh Dittmar, "Integrated Conceptual Design of Joined-Wing Sensor-Craft using Response Surface Models," Air Force Institute of Technology

**4:20-4:40**
Richard Strong, "StrongMobile Aircar Project," Safety Analysis Systems Co.

**<u>Biomedical Engineering</u>: 3:20-5:20 PM Room E163A**
**Chair:** Thomas Hangartner, Wright State University

**3:20-3:40**
Jennifer Garber, "Validation Methodology of a Dynamic Pneumatic Muscle Model," Wright State University

**3:40-4:00**
Maria Gerschutz, "Dynamic Control System Modeling for an Assistive Pneumatic Muscle," Wright State University

**4:00-4:20**
Mary Kundrat, "Prosthetic Lumbar Disc Concept for Alleviating Spinal Dysfunction," University of Dayton

**4:20-4:40**
Bino Varghese, "Assessment of Bone Strength through Finite Element Analysis Based on Radiographs of the Forearm," Wright State University

**4:40-5:00**
Allison Gadd, "Comparing a Model for Pneumatic Muscle with the AV Hill Model for Skeletal Muscle," Wright State University

**5:00-5:20**
Junitha Michael, "Review Of Biomechanics And Design Issues For Total Ankle Replacement Models"

**<u>Industrial and Human Factors III</u>: 3:20-4:00 PM Room E163B**
**Chair:** Allen Revels, AVETeC

**3:20-3:40**
Mitchell Roth, "Emergency Severe Wound Containment Treatment Device Evaluation: An Effective Deployment Feasibility Experiment," Boonshoft Museum of Discovery

**3:40-4:00**
Kristie Nemeth, "Evaluation of a Multimedia Job Performance Aid," University of Dayton Research Institute

**<u>Electronics and Sensors</u>: 4:00-5:20 PM Room E163B**
**Chair:** Sukesh Roy, Innovative Scientific Solutions, Inc.

**4:00-4:20**
Julie Jackson, "Feature Extraction Algorithm for 3D Scene Modeling and Visualization Using Monostatic Synthetic Aperture Radar," The Ohio State University

**4:20-4:40**
Steven Page, "Change in the Dynamic Response of Pressure Transducers from Elevated Temperatures," Wright State University

**4:40-5:00**
Weibin Chen, "Near-field Scanning Optical Microscopy," University of Dayton

**5:00-5:20**
Greg Distler, "Analysis of MUSIC for Angle of Arrival Estimation of Continuous Wave Interference," Miami University

# ABSTRACTS

**Structures and Solid Mechanics I:** **9:00-11:00 AM** **Room E156A**

### Wind Tunnel Testing of Twisted Wing for Longitudinal Control in a Joined Wing Aircraft

Vanessa Bond
*Air Force Institute of Technology, Wright Patterson Air Force Base, OH 45433 USA*
*Robert A. Canfield*
*Air Force Institute of Technology, Wright Patterson Air Force Base, OH 45433 USA*
*Maria da Luz Madruga Santos Matos*
*Academia da Força Aérea, 2710 Sintra, PORTUGAL*
*Afzul Suleman*
*University of Victoria, Victoria, BC CANADA V8W 3P6*
*Maxwell Blair*
*United States Air Force, Wright Patterson Air Force Base, OH 45433 USA*

This study is based on initial testing accomplished to demonstrate the use of wing twist for longitudinal (pitch) control in a joined wing aircraft configuration. The forces and moments required for pitch control were experimentally determined in a Gottingen wind tunnel. Pressure measurements were also reported. The aeroelastic response will be investigated in follow-on testing.

### Validation of a Dissipated Energy Theory for Fatigue Crack Growth Under Mixed-Mode Loading

Craig Baudendistel
*Department of Mechanical and Materials Engineering, Wright State University*
*Nathan Klingbeil*
*Department of Mechanical and Materials Engineering, Wright State University*

This work seeks to experimentally validate a new energy-based theory of fatigue crack growth under mixed-mode loading. A uniaxial test system at AFRL/PRTS has provided the fatigue crack growth rate and fracture toughness testing capability. The test procedure entails placing layered specimens in four-point bending and propagating a crack along the bonded interface. The goal is to quantify a steady-state fatigue crack growth rate and correlate it with mixed-mode fracture toughness data for monotonic loading. Ultimately, the successful validation of the theory will provide two main advancements in aerospace technology. First, it will allow the prediction of fatigue crack growth rates in prospective new materials based on a substantially reduced test matrix of monotonic properties, resulting in shorter material development cycle times. Second, it will allow virtual life prediction in aerospace components employing laser deposited or other next-generation, layered material systems, where interfacial fatigue crack growth is a concern.

### Improved Structural Health Monitoring Using the Randomdec Signatures

Oleg Shiryayev
*Wright State University*
*Joseph C. Slater*

*Wright State University*

The majority of structural health monitoring techniques are based on detection of significant changes in vibration parameters of the structure. The random decrement technique allows estimation of modal parameters without having measurements of the inputs. The technique has been successfully applied for modal analysis and health monitoring of various structures. However, application of the technique requires the assumption of linearity of the system under consideration, which is not always true in reality. In fact, structural deterioration usually causes nonlinear responses. In this work, random decrement signatures are obtained from systems with different types of stiffness nonlinearities. It is anticipated that variations in the signatures and identified modal parameters could be used not only for detection of damage, but also for identification of the type and location of nonlinearities.

**Validating a New Approximate Model for Rolling Mill Deflection and Strip Thickness Profile**

Arif Malik

*Dept. of Mechanical and Materials Engineering, Wright State University*

*Dr. Ramana Grandhi*

*Dept. of Mechanical and Materials Engineering, Wright State University*

A new semi-analytical method has been developed to model the static and dynamic deflection of sheet-metal rolling mills. A major operational requirement in metal rolling is to rapidly compute the transverse thickness profile of the metal sheet and make necessary machine corrections to obtain desirable flatness of the rolled sheet. The new approximate method to calculate rolled metal thickness profile and flatness couples Finite Element Analysis with classical solid-mechanics. It is validated using large scale FEA simulations of the multi-contact problem for various roll sizes, strip dimensions, and loading conditions. Subsequent to validation, the approximate model will be beneficial in optimizing the strip flatness via on-line set-up of rolling mill parameters. Overall improvements in the dimensional quality of the rolled material are thus expected to follow. Presented are results and discussion to-date in validating the approximate model.

**Evaluation of a Distributed Sensing System with Simple Bending Beams**

Enrique Medina

*Radiance Technologies Inc. and Ohio University*

*David Banaszak*

*Air Vehicles Directorate, Air Force Research Laboratory*

We present results of a cooperative effort between the Air Force Research Laboratory Materials and Manufacturing Directorate and Air Vehicles Directorate for evaluating a Distributed Sensing System (DSS). The DSS measures multiple strains at different locations in a timely and efficient manner using optical fiber Bragg gratings. The ease in using large numbers of sensors make the DSS promising for Vehicle Health Monitoring in locations of difficult accessibility. The objective of the work was to verify the operation and accuracy of the DSS as compared to commercial off-the-shelf strain gages. We tested three 18-inches by 1-inch by 1/8-inch beams, each of a different material. Each beam was instrumented with a fiber containing 65 sensors and two bonded foil strain gages, and subjected to a stress history comprising multiple tension and compression events. Fiber Bragg grating sensor measurements satisfactorily agreed with conventional strain measurements. We present results of this evaluation work.

**Suppressing Structural Response using Piezoelectric Patches**

Anusha Anisetti
*Department of Mechanical and Materials Engineering, Wright State University*

*Steve Page*
*Department of Mechanical and Materials Engineering, Wright State University*

*Dr. Joseph Slater*
*Department of Mechanical and Materials Science Engineering, Wright State University*

An experimental assessment of vibration suppression using piezoelectric patch is addressed. Piezoelectric patches provide high frequency, force and stiffness capabilities all of which can be used to improve performance. A patch of this type is placed in a strategic location to oppose predominant mode of vibration in the given structure. An analysis is performed for locating and sizing the actuator. We now have a robust control system developed for a plate using piezoelectric patch and control leads. This system is called a Smart Plate. The control system is implemented in real time. The frequency response function of the smart plate is attained and a circuit is used to suppress the vibration. Results show that the circuit is effective at suppressing the two stripe mode of vibration.

**<u>Aerospace Propulsion and Control:</u>** **9:00-11:00 AM** **Room E156B**

**Comparison of Fuels for Use in a Pulsed Detonation Engine**

Timothy Helfrich
*Air Force Research Laboratory, Propulsion Directorate, Turbine Engine Division, Combustion Branch*

*Dr. Frederick Schauer*
*Air Force Research Laboratory, Propulsion Directorate, Turbine Engine Division, Combustion Branch*

*Dr. John Hoke*
*Innovative Scientific Solutions Incorporated*

In the past few years, several fuels have been researched for use in a pulsed detonation engine (PDE), but the results are scattered among several papers and are focused on different performance parameters. The focus of this research is to compare the performance of five potential PDE fuels; hydrogen, ethylene, propane, JP-8, and S-8. To measure the performance of the PDE, four performance parameters were monitored; ignition time, deflagration to detonation transition (DDT) time, detonation distance, and wavespeed. Ignition time is defined as the duration of time between spark deposition and the initiation of deflagration. Following ignition, a transition from a deflagration wave to a detonation wave occurs. DDT time and detonation distance are then monitored as the time and distance elapsed between the initiation of deflagration and the formation of the detonation wave, respectively. The presentation will include the experimental setup, methodology, and the results of this research.

**Use of Nitromethane to Augment Thrust on a Pulsed Detonation Engine**

Timothy Helfrich
*Air Force Research Laboratory, Propulsion Directorate, Turbine Engine Division, Combustion Branch*

*Dr. Frederick Schauer*
*Air Force Research Laboratory, Propulsion Directorate, Turbine Engine Division, Combustion Branch*
*Dr. John Hoke*
*Innovative Scientific Solutions Incorporated*
Nitromethane is commonly used in automobiles in the National Hot Rod Association to increase horsepower. This research was focused on using nitromethane as a means of augmenting the thrust of a pulsed detonation engine. Specifically, the effect of nitromethane use on thrust, wavespeed, ignition time, and detonation tube temperature were examined. It was necessary to monitor the detonation tube temperature because of the expected increase in flame temperature associated with nitromethane. Varying mixtures of aviation gasoline, ethanol, and nitromethane, with nitromethane volumetric fraction increasing from 0 to 1, were tested to determine the impact of nitromethane in the PDE. The ethanol was initially used as a means to promote mixture of the avgas and nitromethane, but was later found to provide beneficial performance gains. The use of nitromethane resulted in a 56% increase in thrust, 9% increase in ignition time, and approximately a 150 deg_F increase in detonation tube temperature.

## Power Extraction From Turbine Engines - Numerical Simulations

Oleg Shiryayev
*Wright State University*
*M. Wolff*
*Wright State University*
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*Wright State University*
Modern civil and military aircraft are fitted with numerous electronic systems that require large amounts of electric power to be drawn from their engines. Current trend is that power consumption aboard of future aircraft will be growing substantially, thus bringing up the need to investigate feasibility of power extraction, its impact on the engine and the performance of the aircraft. In this project, two models of a typical two-spool turbofan engine are considered. Predictions of engine performance by both models are compared for different power extraction regimes and flight conditions. It was found that engine behavior is highly dependent on the engine control system.

## Analysis of Transient Turbine Engine Electrical Power Extraction Using Hardware in the Loop

Michael Corbett
*PC Krause and Associates, Inc.*
*Jessica Williams*
*PC Krause and Associates, Inc.*
*Dr. Mitch Wolff, Dr. Jason Wells, Dr. Eric Walters*
*PC Krause and Associates, Inc.*
*Peter Lamm*
*United States Air Force Research Laboratory*
Aircraft power demands have continued to increase to the point that subsystems can no longer be neglected or assumed linear in system modeling and analysis. Complex models designed to

facilitate integration of new capabilities have a high computational cost. The use of hardware-in-the-loop (HIL) analysis with real time integration was investigated. A representative electrical power system was removed from the simulation and was replaced with appropriate hardware driven by a 350 HP drive stand. Torque and speed were passed between the hardware and the computer model to maintain synchronization. The turbine engine model was thus usable in a real time, transient environment. Scaling was successfully investigated for simulations that exceeded the drive stand's operating parameters. Excellent agreement was shown between HIL and stand alone model results. These results validated the capability of HIL experimentation and presented the opportunity for future propulsion configuration studies at a minimal cost.

**Flight Control of Hypersonic Scramjet Vehicles Using a Differential Algebraic Approach**

Tony Adami
*Ohio University, Athens, OH*

*J. Jim Zhu*
*Ohio University, Athens, OH*

*Michael A. Bolender, David B. Doman, Michael Oppenheimer*
*Air Force Research Laboratory, Wright Patterson Air Force Base, Dayton, OH*

Trajectory Linearization Control (TLC) is applied to a longitudinal hypersonic scramjet vehicle (HSV) model. The TLC algorithm is based on Differential Algebraic Spectral Theory (DAST) which features a time-varying eigenvalue concept and avoids the use of so-called frozen-time eigenvalues that can lead to unreliable results when applied to time-varying dynamical systems. A TLC controller was first designed for a nonlinear, affine, rigid-body model using an allocation strategy based on trim-condition lookup tables. The tables were populated by trimming the model at multiple operating points while varying velocity and altitude. The trim data was then fitted to a cubic polynomial function, and the lookup tables were replaced by analytical expressions for the effector settings. The TLC design was then verified on a first-principles based, longitudinal, rigid-body hypersonic vehicle model, and initial simulation testing results are presented.

**Dynamic Turbine Engine Modeling For Real Time Experimental Investigations**

Christopher Corbin
*Wright State University*

Real time analysis with hardware in the loop (HIL) provides an economical means of investigating propulsion/power systems for future missions. A critical requirement of HIL is an accurate physics based transient turbine engine model. Traditional cycle deck analysis methods, which are based on steady state principles, will not provide the information required to assess the potential of a new propulsion/power systems. A review of two transient turbine engine models will be presentated. A generic two-spool turbofan engine model that has been developed by AFRL/PRTC in Simulink will be presented. This model has been recently used at WPAFB for HIL research. The other transient turbine engine model reviewed is the Aerodynamic Turbine Engine Code (ATEC) from AEDC. This model is not dependent on compressor and turbine performance maps, therefore it provides more flexibility in the propulsion/power system conceptual design process if it can be utilized for HIL research.

**Fluid Mechanics / CFD I:** 9:00-11:00 AM Room E156C

### FRESH FX Flight 1 Boundary Layer Transition Experiment Design

Roger Kimmel
*Air Force Research Laboratory*

FRESH FX (Fundamental RESearch in Hypersonics Flight eXperiments) is a flight test designed to gather basic research data on aspects of hypersonic flight not easily accessible to ground testing. Flight one focuses primarily on integration of instrumentation on the test vehicle, with application to future flights. Boundary layer transition has been chosen as one aerodynamic parameter to measure in order to assess instrumentation performance. Analysis has been performed to place requirements on the payload. Results show that the temperature of the aeroshell is relatively benign, easing temperature requirements on transducers. Reynolds number on the vehicle is relatively low, making it marginal for smooth-body boundary layer transition. Roughness must be placed on the vehicle to ensure transition and to obtain rough-wall data.

### PIV Seeding Techniques in Large Scale Open Loop Wind Tunnel Facilities

Ryan Schmit
*Air Force Research Laboratory*

*Jim Crafton*
*Innovative Scientific Solution Inc.*

*Jordi Estevadeordal*
*Innovative Scientific Solutions Inc.*

Seeding techniques to validate the use of Particle Image Velocimetry in large scale wind tunnel facilities was performed at the Subsonic Aerodynamic Research Laboratory facility at Wright-Patterson Air Force Base. The SARL facility is an open loop tunnel with a 7' by 10 octagonal test section that has 56% optical access and the Mach number varies from 0.2 to 0.5. Two seeding techniques were tested at Mach 0.2 and 0.3: a Rosco fogger line seeder system originally designed for flow visualization in the tunnel and a fluidized bed of aluminum oxide dispensing from a multi-port rod. Two- and 3-component PIV images were taken in the streamwise plane over a semi hemispherical geometry that includes a shear layer and a 3D backward facing step. The results show the Rosco line seeder does produce excellent flow visualization images whereas the aluminum oxide seeder produces better seed dispersion resulting in excellent PIV images.

### Phase Locked Investigation of Separation Control in Low Pressure Turbine Using Pulsed Vortex Generator Jets

Nathan Woods
*Air Force Research Laboratory, Propulsion Directorate*

*Dr. Rolf Sondergaard*
*Air Force Research Laboratory, Propulsion Directorate*

*Dr. Richard Rivir*
*Air Force Research Laboratory, Propulsion Directorate*

*Mark McQuilling*

*Wright State University, Department of Mechanical and Materials Engineering*
*Dr. Mitch Wolff*
*Wright State University, Department of Mechanical and Materials Engineering*
The periodic fluctuation of velocity in the boundary layer due to forcing of Vortex Generator Jets (VGJs) injected over the aft portion of the suction surface of the Pack-B turbine blade is reported. Blade Reynolds numbers in the turbine cascade match those that occur in aircraft engines while at high altitude cruise. The blowing ratio was set to 2. A pulsing frequency of 10Hz was studied with a duty cycle of 50%. The VGJs are pitched at 30 degrees and have a skew angle of 90 degrees to the freestream and are located at 45% and 63% axial chord. PIV data phase locked to the VGJ forcing was used to obtain planar velocity data around the blade. 32 points per cycle were analyzed. The phase locked PIV images reveal the fluctuation of the flow velocity in the boundary layer with respect to the pulsing period of the VGJ

**The Least Squares Finite Element Method Applied to Fluid-Structure Interaction Problems**

Cody Rasmussen
*Air Force Institute of Technology, PhD Candidate*
*Robert A. Canfield*
*Air Force Institute of Technology, Associate Professor*
Fluid-Structure Interaction problems prove difficult due to coupled behavior. Different numerical methods are often used to solve fluid and structural problems separately. Least Squares Finite Element Methods (LSFEM) is a numerical solution technique capable of accurately solving both fluids and structures. LSFEM are well suited to handle fluid dynamics and other transport problems where the Galerkin approach encounters difficulties when applied to non-self-adjoint equations. The implementation of LSFEM in both fluids and structures proved useful when considering coupled problems such as Fluid-Structure Interaction. Two basic Fluid-Structure Interaction problems were considered for this project. One was a basic driven cavity flow problem with a flexible side wall and the other was a converging channel problem with a flexible ramp wall. This project outlines the first steps taken to examine these methods.

**Spatially Resolved Temperatures of a Dielectric Barrier Discharge Using Spectroscopy**

*Scott Stanfield*
*Wright State University*
*James Menart*
*Wright State University*
*Charles DeJoseph, Roger L. Kimmel and James R. Hayes*
*Air Force Research Laboratory*
Dielectric barrier discharges (DBD) are flow control devices that through the dissipation of energy and momentum coupling are capable of substantially altering the gas flow around it. In this work emission spectroscopy, which is a non-intrusive technique, is used to map out the thermal temperatures of the discharge region of the DBD. The technique measures the electronic band structure of nitrogen and then iteratively overlays theoretical spectrums at different rotational temperatures to determine the temperature of the gas in which the DBD is burning. The actual temperature determined is the rotational temperature; however, at these pressures and

temperatures it is standard procedure to assume that the rotational and translational temperatures are in equilibrium. Thus the gas temperature in the DBD is accurately determined with this diagnostic tool. The results obtained are a good first step for understanding the spatial distribution of the dissipated energy from the DBD.

**The Mine Face Ventilation: A Comparison of CFD Results Against the Bench Mark Experiments for the CFD Code Validation**

Veera Venkata Sunil Kumar Vytla
*Wright State University*

*Andrew Wala*
*University of Kentucky*

*George P Huang*
*Wright State University*

*C Taylor*
*NIOSH, Pittsburg*

One of the concerns during the coal extraction, using room-and pillar mining method, is that large volumes of methane are released. It is necessary that the methane concentration be checked and maintained at safe levels. There are different ventilation techniques and systems that supply air to dilute and carry-out the accumulated methane. There is a need for a tool which could be used to design effective face ventilation systems. CFD is a promising method that has potential to solve fluid flow problems and generate opportunity to analyze and design face ventilation systems. An effort has been made to perform a comprehensive validation study of CFD tools against the experiments. These experiments, coordinated by the mining engineering faculty, have been carried by researchers at the NIOSH Pittsburgh Research Center in a full-scale coal mine face gallery. This talk focuses on study of methane behavior in the empty mining face area.

**Design & Optimization I:** **9:00-11:00 AM** **Room E157**

**Optimal Tracking Control for a Two Disk Rotating System**

Darren Holland
*University of Michigan Graduate Student*

*Dr. Jeff Dalton*
*AVETeC*

High Cycle Fatigue (HCF) is of primary concern to turbine engine design. Traditional analysis assumes that the force acting on a component is either sinusoidal or a constant value. The turbine engine high pressure spool shaft which connects a turbine to the compressor is examined. The addition of a control system to a Simulink(R) turbine engine model allows for a velocity profile to be translated into a torque profile. This results in a more accurate, fatigue analysis. Different control systems such as the proportional (P), proportional plus integral (PI), and internal model controllers regulate the system. The internal model controller is optimized for a generic turbine engine. A torque profile is generated for future fatigue analysis.

**Modeling and Simulation of a Micro Turbine Generator to be Coupled with a MCFC for Distributed Generation**

Karleine Justice

*Wright State University, Dayton OH*

The development of hybrid power systems that integrate a fuel cell and a power generating source, i.e., micro turbine generator (MTG) have become the desired source of distributed generation. Not only do these hybrid power systems provide remarkably high efficiencies, but with use of a natural gas fuel an innate low level of pollutant production is present. The modeling and simulation of a MTG can be integrated with a MCFC model to give a combined power of 250kW. The responses of the MTG as a stand alone unit or as part of the hybrid system can be explored with both steady state and transient conditions present. A heat exchanger system will be incorporated to recover heat from the fuel cell for use in the MTG. The MTG model is assembled based on a component approach that allows for each component to function independently or as an integrated whole.

## Multiattribute Optimization based on Conjoint Analysis

Hemanth Amarchinta
*Dept. Mechanical and Materials Engineering, Wright State University*
*Ramana V. Grandhi*
*Dept. Mechanical and Materials Engineering, Wright State University*

Multiattribute optimization has received much attention in the recent past and many algorithms have been developed to address this issue. The step of aggregating multiple attributes into a single objective has received less attention than developing efficient optimizers. In this study a popular method in management science known as Conjoint analysis is used to solve the multiattribute problem by converting into single objective where the designer's preferences are included in the optimization and a better preferred design can be obtained based on the preferences of the designer. Comparison of preferences involved in the existing methods is discussed showing the need for including the tradeoff analysis in the optimization. The procedure for calculating the utility value based on conjoint analysis is shown and applied to engineering problem.

## Application of Vehicle Routing and Multiperiod Assignment Problem to UAV Planning

Rafael Aleman
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*Xinhui Zhang*
*Department of Biomedical, Industrial and Human Factors Engineering, Wright State University*
*Raymond Hill*
*Department of Biomedical, Industrial and Human Factors Engineering, Wright State University*

The vehicle routing problem (VRP) is one of the core problems in transportation, logistics, and supply chain management where there is a fleet of vehicles and a set of geographically scattered delivery points with fixed demands. The optimization problem is to determine which customers will be assigned to each vehicle and what route will the vehicle follow to serve the assigned customers, while minimizing the operational costs of the fleet. This project addresses assignment of a set of unmanned aerial vehicles to a set of mobile military targets that follow known trajectories over time. A neighborhood-based metaheuristic is developed to assign the customer demands to the vehicles over time by decomposing the problem into a multiple depot (MDVRP) and split delivery (SDVRP) vehicle routing problem with mobile customers. Our approach introduces a new variant for the VRP and provides solutions in a reasonable computational time.

### Knapsack Problems – Empirical Study and Test Problem Generation

Chaitr Hiremath
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*Raymond Hill*
*Department of Biomedical, Industrial and Human Factors Engineering, Wright State University*

The knapsack problem (KP) has been used to model various decision making processes. Industrial applications find the need for satisfying additional constraints and these necessities lead to the variants and extensions of KP which are complex to solve. A variety of heuristic approaches have been developed for the KP and its variants. These approaches have been tested and compared using test problems. These approaches vary in their performances in computational time, memory requirements, solution quality or computational complexity. We present an overview of different types of KP, test problem generation methods and the implications the developed test sets have on findings from empirical studies of heuristics. This discussion focuses on the Multidimensional Knapsack Problem (MDKP) and Multiple-choice Multidimensional Knapsack Problem - the more complex variants of the KP.

### Reliability Based Design, Modelling and Analysis of Unmanned Undersea Vehicle

Gulshan Singh
*Wright State University*
*Dr. Ramana V. Grandhi*
*Wright State University*

While there has been a lot of recent work in the area of undersea weapons, there has not been substantial work in high fidelity finite element modeling and analysis of unmanned undersea vehicles (UUV). Due to different loading conditions, application, complexities of weaponization, and stability requirements, a new analysis is needed to develop UUVs to meet the Navy's present and future needs. In this work, a high fidelity UUV concept model is developed and validated for mesh size, element type, and accuracy. Variabilities are unavoidable in inputs and responses of any real life applications due to uncertainties in load, materials, dimensions, and manufacturing quality. Therefore, different distributions are assumed for various variables, i.e., Gaussian distribution for Young's modulus. A reliability-based design of this model is performed with skin thickness, ring and longitudinal stiffener width and height, and Young's modulus as uncertain variables.

## <u>Heat Transfer and Thermal Sciences</u>: 9:00-11:00 AM Room E163A

### Control of High-Speed Aerodynamic Interaction by Pulsed Energy Deposition

Hong Yan
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*Datta Gaitonde*
*Air Force Research Laboratory,Wright-Patterson AFB*

This study investigates the effect of energy addition on the Edney IV interaction to mitigate stress and heat loads on the surface of a sphere. The full three-dimensional Reynolds-averaged

Navier-Stokes equations are solved with the k-w turbulence model. The surface pressure prediction without energy addition is found to be in good agreement with experiments and the peak value is noted to be 1.8 times the value observed without the impinging shock. For flow control, a spherical energy pulse is deposited upstream of the primary triple point. The unsteady interaction of the energy spot and its induced blast wave with the oblique shock, the distorted bow shock and the impinging supersonic jet is examined. The simulations indicate significant impact on the heat flux and pressure distribution on the surface of the blunt body. The integrated stress and thermal loads are reduced mainly due to the effect of the expansion waves.

**Thermal Conductivity Improvement in Carbon Nanoparticle Doped PAO-Oil: An Experimental and Theoretical Study**

Shadab Shaikh
*University of Dayton*

*Dr. Khalid Lafdi*
*AFRL/PRPS, Power Division, Wright Patterson AFB*

*Dr. R. Ponnappan*
*AFRL/PRPS, Power Division, Wright Patterson AFB*

The present work involves a study on thermal conductivity of nanofluids for three types of nanoparticles: carbon-nanotubes (CNT), exfoliated graphite (EXG), and heat treated nanofibers (HTT) with PAO-oil as base fluid. An experimental analysis is performed using a laserflash technique for measuring thermal conductivity of the three nanofluids, with different nanoparticles loading. The experimental results revealed similar trend as observed in literature for nanofluids with a maximum enhancement of approximately 161% for the CNT-nanofluid. The overall percent enhancements for different volume fraction of nanoparticles are highest for the CNT-nanofluid followed by the EXG and the HTT. In the second part of study a theoretical model is formulated based on a novel point of view regarding arrangement of nanoparticles in the base fluid. The predictions from the model showed a good agreement with experimental results. The findings from this study can have a great potential in the field of thermal management.

**Dynamic Simulation of Turbine Engine Used with a Molten Carbonate Fuel Cell for Power Generation**

Carlos Gutierrez
*Wright State University*

*Brian Wolff*
*Purdue University*

Molten carbonate fuel cells (MCFCs ) have a high operating point of approximately 650 C (1200 F). This is due to achieve sufficient conductivity of its carbonate electrolyte. Therefore, a gas turbine engine coupled with a MCFC is desirable since the engine can be used to provide hot air to the cathode, and the cathode gas residue can then be used to raise the temperature of the natural gas and water vapor mixture (fuel) before it enters the MCFC at the anode. Dynamic models in MATLAB/Simulink of a gas turbine engine with other power plant components, such as heat exchangers, are being developed to be used with a MCFC model in real time to account for the changes of this system (MCFC/turbine engine) due to sudden performance changes such as power loads, air flows, etc.

**Experimental Verification of Source Temperature Modulation via a Thermal Switch in Thermoelectric Energy Harvesting**

Robin McCarty
*Univeristy of Dayton*

*Dylan Monaghan*
*WPAFB/ARFL VASA*

*Kevin Hallinan*
*Univerisity of Dayton*

*Brian Sanders*
*WPAFB/AFRL VASA*

This paper provides a description of research seeking to experimentally verify the effectiveness of a thermal switch used in series with TE devices for waste heat recovery for constant and variable source heat input and for variable source thermal capacitance. Using an experimental set-up comprised serially of a fixed heat source, a variable thermal resistance air gap serving as a thermal switch, a thermoelectric device and a heat sink, the time-averaged power output to power input ratios improved up to 15% and 30% respectively for constant and variable heat input in certain design space conditions. The experimental results suggest that the thermal capacitance of the heat source must be greater than the thermal capacitance of the TE device in order for thermal switching to improve the time-averaged power output to power input ratios of waste heat recovery systems. The results have direct application to aircraft energy harvesting.

**Femtosecond CARS Measurement of Gas-Phase Temperatures from Frequency-Spread Dephasing of the Raman Coherence**

Sukesh Roy
*Innovative Scientific Solutions, Inc.*

*Robert P. Lucht*
*Purdue University*

*James R. Gord*
*Air Force Research Laboratory, Propulsion Directorate*

Gas-phase temperatures and species concentrations are measured from the magnitude and decay of the initial Raman coherence in the femtosecond (fs) coherent anti-Stokes Raman scattering (CARS) process. A time-delayed probe beam is scattered from the Raman polarization induced by the pump and Stokes beams to generate the fs-CARS signal. The temperature is determined from the decay of the CARS signal with increasing probe-delay, and concentration is determined from the ratio of the initial CARS signal to the nonresonant background signal. The initial Raman coherence then dephases at a rate determined by the temperature-sensitive frequency spread of the Raman transitions. This frequency-spread dephasing occurs on a time scale much faster than the characteristic time for collisions, and the temperature and species concentration can be determined without taking into account the effects of collisions.

**Application of Electronic-Resonance-Enhanced Coherent Anti-Stokes Raman Scattering Spectroscopy for Minor Species Detection in Reacting Flows**

Sukesh Roy
*Innovative Scientific Solutions, Inc.*

*Waruna D Kulatilaka*
*Purdue University*
*Robert P Lucht*
*Purdue University*
*James R Gord*
*Air Force Research Laboratory, Propulsion Directorate*

Electronic-resonance-enhanced CARS spectroscopy of nitric oxide (NO) is presented. In ERE-CARS, the frequency difference between visible Raman pump and Stokes beams is tuned to a vibrational Q-branch Raman resonance of NO to create a Raman polarization in the medium. The CARS signal at ~226 nm is generated when a second pump beam at ~236 nm is tuned into resonance with rotational transitions in the (1,0) band of the A-X electronic transition. There are two major advantages of the proposed technique: (1) the ERE-CARS signal is essentially independent of quenching, and (2) the ERE-CARS signal increases with pressure. These findings are very significant for the detection of NO using ERE-CARS in high-pressure combustion environments, where the quenching rate can vary rapidly as a function of both space and time.

**<u>Industrial and Human Factors I:</u>** **9:00-11:00 AM** **Room E163B**

### Power Spectrum Weighted Edge Analysis for Target Detection in Images

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*Julie A. Skipper*
*Department of Biomedical, Industrial and Human Factors Engineering, Wright State University*

Edge extraction for target detection often yields noisy images with broken edges contributing to missed detections, and extraneous lines that may contribute to false target detections. We present a sliding-block approach for target detection using power spectrum analysis. In general, lines in an edge image corresponding to a given frequency band will be represented as a peak in the Fourier domain at a radius corresponding to that frequency, and direction corresponding to their orientation in the spatial domain. Knowing the line width and spacing, a band-pass filter is designed to extract the Fourier peaks corresponding to the target edge lines and suppress noise in the image. Target edges are then detected by thresholding the Fourier peaks. With Scud missile launcher replicas as target objects, the method has been successfully tested on terrain board test images under different backgrounds, illumination and imaging geometries with cameras of different spatial resolution and bit-depth.

### Histogram-based Template Matching for Object Detection in Images with Varying Contrast

Christina Schrider
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*Dr. Julie A. Skipper*
*Department of Biomedical, Human Factors and Industrial Engineering, Wright State University*

We have developed a semi-automatic target detection algorithm that is relatively insensitive to image brightness and contrast. For each evaluated image region of interest (ROI), a sliding difference method of histogram comparison is performed, wherein the absolute sum of histogram differences of a known object template and the ROI is calculated. A new sum is calculated incrementally as the histograms slide together and the minimum sum is stored in a corresponding response plane where local minima suggest target locations. Whereas in the ideal situation image contrast would precisely match that of the template, in real world situations, contrast could be compromised by illumination conditions, cloud cover, etc. A random contrast manipulation, termed wobble, is performed on the template histogram. Applying a set of wobbled template histograms to the ROI and selecting the minimum offers a higher probability of matching the image contrast than would be expected using fixed parameters.

## Cognitive Biases and Heuristics in Human Decision Making in Complex, Dynamic Environments

Mary Fendley
*Wright State University*
*Dr. S. Narayanan*
*Wright State University*

When performing time-critical decision making in a complex, dynamic environment, humans break this complex task down into simpler judgmental tasks using heuristic principles. Heuristics lead to biases that influence the decision maker. These biases can be exacerbated by the system design. Decision making involving large amounts of information and short decision times is especially prominent in military applications involving imagery from multiple sensors. Little research has been done on designing multi-sensory data fusion systems using principles of cognitive engineering. The goal of this research is to design, implement, and evaluate a support system concurrently with model-based visual interfaces to enable image analysts to interpret images from large amounts of information. This interdisciplinary approach integrates algorithms on information fusion with human factors research on model-based display design and the use of cognitive heuristics in an environment where analysts have to process images and make decisions in a time-critical manner.

## Agent-Based Modeling - A Growing Technique for Modeling Complex Systems

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*Raymond Hill*
*Department of Biomedical, Industrial and Human Factors Engineering, Wright State University*

Simulation is a modeling technique portraying the real world behavior by using similar models to understand the underlying system. Agent-based modeling (ABM) is a relatively new simulation technique built around a set of integrated software components called agents that exhibit autonomy and deliberation in their actions and are capable of interacting with each other and the environment in which they operate. ABMs have found application in diverse fields like biology, social science, warfare, engineering and many others. Complex systems are dynamic and unpredictable requiring constant adaptation to the changes in the environment. Agents provide just the kind of adaptation and alternative behaviors to negotiate with the dynamic changes of the operational environment. The initial success and the novelty of these ABMs have produced a large number of methodologies with little forethought causing confusion at times necessitating the need for a systematic approach and a sound methodology for generating robust ABMs.

**Analysis for Base-Stock Levels in Multi-Echelon Inventory Systems with Random Capacity and Intermediary Product Demand**

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*Frank W. Ciarallo*
*Biomedical, Industrial & Human Factors Engineering, Wright State University, Dayton, OH 45431*

Operations and production managers constantly face the challenge of determining the correct level of inventories at each stage of the supply chain. The system considered here is a three-echelon assembly system with an intermediate product demand in one of the upper echelon, i.e. external demands at upper echelons. The components are procured from the external suppliers, are assembled into intermediate product and final products, and sold to respective customers. Uncertainty is involved in both demand and supply of components, intermediate product and final product. A mathematical model for a capacitated three-echelon system with demand for intermediate and final product is developed. Optimal base stock levels for the components, intermediate and final product based on a required customer service level at each stage is determined. A simulation based inventory optimization approach using OptQuest in ARENA (a simulation package) is employed.

**Visualization Methods and User Interface Design Guidelines for Rapid Decision Making in Multi-Task, Complex Environments**

Sriram Mahadevan
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*Raymond Hill*
*Department of Biomedical, Industrial, and Human Factors Engineering, Wright State University*

Real-world scenarios involving the command and control of autonomous air vehicles are complex dynamic systems and are information rich. Operators working as supervisors, constantly monitor and control the semi-automated systems, conducting situation assessment and making decisions under time pressure. To date, these operators are largely single-task focused. However, supervisory control in a dual-task environment is a possibility in the near future. Existing interface design methodologies have not delved into defining information displays for dual-task environments under varying temporal conditions. The current research focuses on designing displays and advanced cueing techniques to support the operator in dual-task environments, enabling quick situation assessment and rapid decision making. The research effort towards defining and validating the information displays and cues will be a three-step experimentation process, involving human participants and, that is set-up around a Search and Identify scenario using Unmanned Combat Aerial Vehicles (UCAVs).

**<u>Structures and Solid Mechanics II:</u>** **1:00-3:00 PM** **Room E156A**

**Investigation into Bolted Joint Dynamics**

Steven Page
*Wright State University*

*Oleg Shiryayev*
*Wright State University*

*Joseph Slater*
*Wright State University*

A recent push in the area of analysis and design is the use of probabilistic methods in determining failure. This direction is often hindered by the complexity inherent in built up structures. One such complexity is the use of bolts to join two surfaces. Many models exist to explain joint behaviors, but few capture the actual physics behind the observed phenomena. This research attempts to investigate the physics behind the phenomena.

**Investigation of Vibrational Behavior Control Using Magneto-Rheological Fluids**

Christine Esperanza
*Wright State University*

*Steven Page*
*Wright State University*

*Joseph Slater*
*Wright State University*

Semi-active control over the vibrational behavior of fan blades is investigated by testing analogous structures such as beams and plates. Previous investigation involved primary use of a beam embedded with magneto-rheological fluid, the damping and stiffness of which was modified with magnetic fields from disk magnets. The current investigation aims to improve testing methods and obtain better results. Areas of modification include the use of rare earth (neodymium) magnets and production of a plate (as opposed to a beam). New results show significant improvement over previous test data; natural peak frequency shifts can involve differences up to a 100 Hz.

**Integrated Stuctural Health Monitoring Systems**

James Rodriguez
*Air Force Institute of Technology*

*Matthew Bond*
*Air Force Institute of Technology*

*Hieu Nguyen*
*Air Force Institute of Technology*

*Joerg Walter*
*Air Force Institute of Technology*

*Som Soni*
*Air Force Institute of Technology*

Fiscal constraints have caused the extension of the original service life of aging military aircraft. This life extension often requires increased periodic and in-depth inspections, increasing maintenance costs and resulting in longer periods of aircraft downtime. An integrated structural health monitoring system (ISHMS) for aging aircraft may reduce the current inspection burden, and thus decrease costs and system downtime. This thesis continued the work of a previous thesis to further develop a systems engineering approach to define, test and install an ISHMS on an aging aircraft. User analysis, user requirements, system requirements, and Department of Defense Architecture Framework system architectures formed the basis for the systems engineering process presented. The requirements and architectures were applied to a real-world

Air Force structural problem to validate the architectural design. The example presented in this thesis will serve as a reference point for further applications of ISHMS.

### Analysis of Functionally Graded Circular Plates Subject to a Low-Velocity Impact Event

Reid Larson
*Air Force Institute of Technology*
*Dr. Anthony N. Palazotto*
*Air Force Institute of Technology*

Functionally graded materials (FGMs) are advanced composites with mechanical properties that vary continuously through a given dimension. The behavior of functionally graded plates and shells subject to an impact from a projectile is of great interest. Analyses were performed given a low-velocity impact event between a spherical projectile and a thin circular plate. The circular plate is composed of a ceramic and metal combination graded through-the-thickness using various power law distributions to control plate properties. The plate was assigned either clamped or simply supported boundary conditions. The impact response of each configuration was approximated using analytical techniques that assume the rule-of-mixtures sufficiently describes the net properties in a global sense. Finite element simulations of the impact event were generated using the rule-of-mixtures to describe plate properties locally through the thickness. The analytical and finite element results are compared to give insight into the problem.

### Analysis of Functionally Graded Plates with FEM

Inseok Park
*Dept. of Mechanical and Materials Engineering, Wright State University*
*Dr. Ramana Grandhi*
*Dept. of Mechanical and Materials Engineering, Wright State University*

Functionally graded Structures are those where the volume fractions of two or more materials are varied continuously as a function of position along certain dimension(s) of the structure to achieve a required function. In this study, a simply supported rectangular plate composed of functionally graded materials was dealt with as the structure to be analyzed. Until now, several methods to analyze functionally graded plates have been proposed. And here the Third-order Shear Deformation Theory (TSDT) of Reddy, which is evaluated to be largely accurate, was applied through using FEM. In addition, it was studied to compare it to single material plates and find out what profile for volume fraction variation makes the deflection minimum.

### Effect of Phase Difference Between Axial and Contact Loads on Fretting Fatigue Behavior of Titanium Alloy Ti-6Al-4V.

*Mohammad Almajali*

Fretting fatigue occures between two contacting components. It reduces fatigue life comparing to plain fatigue. The primary goal of this study is to investigate the effect of phase difference between axial and contact loads on fretting fatigue behavior of Titanuim alloy. Cracks were always found to initiate at the contact surface and near the trailing edge in all tests. The software program, ABAQUS, was used in Finite Element Analysis FEA to determine the contact region state variables such as stress, strain, and displacement. The fatigue parameters; such as the stress range, effective stress, and modified shear stress range (MSSR) were analyzed to predict the fatigue life. The out of phase condition increased the fatigue life from 20% to 30% in the low cycle regime and up to 150% in the high cycle regime. The MSSR parameter was very effective in predicting the fatigue life.

**<u>Materials I</u>:** **1:00-3:00 PM** **Room E156B**

### Optical Dispersion and Residual Stress of Sputtered Germanium Thin Films for IR Applications

Emily Fehrman
*University of Dayton, DAGSI Fellow*

*Dr. Andrew Sarangan*
*University of Dayton*

*Dr. Aziz Mafoud*
*University of Dayton*

The low absorption coefficient of germanium in the near and mid-infrared wavelengths makes it a very attractive material for a variety of IR applications. The high index of refraction of germanium makes it ideal in applications requiring muli-layer thin films, such as transmission filters and anti-reflection coatings. In this study, the properties of RF-magnetron sputtered germanium films were examined for optical dispersion in the 3-5 ƒÝm wavelength and residual stress. The reflection and transmission spectra were investigated using Fourier Transform Infrared Spectroscopy (FTIR). The argon gas pressure and the radio frequency (RF) power were varied to examine their effects on dispersion and stress. The FTIR spectra were used to determine the dispersion of the films, and Raman spectroscopy was used to characterize the residual stress.

### On the Oxidation Properties of CaBMGs

James Dahlman
*AFRL/MLLMD*

*Dr. Daniel Miracle*
*AFRL/MLLMD*

*Dr. Oleg Senkov*
*AFRL/MLLMD and UES Inc.*

*James Michael Scott*
*AFRL/MLLMD and UES Inc.*

Calcium based bulk metallic glasses (CaBMGs) were generated using specific recently developed techniques. Different procedures for uniformly analyzing the oxidative properties of ternary (Ca-Mg-Zn, Ca-Mg-Cu), quaternary (Ca-Mg-Zn-Cu), and quinternary (Ca-Mg-Zn-Cu-Al) alloys were fashioned and evaluated. Correlations between sample preparation techniques and sample quality were established and a standard preparation procedure was chosen. Following this procedure, an accelerated method for deciphering the corrosion resistance in air was created using a static aqueous environment at room temperature. Four alloys were subjected to the testing method, and quantitative results were analyzed. Corrosion byproducts were evaluated using X-ray diffraction (XRD), wet chemical analysis (Chemsys), Scanning Electron Microscopy (SEM), and Electron Dispersion Spectroscopy (EDS).

**Effect of Beam Width on Melt Pool Geometry and Microstructure in Laser-Based Manufacturing Processes**

Nathan Klingbeil
*Department of Mechanical & Materials Engineering, Wright State University*
*Srikanth Bontha*
*Department of Mechanical & Materials Engineering, Wright State University*

The ability to control geometric and mechanical properties of parts fabricated using laser-based manufacturing processes requires an understanding and control of melt pool geometry and microstructure. Previous work by the authors has employed the Rosenthal solution for a moving point heat source to determine the effects of process variables (laser power and velocity) on solidification cooling rates and thermal gradients controlling microstructure (grain size and morphology) in laser deposited materials. Through numerical superposition of the Rosenthal solution, the current work extends the approach to include the effects of a distributed heat source for both 2-D thin-wall and bulky 3-D geometries. Results are further interpreted in the context of a solidification map for predicting grain morphology specifically in Ti-6Al-4V. The results of this work suggest that intentional variations in laser beam width could potentially enable significant changes in melt pool geometry while maintaining a desired microstructure.

**A Nanocomposite As A New Concept To Overcome The Current Polymer Limitations**

Bryan Debelak
*University of Dayton*
*Khalid Lafdi*
*University of Dayton*

An effective method for the dispersion of graphite in the form of nanosheets, which have been ultrasonicated and highly sheared, into a polymer matrix was performed via in situ polymerization was utilized to produce epoxy/expanded graphite (EG) nanocomposites. For this study, three types of epoxy/EG nanocomposites, having different graphite particle sizes, were prepared with their respective particle sizes being 50, 100, and 150 mesh. Many nanocomposites were prepared using graphite loading levels from 0.1-20% by weight. The physical properties i.e. electrical, thermal and mechanical of these nanocomposites were determined. The structural characteristics were studied using scanning electron and optical microscopy. The nanocomposites were proven to be both a high performance polymeric material with tailored mechanical, electrical and thermal properties. Therefore, they show potential uses for high temperature conducting materials among other future applications.

**The Use of CrCN, TiAlN, Ni, and CuNiIn Coatings for Gross Slip Fretting Wear Amelioration at Ti6Al4V Interfaces**

Carl Hager
*Wright State University and Universal Technology Corporation*
*Dr. Jeffrey Sanders*
*United States Air Force Research Laboratory*
*Dr. Shashi Sharma*
*United States Air Force Research Laboratory*
*Dr. Andrey Voevodin*
*United States Air Force Research Laboratory*

Fretting is a low amplitude oscillatory wear that occurs at component interfaces and can accelerate crack initiation as well as interfacial degradation. Prevalent in Ti-alloy contacts, fretting wear often occurs at the blade/disk interfaces of fan and compressor stages in turbine engines, causing premature component failure. In many cases plasma sprayed CuNiIn coatings and dry film lubricants are applied to blade roots to mitigate the fretting problem. However, the CuNiIn coatings can cause severe damage to the uncoated Ti-alloy counter parts once the lubricants wear out. In this study bench level gross slip fretting wear tests were conducted at room temperature on unlubricated Ti6Al4V surfaces mated with CuNiIn and commercially pure Ni plasma sprayed surfaces. Additional tests were then conducted after applying 2µm thick PVD deposited TiAlN and CrCN coatings to the surfaces of a second set of Ti6Al4V mating pairs. This presentation will convey the results of these tests.

**Investigation of Conductive Materials for Lightning Strike Protection**

Alicia Drain
*Air Force Research Laboratory, Materials and Manufacturing Directorate, Wright-Patterson AFB, OH 45433*

*Jennifer Chase Fielding*
*Air Force Research Laboratory, Materials and Manufacturing Directorate, Wright-Patterson AFB, OH 45433*

*Thao Gibson and Sirina Putthinarat*
*University of Dayton Research Institute, Dayton OH 45436*

*Megan Stoffel*
*SOCHE*

Polymeric composites have been widely used in aerospace applications because they are light weight and have high strength. However, polymeric composites have poor conductivity which causes significant damage to the aircraft when it is struck by lightning. The purpose of this research is to examine the conductive materials including nano and macro-materials for lightning strike protection (LSP). The materials were examined using scanning electron microscope (SEM). The conductivity of materials will be presented. These materials were studied in veil or mat forms which were placed on one side of the composites. The resin transfer molded technique was used to fabricate the composite system. The composite system was characterized by ultrasonic scan, microscopic analysis, and SEM.

**Fluid Mechanics/CFD II: 1:00-3:00 PM Room E156C**

**Influence of Loading Distribution on Low-Pressure Turbine Aerodynamic Performance**

Mark McQuilling
*Wright State University*

*Dr. John Clark*
*Air Force Research Laboratorory, Wright-Patterson AFB*

*Dr. Mitch Wolff*
*Department of Mechanical & Materials Engineering, Wright State University*

Low-pressure turbine (LPT) blades of modern gas turbine engines currently suffer from lowered efficiencies at high-altitude cruise. At higher altitudes, the density of air drops and

reduces the momentum of the flow within the LPT section. The combination of an adverse pressure gradient on the LPT suction surface along with the lowered momentum flow allows transition and separation effects to increase the losses sustained by these designs. This study illustrates how tailoring the loading distribution along the suction surface allows a higher-lift design while maintaining and improving the low-Re characteristic of LPT blades. Computational results are obtained using Dan Dorney's Wildcat flow solver along with Praisner and Clark's separated flow transition model. Results are presented for a range of Reynolds number respective of LPT flow conditions and contrasts are given between front-loaded, mid-loaded, and aft-loaded designs.

**Analysis of Swimming and Flying in Nature**
**Using an Immersed Boundary Method**

Haibo Dong
*Dept. Mechanical and Materials Engineering, Wright State University*

*Rajat Mittal*
*Dept. Mechanical and Aerospace Engineering, The George Washington University*

A sharp interface immersed boundary method (IBM) has been developed for numerically simulating complex biological flows. This solver has being used to study the fluid dynamics of fish pectoral fins, swimming in humans, as well as insect flight. The study of the fish pectoral fin is directed towards developing an engineered artificial muscle pectoral fin that can act as a maneuvering thruster for autonomous underwater vehicles. In human swimming our interest is in understanding the fluid dynamics of the dolphin kick which is a key component in competitive swimming. Laser body scans of Olympic swimmers with advanced animation techniques are coupled to create a very realistic model of this stroke. At last, results from computations of flow past a modeled dragonfly in flight will be presented. The idea here is to examine the aerodynamics of dragonfly flight in all its complexity including the role of wing-wing/wing-body interaction etc.

**Extending Missile Range Using Alternative Wings**

Matthew Dillsaver
*Air Force Institute of Technology*

*Milton Franke*
*Air Force Institute of Technology*

The Air Force is always looking for new ways to extend the range of missiles and guided bombs. One approach currently being researched is the use of alternative wing configurations to accomplish this goal. Recent research has shown that range can be increased through the use of a joined wing. Another approach for increasing range is through the use of oblique wings. This research will center on the benefits or shortcomings of oblique wings. It will also investigate the separation effects between the aircraft and a missile with oblique wings at different degrees of obliquity.

**Analysis on the Instantaneous and Phase Averaged Velocity Distributions from the Flow Fields Generated by Dielectric Barrier Discharges (DBD)**

Roger Kimmel
*AFRL/VAAA, Wright-Patterson Air Force Base, OH 45433*

*Jordi Estevadeordal*
*Innovative Scientific Solutions, Inc., 2766 Indian Ripple Road, Dayton, OH 45440*
*Sivaram Gogineni*
*Innovative Scientific Solutions, Inc., 2766 Indian Ripple Road, Dayton, OH 45440*

Particle-image velocimetry (PIV) experiments were conducted to characterize the flow field induced by dielectric barrier discharges (DBD). The DBD were created in a quiescent environment and the effect of the driving signal characteristics such as frequency, amplitude, phase, and waveform was analyzed. Views normal and parallel to the DBD captured upstream and downstream flow characteristics including the wall jet formation, velocity, thickness and unsteadiness, the entrainment and recirculation patterns around the discharge, and the spanwise variations and streamwise streaks near the wall. Details of the flow near the plasma region and wave phase patterns were captured by closed-up views and phase-locked measurements. The effect of buoyancy was also studied by flipping the orientation of the DBD. The effects of PIV seeding material on the plasma discharge were also evaluated. The results are being used for validation and development of CFD models.

**Using In-Situ Error Tracking For Mode Selection in Proper Orthogonal Decomposition Reduced Order Modelling**

Michael Maddux
*Wright State University*

Proper Orthogonal Decomposition (POD) is used to create a Reduced Order Model (ROM) comprised of basis functions onto which the governing equations of a Computational Fluid Dynamics (CFD) problem are projected via Galerkin's method. The dominant characteristics of the flow are extracted using Karhunen- Lo`eve analysis. Computational expense is recovered by applying the ROM to the solution under conditions different from which the model was created. The influence of individual POD basis functions on the solution varies. Changes to design parameters and boundary conditions of the system may also affect the influence of individual basis functions. Methods were developed to determine the influence of these individual basis functions in-situ. Methods used in this work are: tracking normalized error induced by exclusion of basis functions, the contribution of individual basis functions to the solution and the residual value of the excluded or truncated basis functions as proposed by Dr. Joseph Slater.

**H2O and CO2 Concentration Measurements Using a Diode-Laser-Based Optical Parametric Oscillator at 2750 nm**

Sukesh Roy
*Innovative Scientific Solutions, Inc.*
*Keith G Grinstead*
*Innovative Scientific Solutions, Inc.*
*Terry R Meyer*
*Iowa State University*
*James R Gord*
*Air Force Research Laboratory, Propulsion Directorate*

A diode-laser-based optical parametric oscillator (OPO) has been used to measure the concentration of H2O and CO2 in reacting flows by direct absorption spectroscopy. The wavelength of a laser system at ~1080 nm was tuned at a rate of 1 to 5 kHz by adjusting the

pump diode-laser current. The pump beam at ~1080 nm was split into signal and idler beams during the parametric process in a periodically poled lithium niobate (PPLN) crystal. The idler beam at ~2750 nm was used for H2O and CO2 concentration measurements by direct absorption spectroscopy in a C2H2-air laminar diffusion flame stabilized over a Hencken burner. One unique feature of this sensor is high output power in the mid-infrared spectral region, enabling absorption-based measurements over relatively short path lengths. Efforts are under way to increase the scanning rate of this laser system to 10 to 20 kHz for measurements in unsteady reacting flows.

**Design & Optimization II:** **1:00-3:00 PM** **Room E157**

### Trajectory Generation on Approach and Landing for RLVs Using Motion Primitives and Neighboring Optimal Control

Zhesheng Jiang
*Department of Electrical and Computer Engineering, University of Dayton*
*Dr. Raúl Ordóñez*
*Department of Electrical and Computer Engineering, University of Dayton*

A major objective of next generation Reusable Launch Vehicle (RLV) programs includes significant improvements in vehicle safety, reliability, and operational costs. In this presentation, trajectory generation on approach/landing (A&L) for RLVs using Motion Primitives (MPs) and Neighboring Optimal Control (NOC) is discussed. The proposed approach is based on an MP scheme which consists of trims and maneuvers. From an initial point to a given touchdown point, all feasible trajectories that satisfy certain constraints are generated and saved into a trajectory database. An optimal trajectory can be found off-line by using Dijkstra's algorithm. The off-line optimal trajectory is then reshaped into a neighboring feasible trajectory on-line by using NOC approach. A Neighboring Feasible Trajectory Existence Theorem (NFTET) is investigated and its proof is provided as well. The results show that the vehicle with stuck effectors can be recovered from failures in real-time. Finally, robustness issues on NOC approach are discussed.

### Design a Novel Microstrip Leaky Wave Antenna with High Bandwidth

Hai Jiang
*Department of Electrical and Computer Engineering, University of Dayton*
*Krishna M. Pasala*
*Department of Electrical and Computer Engineering, University of Dayton*

For many air-borne applications, it is advantageous to have antennas which are light-weight, low-profile and high-bandwidth. Printed leaky wave antennas meet these requirements and are considered here. The specific configuration consists of an open microstrip excited asymmetrically. In the present work, analytical expressions are derived for the propagation constant and the fields in microstrip and the Finite Elements (FE) method is used as a tool to validate the theory. The agreement between theoretical and simulated results is on the order of 5%. It is demonstrated that by periodically loading the microstrip line with air gaps and keeping the period much less than a single wavelength, it is possible to control the characteristics of the leaky wave mode to realize a leaky wave antenna whose band-width is increased by a factor of 50% or more compared to the homogeneous substrate antenna while leaving the pattern characteristics essentially unchanged.

**Unmanned Undersea Vehicle Structural Optimization**

Todd Benanzer
*Wright State University*

*Ramana Grandhi*
*Wright State University*

The Navy is currently investing much research into the design and possible applications of Unmanned Undersea Vehicles (UUVs). It is the Navy's vision that UUVs will play an integral role in their future fighting force. The missions UUVs will fill include reconnaissance, combat, payload delivery, as well as several others. This research first involves a study into the possible load conditions that the UUV must withstand, including transportation loads as well as in-mission loading. Once these load cases are identified, an optimization is performed to decide on the best possible configuration of the UUV.

**2-D Trajectory Optimization Satisfying Waypoints and No-Fly Zone Constraints**

Timothy Jorris
*Air Force Institute of Technology*

*Richard G. Cobb*
*Air Force Institute of Technology*

The vehicle of study is the Common Aero Vehicle. Of military interest is the ability to autonomously mission plan multiple intermediate waypoints and no-fly zones, while ensuring a flyable trajectory. The cost function is flight time due to time-critical targets. Due to hypersonic velocity during reentry the turn radii are significant compared to the overall range from initial point to final target. The research herein demonstrates an analytical geometric trajectory optimization technique and compares it to numerically derived results. The result converges to the optimal solution with less computational time and assurance that a solution exists.

**Design a Thermal Protection System to Enable Effective Structural Health Monitoring**

Randy Tobe
*Wright State University*

*Dr. Ramana V. Grandhi*
*Wright State University*

*Dr. Mark Derriso*
*Wright-Patterson Air Force Base*

An initial investigation has been performed on a finite element model of a thermal protection system. This investigation has shown the natural frequencies and mode shapes for the model. These results will be compared to forthcoming frequency analysis from the Air Force Research Laboratory to validate the finite element model. After the model is validated, the brackets and backing structure of the thermal protection system will be designed using shape and/or topology optimization to improve the frequency characteristics of the model. The improved design will allow for structural health monitoring to be performed more accurately, resulting in a reduction in maintenance costs and down time.

**Computational Study of Optimal Magnetic Circuit Configurations for an Ion Engine**

Taiwo Ogunjobi
*Wright State University, Dayton OH*

*James Menart*
*Wright State University, Dayton OH*

Ion propulsion thrusters converts electrical energy to thrust via generation of a plasma and an electrostatic acceleration of the ions through a pair of grids. The accelerated ions exit the engine at high velocities to produce thrust. A parameter upon which the efficiency of an ion thruster depends is its ability to retain primary electrons within the discharge chamber. The ability of the engine to retain primary electrons is controlled by applying a static magnetic field. For the magnet field, permanent magnets, placed on the discharge chamber's walls in various configurations, prevent primary electrons from reaching the anode walls. The work being presented studies the ability of these magnetic circuit configurations to confine primary electrons inside the discharge. The magnetic circuit configurations studied include magnet pairs on either the front, side, or back wall of the chamber. The confinement results and the mechanisms that govern the trends observed is discussed.

**Undergraduate Projects:** **1:00-3:00 PM** **Room E163A**

**Design of a High Altitude Balloon Payload**

Michael Corbett
*Wright State University*

*Jessica Williams*
*Wright State University*

*John Holtkamp*
*Wright State University*

The goals of this project were to design and build a payload for attachment to a helium filled weather balloon that would reach an altitude of 100,000 feet. The payload was to contain experiments as well as tracking and recovery systems. Some components of the tracking and recovery system included a parachute, GPS (Global Positioning System) receivers, a BASIC Stamp microprocessor, amateur (HAM) radios, and a Morse code beacon. The system designed by Wright State University's first HAB (high altitude balloon) team was intended to be reliable, reusable, and expandable. The initial launches were to establish a dependable system for tracking and recovering the payload. Latitude, longitude, heading, speed, altitude, and internal box temperature were all recorded with timestamps and were also broadcast out from the box for tracking. A digital camera was also included to capture the flight visually. The HAB team continues research and experimentation using this system.

**All-Limb Powered Vehicle Design**

Michael Pirnia
*Designer*

*Amanda Wilcox*
*Designer*

*Ankush Mittal*
*GTA*

*Junghsen Lieh*
*Faculty Design Advisor*

An agile and efficient human-powered vehicle that may be used for exercise, recreation and transportation was designed and competed in an ASME competition held on May 5-7, 2006, in the University of North Carolina. The vehicle was tested on its ability to maneuver around an obstacle course, accelerate in a sprint and carry passengers along with a small load in an endurance race. The vehicle is powered by two riders. The driver at the front is in charge of steering and gear shifting, along with foot pedaling. The person in the rear provides most of the power by pedaling with feet and rowing with hand cranks. Transportability was achieved with removable front and rear sub-frames that house the main drive-train mechanisms. In order to keep the vehicle light and rigid, the frame is a one piece aluminum dual rail.

## Design of Remote Controlled Aircraft For Entry in SAE AeroDesign Micro Class Competition

William Bennett
*Wright State University*

*Tye Gietzen*
*Wright State University*

*Adrienne Schaab*
*Wright State University*

The SAE AeroDesign Competition challenges students to design remote controlled airplanes to achieve a desired mission profile. In the micro class of the competition this mission is to lift a payload of the highest possible percentage of the planes empty weight. The 2006 Wright State University team accomplished this goal through extensive material, power plant, and construction research. The design consisted of an airplane constructed from lightweight foam sheets that are glued together, a small but very powerful electric motor, and a rugged airframe. The team overcame challenges and was successful in completing ten test flights before the competition. Some modifications to the airframe were required but once completed the team was able to achieve a maximum lifted payload of thirty-five ounces and a plane weight of eleven ounces. This yielded a high enough flight score to win the competition in the first year Wright State had entered this class.

## Optical Analysis of the Emissive Plume Structure During Pulsed Laser Deposition of YBCO

Charles Phelps
*Wright State University, Air Force Institute of Technology*

*Carl Druffner*
*University of Dayton*

*Glen Perram*
*Air Force Institute of Technology*

*Rand Biggers*
*Air Force Research Lab*

The high temperature superconductor, YBa2Cu3O7-x (YBCO) offers great promise for power generation, particularly for emerging directed energy weapons applications. However, the manufacture of YBCO wire requires further development. In the current work, optical diagnostics using spectrally filtered images collected during the pulsed laser deposition of YBCO have been analyzed to understand the plume expansion under various background pressures. Drag and blast wave models for explosive plume propagation have been investigated. An ICCD camera system has been utilized to capture the ablated plume matter in flight with high spectral, spatial, and temporal resolution. Bandpass filters were used to investigate the plume's compositional species such as Ba, Y, and Cu. This presentation will detail the image analysis and model fitting of the YBCO plume expansion at various oxygen background gas pressures from 10 to 1000 mTorr.

**Raider Rover: DGPS Guided Autonomous Lawnmower**

Mark Arlinghaus
*Wright State University*

*Arunesh Roy*
*Wright State University*

This paper presents the development of an autonomous lawnmower which can intelligently navigate a field and avoid obstacles. The lawnmower uses a sophisticated global positioning system (GPS) for position tracking and guidance. Once the mower is in motion, ultrasonic range finding sensors are used for real-time obstacle detection. The system uses a master-slave processing hierarchy to gather information from the sensors and make decisions. The vehicle systematically traverses the mowing area in a predetermined path using the GPS for guidance. However, if an obstacle is detected, the mower travels around the object and returns to the GPS guided path.

**University of Cincinnati BEARSat Program**

Jacob Hause
*University of Cincinnati*

*Dr. Trevor Williams*
*University of Cincinnati*

A relatively new program to the University of Cincinnati is the student built nanosatellite program. The program is funded by the Air Force and is a competition between 11 universities. The winner is awarded a launch as a secondary payload on a future launch vehicle. The University of Cincinnati has designed a satellite, BEARSat, which meets the specifications put down by the Air Force University NanoSat program. The satellite has a mass of less than 30 kg and will be built within the $110,000 budget given to each school. On board the satellite are four experiments, two of which are concerned with thermal control, one flash memory radiation effects experiment, and the last being a solar concentrator. The thermal experiments consist of a phase change material switch and reservoir. This will be our team's submission to the Air Force for flight review, in April 2007.

**<u>Industrial and Human Factors II:</u>** **1:00-3:00 PM** **Room E163B**

**Functional Near-Infrared (fNIR) Techniques for Operator Functional State Assessment**

Justin Estepp
*Department of Biomedical, Industrial and Human Factors Engineering, Wright State University*

*Ping He*
*Department of Biomedical, Industrial and Human Factors Engineering, Wright State University*

As the need for Operator Functional State (OFS) Assessment in complex aviation systems increases, new methods for creating more robust features used in cognitive state classification must be investigated. One technique currently being investigated is the use of Functional Near-Infrared (fNIR) imaging to assess cognitive function. There are several aspects of fNIR that make for an attractive physiologically-based measure of cognitive function, including its non-invasiveness, hardware scale, and real-time capability, in comparison to other methods, including Functional Magnetic Resonance Imaging (fMRI) and Positron Emission Topography (PET). Current work is focused on comparing results obtained by fNIR techniques in cognitive lab tasks with those reported in fMRI and PET literature. Once this work is completed, a better understanding of the application of fNIR techniques to cognitive state assessment will be obtained. This knowledge can then be applied to more complex environments in which OFS Assessment is critical to overall system performance.

**Multiple-task Perception Information Processing by the Human Operator**

Rachel Kinsler
*Department of Biomedical, Industrial and Human Factors Engineering, Wright State University*
*Dr. C. A. Phillips*
*Department of Biomedical, Industrial and Human Factors Engineering, Wright State University*

There exist relatively few quantitative performance metrics that describe perception information processing by a human operator. This work examines: (1) the effect machine-generated total baud rate (BIN) had on human output total baud rate (BO); (2) the quality of the BO; and (3) the classification of the human operators according to their performance. Five tasks (quantified using Hick-Hyman and Fitts' Laws) were machine-generated by the Multi-Attribute Task Battery (MATB) and presented at five levels of BIN. The results for the thirty-two human operators indicated a common performance pattern. A performance metric was defined as the slope of a linear regression line for each human operator as compared to a unity gain line. The performance metrics were then plotted and found to follow a Gaussian distribution. Statistical analysis of this distribution permitted the classification of human operators in terms of performance. An ergonomic application using these metrics is discussed.

**Development of Simulation Environment by Integrating Process and Event Driven Approaches**

Vishnu Kesaraju
*Biomedical, Industrial & Human Factors Engineering, Wright State University, Dayton, OH 45431, USA*
*Frank W. Ciarallo*
*Biomedical, Industrial & Human Factors Engineering, Wright State University, Dayton, OH 45431, USA*

The overall objective of this research is to develop simulation environment that models the system dynamics with both the approaches i.e. process driven and event driven. In process driven simulation, the system is represented by block diagrams or system networks through which entities flow to mimic real life system objects. Whereas in event driven simulation, the system is represented by event graphs which focuses on the abstraction of the event rather than on observable physical entities. The research aims to combine the compactness of the process simulation and sophistication of the event simulation. Object oriented programming has been adopted to build the necessary machinery. Software engineering techniques like patterns are employed to increase the efficiency of the software lifecycle. The research exploits the relationship between the entities and events and this relationship forms the basis of the interface between process and event levels.

**A Novel ROC Approach For Performance Evaluation of Target Detection Algorithms**

Priya Ganapathy
*BioMedical Imaging Laboratorary, Dept. of Biomedical, Industrial and Human Factors Engineering, Wright State University*

*Julie A. Skipper*
*BioMedical Imaging Laboratory, Miami Valley Hospital and Wright State University*

In automated target recognition systems, the receiver operator characteristic (ROC) metric, area under the curve (AUC) is a globally emerging measure of classifying accuracy. AUC computation involves the careful assignment of detection algorithm's output i.e., response plane (RP) pixels as either true negatives (TN), false positives (FP), true positives (TP) or false negatives (FN). Historically, evaluation methods have excluded the background and considered only spoof objects as TN, thereby potentially exaggerating the algorithm's performance. Here, a new ROC approach has been developed that divides the entire image into mutually exclusive target (TP) and background (TN) grid squares with adjustable size. Based on the overlap of the thresholded RP with the TP and TN grids, the FN and FP fractions are computed. A pilot study revealed a statistical significance ($p<0.001$) at 95% confidence interval for an ANOVA-based comparison of the AUCs for three detection algorithm parameter settings on ten evaluation images.

**Multimedia Job Performance Aid for the Flightline**

Kristie Nemeth
*University of Dayton Research Institute*

*Laurie Quill*
*University of Dayton Research Institute*

*Christopher Mooney*
*Kelley's Logistics Support Systems*

*Robert Fudge*
*Kelley's Logistics Support Systems*

*Justin Adams*
*Air Force Research Laboratory*

Our team has developed a multimedia job aiding and training tool for novice U.S. Air Force flightline aircraft maintainers. Current training is designed to leverage expertise from experienced trainers as well as step-by-step instructions from technical manuals, job guides or checklists which are typically paper-based. Reduction in workforce and increased system complexity limits opportunities for training new technicians. This requires that training is rapid and of high quality as time and quantity cannot be guaranteed. Research in learning preferences shows that people learn in a variety of ways, and that they are sensitive to how information is presented to them. When these styles are supported, learning is enriched and occurs faster. This

presentation will discuss an Air Force research project aimed at changing the flightline training environment by providing for a variety of learning styles through a multimedia job aiding and training tool to support this highly constrained training environment.

**Assembly Toys Used To Simulate Maintenance Activity**

Kristie Nemeth
*University of Dayton Research Institute*
*Laurie Quill*
*University of Dayton Research Institute*
*Christopher Mooney*
*Kelley\\\'s Logistics Support Systems*
*Robert Fudge*
*Kelley\\\'s Logistics Support Systems*
*Justin Adams*
*Air Force Research Laboratory*

Tools created for U.S. Air Force flightline aircraft maintenance are difficult to evaluate in a realistic environment. Aircraft cannot be disassembled or modified unless real problems exist. Waiting around for the same problem to occur in multiple aircraft isn't feasible. Our team developed a job aiding and training tool for novice maintainers which needed to be evaluated without the use of actual aircraft, for the reasons stated. We started by gathering information from experienced maintenance training specialists about cues or techniques they use when teaching. Next we conducted cognitive walk-throughs for several representative maintenance tasks. At this point we were able to develop a "machine" using a K'NEX constructor toy set assembly with an associated series of maintenance activities. Step-by-step technical manual job guides and checklists were developed using existing Air Force documents as models to simulate the traditional presentations of maintenance information. This process will be discussed.

**<u>Engineering Education:</u>** **3:20-5:00 PM** **Room E156A**

**The Wright State Model for Engineering Mathematics Education**

Nathan Klingbeil
*Department of Mechanical & Materials Engineering, Wright State University*
*Richard Mercer*
*Department of Mathematics & Statistics*
*Kuldp Rattan*
*Department of Electrical Engineering*
*Michael Raymer*
*Department of Computer Science & Engineering*
*David Reynolds*
*Department of Biomedical, Industrial and Human Factors Engineering*

The inability of incoming students to advance past the traditional freshman calculus sequence is a primary cause of attrition in engineering programs across the country. This presentation describes an NSF funded initiative at WSU to redefine the way engineering mathematics is taught, with the goal of increasing student retention, motivation and success in engineering. The

approach involves the introduction of a novel freshman engineering mathematics course (EGR 101), which replaces traditional math prerequisite requirements for core sophomore engineering courses. This enables a significant restructuring of the engineering curriculum, including the placement of formerly sophomore-level engineering courses within the freshman year. The result shifts the traditional emphasis on math prerequisite requirements to an emphasis on engineering motivation for math, with a just-in-time structuring of the new math sequence. This presentation provides an overview of the WSU model, followed by an assessment of student performance, perception and retention through its initial implementation.

**Why Does Website Accessibility Matter?**

Carol Buechler
*Buechler Computers and Engineers*

You may say "it's the Law, or it soon will be for me." And that could be true. But I am going to say that any time computer people work on how to communicate information, everyone wins. Have you noticed that mental health clients have no standard for style, no rules and a logo to win? It is my contention what those standards would entail appropriate software and not just beta testing programs to be featured next month in a magazine. Those standards would also involve affordable machines since limitations in medical insurance mean you are buying services or pills rather than new/fast/small/state of the art/maxed out gizmos. You know the website you built (or rebuild) in great detail and how this week's offering is different from that of a month ago. To the first time visitor, the issue is communication: can you meet my needs, answer my questions, confirm.

**University of Cincinnati ICARUS BaLLOONS, Past Present, and Future**

Matthew Urbaniak
*University of Cincinnati*
*Jenna Stahl*
*University of Cincinnati*
*Josh Cory*
*University of Cincinnati*

The University of Cincinnati, Department of Aerospace Engineering through the financial support of the Ohio Space Grant Consortium has developed a high-altitude balloon launch program entitled ICARUS BaLLOONS (Instrumentation Carrier for Aerospace Research in the Upper Stratosphere utilizing Balloon Launch of Low-cost Original Operational Nano-Satellite technology). This presentation will showcase the accomplishments of the program, show the present activities of the students, and discuss the goals of the program. The evolution of the program from its conception to its current activities in the support of student programs within the Department of Aerospace Engineering such as the Senior Satellite Design BEARSat will be discussed. The presentation will conclude with the goals of the program and the future plans for launches and expanded scientific research.

**A Unique Approach to Service Learning:**
**The ETHOS Program At The University Of Dayton**

Nicholas Hoffman
*the University of Dayton*

*Eric Urban*
*the University of Dayton*

The emphasis of the ETHOS program at the University of Dayton is placed on ideas and implementation of Appropriate Technology, Sustainable Development and Service-learning through technical immersion, integrated classroom work, collaborative research and on-campus activities. An overview of the UD ETHOS program will be given, highlighting some of the differences between ETHOS and similar programs. Experiences from technical immersion trips will be discussed as well as some of the possibilities for the future of the ETHOS program.

**Faculty Course Assessment as a Part of the Accreditation Board of Engineering and Technology (ABET) Accreditation Process for the Cedarville University Engineering Department**

Jeff Shortt
*Cedarville University Engineering and Computer Science Department*

The Cedarville University Engineering Department has currently undertaken the effort to renew the accreditation of the Mechanical and Electrical Engineering programs and to apply for accreditation of the new Computer Engineering and Computer Science programs. Faculty course assessment documentation is an important part of the accreditation process. The presentation shall describe the overall program implementation in which this part of faculty participation is to occur at Cedarville University. Briefly, the Engineering Department Assessment Committee has asked the faculty to document the course progress, changes, grades, etc. in one of two specific formats suitable for ABET review. After this description, examples will be presented to illustrate the documentation of the reports. Some interesting results have been noted from this and those will be presented.

**<u>Materials II</u>:** **3:20-4:40 PM** **Room E156B**

**Heat Treatment and Processing of Boron Modified Beta-Titanium Alloys**

Balakrishna Cherukuri
*Wright State University*

*Dr. Raghavan Srinivasan*
*Wright State University*

Trace boron additions have been shown to reduce the grain size of to titanium alloys in as-cast condition. Two beta titanium alloys: Beta-21S and Ti-5553 with 0.1 wt% B and without boron additions were studied. The alloys were solution treated above the beta transus temperature to investigate the grain growth. The alloys were aged from the solution treated condition at different temperatures and times to study the kinetics of alpha phase precipitation. Room temperature plane strain compression testing was carried out to evaluate the feasibility of cold rolling Beta-21S. Initial results suggest that the boron addition restricts grain growth above the beta transus temperature. Other results presented will include comparisons between boron modified and unmodified alloys, detailed microstructural characterization of grain size distribution, TiB particles and alpha phase precipitation. Mechanical properties of heat treated alloys will be presented in the light of enhanced properties achieved through boron additions.

**Kinematically Designed Flexible Skins for Morphing Aircraft**

Christine Pastor

*University of Dayton*

*Brian Sanders*
*Air Vehicles Directorate, Air Force Research Labratory*

*James Joo*
*University of Dayton Research Institute, Aerospace Mechanics*

*Robin McCarty*
*University of Dayton*

This investigation targeted the development of flexible materials that when combined with mechanized structures can enable large rigid body deformations of aircraft structures while maintaining its aerodynamic shape. The solution presented in this work focuses on determining the distribution of material properties to design such a skin using topology optimization techniques. The matrix material selected in this research is a representative Shape Memory Polymer (SMP), which is embedded with a reinforcing fiber. The fiber plays a dual role in that in addition to serving as a reinforcing element it also provides the means to activate the material response (e.g., changing cross link density) via resistive heating. In depth heat transfer analysis and experiments were conducted to understand power requirements and minimum spacing of the fibers to activate the desired material response.

**Strain Dependent Material Properties of Had Coatings**

Shad Reed
*Air Force Institute of Technology*

*Anthony N. Palazotto*
*Air Force Institute of Technology*

*William Baker*
*Air Force Institute of Technology*

A novel vibration experiment consisting of a free-free boundary condition, an electromagnetic excitation source, a vacuum chamber, and a laser vibrometer based surface measurement system has been developed that permits high levels of excitation on highly damped specimens with a minimal amount of unwanted systematic error. The experiment was used to identify the strain dependent damping and stiffness properties of a material used in free-layer damping treatments. Existing data sets from other sources indicate that the properties of this material are dependent upon the initial conditions of the experiment and this study will attempt to verify this claim. Several free decay vibration tests will be performed starting from different initial amplitudes and the results will be compared. Additionally, the presentation will address other potential complications associated with this material such as long term memory effects and temperature dependencies.

**Biocompatibility of Carbon Nanomaterials**

Christin Grabinski
*University of Dayton and Air Force Research Laboratories*

*Khalid Lafdi*
*University Dayton, Department of Chemical and Materials Engineering*

*Saber Hussain*
*Applied Biotechnology Branch, Human Effectiveness Directorate, Air Force Research Laboratory*

*John Schlager*
*Applied Biotechnology Branch, Human Effectiveness Directorate, Air Force Research Laboratory*

In evaluating biocompatibility of nanomaterials, it is important to understand how individual physicochemical parameters affect their toxicity. In this in vitro study, the cellular effect of four well-characterized carbon-based materials possessing diameters from micro- to nano- dimension were investigated using mouse keratinocytes (HEL-30) as a representative model for skin toxicity. The materials tested included conventional fibers (CF; 10 um diameter), nanofibers (NF; 100 nm diameter), multi-walled nanotubes (MWNT; 10 nm diameter), and single-walled nanotubes (SWNT; 1 nm diameter). CF and NF did not significantly affect cell viability, but MWNT and SWNT reduced cell viability in a time-dependent manner up to 48 hours. The results of this study suggest that decreasing dimension increases toxicological affects to cells. When decreasing the dimension of a material, however, the surface energy increases. Further studies are needed to determine the toxicological effect of surface energy with constant dimension.

**Computer Science:** **3:20-5:00 PM** **Room E156C**

### Dynamically Building Inter-connections Between On-chip IP Cores

Fei Wang

*Jack Jean*

Commercial FPGA chips can only support 1D partial reconfiguration, and connections between on-chip IP cores are predefined at compile time. 2D partial reconfiguration with dynamic connections has been a dream because of higher chip utilization. In a dynamic partial reconfiguration environment, how to place a new IP core while keeping necessary connections with it? What's the area cost of associated infrastructures? What's time cost to build such connections online? This research explores those questions. An operating system kernel is expected to manage on-chip IP cores and their connections. Performances of the operating system and cost of the new chip architecture are evaluated.

### The Morphable Nanoprocessor Architecture: Reconfiguration at Runtime

Justin Teller
*Electrical and Computer Engineering Department, The Ohio State University*

*Fusun Ozguner*
*Electrical and Computer Engineering Department, The Ohio State University*

*Robert Ewing*
*US Airforce Research Laboratory, Wright-Patterson Air Force Base*

We have identified the nanoprocessor architecture as a classification tool for current and future explicitly parallel computing machines. Nanoprocessor architectures enable logical reconfiguration, optimizing the hardware for the application. Previous research proposes fixing the configuration at compile time [6,10,13]. We propose changing the configuration at runtime, enabling the nanoprocessor architecture to "learn" a more optimal way to use computational and memory resources in a changing computational environment. We introduce three optimizations to use for reconfiguration: dynamic prefetching, dynamic multi-threading, and binary optimization. We examine GPS acquisition as an example application, showing that runtime reconfiguration using dynamic prefetching is an appropriate optimization. Finally, we demonstrate that runtime reconfiguration increases GPS acquisition performance by over 25% in some cases.

**Analysis Of Large Scale Image Data Using Out-Of-Core Rendering Techniques**

Chandrashekara Hassan Raju
*Wright State University*

*Thomas Wischgoll*
*Wright State University*

Analysis of large scale image data has many applications in the medical and health related fields. The application domain of this field even extends beyond these areas. It is of great importance to analyze image-based datasets by extracting important features to understand the underlying structure of the data for further analysis by the specialist. One of the main challenges researchers are facing is to work with large scale image data which might range from several megabytes to several gigabytes. For example, microCT scans at high resolutions, such as 4-6µm, can easily consist of up to a few gigabytes in size. The objective of this research is to analyze such large scale image datasets using out-of-core techniques based on memory mapping allowing the software system to process datasets that exceed the amount of main memory present in the computer system.

**Security and Access Control in Collaboration Systems: Challenges and Future Direction**

Jian Zhu

*Dr. Waleed W. Smari*

Proliferation of computer based collaboration brings new issues and concerns to the area of security and access control of computing and networking systems. New requirements should be fulfilled and new security technologies and measures should be developed to meet this challenge. This paper/presentation addresses the additional concerns, methods, and proposed solutions associated with collaboration systems security. It will discuss specific challenges and requirements according to the characteristics of these systems and their applications. It will also investigate the current state-of-the-art that emphasizes various aspects of security and access control and explore some of the promising approaches and future directions.

**CTRNN-EH Controllers: Implications towards building Artificial Nervous System for Biomimetic Micro Air Vehicle**

Sanjay Boddhu
*Department of Computer Science and Engineering, Wright State University.*

*John C. Gallagher*
*Department of Computer Science and Engineering & Electrical Engineering, Wright State University.*

One of the major challenges in envisioning the Biomimetic Flapping Wing Air Vehicle (BFMAV) is the design of a highly dynamical rhythmic pattern generator, which is crucial for appropriate actuation of the wing motion at different phases of flight. This presentation discusses the rationale to employ CTRNN-EH (Continuous Time Recurrent Neural Networks-Evolvable Hardware) approach in designing these adaptive flapping pattern generators for BFMAVs. The basis for this work is based on the previous successful efforts in designing highly efficient locomotion controllers for walking robots and feasibility of low-power and small area analog hardware implementation of the same. A brief summary of relevant ongoing experiments and their inferences for the future work will be provided.

**<u>Design & Optimization III:</u>** **3:20-4:40 PM** **Room E157**

### Multi-Disciplinary Optimization of a Distributed Actuation System in a Flexible Morphing Wing

James Westfall
*Air Force Institute of Technology, Wright-Patterson AFB, OH 45433*
*Dr. Robert A. Canfield*
*Associate Professor, Air Force Institute of Technology, Wright-Patterson AFB, OH 45433*
*Dr. James J. Joo*
*Aerospace Mechanics Division, University of Dayton Research Institute, Dayton, OH 45469*
*Dr. Brian Sanders*
*Air Vehicles Directorate, Air Force Research Laboratory, Wright-Patterson AFB, OH 45433*

This study investigates the optimal distribution and orientation of actuators throughout an in-plane morphing flexible wing structure. The drive to minimize structural weight causes a wing to be more flexible, and the location and orientation of the actuators become more critical as the structure becomes more flexible. It will be shown that the optimal location and orientation will vary depending on the loading conditions and initial configuration of the wing. Sequential quadratic programming optimization techniques are utilized to locate and orient those actuators, and also to effectively size the members of the structure, for various loading conditions and configurations. The optimization problem is stated such to minimize weight, while maximizing the geometric advantage and efficiency of the system. Initially, a purely rigid system, for both the single cell and three cell models are studied. Next, the elastic case for both the single cell and three cell models are examined.

### Path Planning Algorithm Creation -Discussion Of Principles

Alan Jennings
*Department of Electrical and Computer Engineering, University of Dayton*
*Raúl Ordóñez*
*Department of Electrical and Computer Engineering, University of Dayton*

Path planning is a developing field in response to the demand for autonomous decisions and the advances in computation and sensor power. The principles of how to compose and simulate a path planning algorithm are presented. The goal of the presentation is to instruct how to implement and tailor path planning for particular applications. The application of the presentation is to a three-wheel hand cart (pallet jack) following the Dubin's car model. Self-image requirements are explained and how they relate to vehicle dynamics. Path composition is based on determining sub-goals to avoid obstacles. From the path, steering and velocity commands are composed. Results are simulated using a quick approximation and a more computational solution. Limitations arise from the algorithm and approximations; both should be ascertained through simulations.

**Integrated Conceptual Design of Joined-Wing Sensor-Craft Using Response Surface Models**

Josh Dittmar
*Air Force Institute of Technology, Wright Patterson Air Force Base, OH 45433 USA*
*Robert A. Canfield*
*Air Force Institute of Technology, Wright Patterson Air Force Base, OH 45433 USA*

Discussion of integrated multidisciplinary conceptual design and analysis of Boeing's joined-wing SensorCraft. The analysis was completed using structural optimization, aerodynamic analyses, and response surface methodology on a composite structural model and integrated with Phoenix Integration's ModelCenter software. Design variables were: front wing sweep, aft wing sweep, outboard wing sweep, joint location, vertical offset and thickness to chord ratio (t/c). This research demonstrated the utility of integrated low-order models for fast and inexpensive modeling of unconventional aircraft designs.

**StrongMobile Aircar Project**

Richard Strong
*Safety Analysis Systems Co.*

The design was the subject of the inventor's Aeronautical Engineering course at the University of Michigan in 1963 and has evolved over time to be a viable flyable automobile concept. His latest effort was building and exhibiting a full-size mockup model at the Experimental Aircraft Association's AirVenture 2005. The project is developing an aircar system that can carry people safely and easily from door-to-door on frequent medium-range trips, such as routine regional business travel. The Magic Dragon design is of a single-unit vehicle that can be operated either as an automobile or as an airplane, with automatic 'push-button' transformation, just like magic. StrongMobile Magic Dragons will have a payload of a driver-pilot and either one passenger or three passengers and baggage, or an equal amount of cargo or equipment. Flight performance is estimated to compare favorably with current lightplanes or airliners, on a door-to-door basis. More is at www.strongware.com .

**<u>Biomedical Engineering</u>: 3:20-5:20 PM Room E163A**

**Validation Methodology of a Dynamic Pneumatic Muscle Model**

Jennifer Garber
*Department of Biomedical, Industrial and Human Factors Engineering, Wright State University*
*Dr. David B. Reynolds*
*Department of Biomedical, Industrial and Human Factors Engineering, Wright State University*
*Dr. C. A. Phillips*
*Department of Biomedical, Industrial and Human Factors Engineering, Wright State University*

A methodology has been created to further validate the previously proposed three-element dynamic characterization model for a pneumatic muscle actuator. This model is a parallel configuration of a spring element, damping element and contractile element. The model coefficients were determined from dynamic responses to step decreases in loading. The proposed methodology will attempt to utilize this three-element model with dynamic loading in the form of ramp functions to characterize a commercially available muscle. Currently, the test system does not allow for the use of dynamic loading, and therefore a new pneumatic muscle test station is being created for this proposed research. The overall objective of this research is to use these characterized parameters to simulate the operation of a physical assistive device.

### Dynamic Control System Modeling for an Assistive Pneumatic Muscle

Maria Gerschutz
*Department of Biomedical, Industrial, and Human Factors Engineering, Wright State University*
*Dr. C. A. Phillips*
*Department of Biomedical, Industrial, and Human Factors Engineering, Wright State University*
*Dr. D. B. Reynolds*
*Department of Biomedical, Industrial, and Human Factors Engineering, Wright State University*

Pneumatic muscle (PM) actuators have two major benefits compared to other actuators: greater power/weight and power/volume ratio. It acts similarly to skeletal muscle which is beneficial in designing assistive devices for human muscle. However, PM actuators are difficult to control due to nonlinearities regarding pressure change in the bladder. An assistive PM control system is constructed based on a three-element model. It is composed of a contracting, damping, and spring element in parallel. The task analyzes the sit-to-stand motion focusing on the moments about the knee. A control schematic was designed to simulate the required voltage/pressure profiles to allow the human to stand. Cases were formulated to simulate different scenarios. The simulated data indicated the feasibility of the task. Future work will extend to include the control system time constant and actual human kinematic/kinetic data. The research goal is to utilize the voltage/pressure profiles to operate a mechanical system.

### Prosthetic Lumbar Disc Concept for Alleviating Spinal Dysfunction

Mary Kundrat
*University of Dayton, PhD Candidate, DAGSI Fellow*

To maintain people's mobility and quality of life as long as possible, it is necessary to repair, or sometimes even replace parts of the human body. The spine endures tremendous amounts of force, stress, and fatigue. Excessive loading and even normal daily activities can contribute to vertebral fractures, disc herniation and disc degeneration. This fuels the need for new medical implants and biomaterials as a means of alleviating spinal dysfunction. Bioceramics have the potential to ensure the stability and success of a lumbar spinal implant. This theory was verified using finite element analysis which compared how a healthy disc, a degenerated disc, a spinally fused lumbar segment and a ceramic disc performed with respect to each other, under normal loading situations. The results indicated a prosthetic disc composed of a ceramic material offered the best alternative to a healthy disc with respect to maintaining proper lumbar spine mobility and function.

### Assessment of Bone Strength through Finite Element Analysis Based on Radiographs of the Forearm

Bino Varghese
*BioMedical Imaging Laboratory, Wright State University & Miami Valley Hospital, Dayton, OH, USA*
*Thomas N. Hangartner*
*BioMedical Imaging Laboratory, Wright State University & Miami Valley Hospital, Dayton, OH, USA*

*Marvin E. Miller*
*BioMedical Imaging Laboratory, Wright State University & Children\'s Hospital, Dayton, OH, USA*

In this study we are trying to predict the strength of the human radii. Using the geometric information of radii from radiographs we construct 3D finite-element models, assuming that all bone cross-sections are elliptical in shape. The finite-element models are subjected to cantilever loading to determine locations in the bone with the highest propensity to fracture (i.e. points of maximum stress). In the constructed models of both normal (18 infants) and diseased (11 temporary brittle bone infants) cases, the variation in bone strength solely due to changes in bone architecture are studied. The material properties are left unaltered. The receiver operating curve (ROC) analysis of the maximum fracture load normalized for bone length showed an 81.8% area under the curve. Other parameters indicative of bone strength such as section modulus, cortical thickness and bone length had an ROC value of 75.3%, 73.2% and 62.6%, respectively.

**Comparing a Model for Pneumatic Muscle with the AV Hill Model for Skeletal Muscle**

Allison Gadd
*Department of Biomedical, Industrial and Human Factors Engineering, Wright State University*
*David Reynolds*
*Department of Biomedical, Industrial and Human Factors Engineering, Wright State University*
*Chandler Phillips*
*Department of Biomedical, Industrial and Human Factors Engineering, Wright State University*

A common issue when dealing with the characterizations of a pneumatic muscle (PM) is the non-linearity of the PM's response. Reynolds and co-workers have previously found that the response of an in-house built PM could be modeled with a linear equation with pressure dependent coefficients in which a certain input pressure (P) generates a contractile force to lift a hanging external force (Fext). The aforementioned model was built in Simulink® and the input pressure and the external applied force could be easily changed. Various combinations of P and Fext where used in order to manipulate the model. The output responses were found to be similar to the AV Hill force-velocity profile. The models still differed in several significant ways probably resulting from the underlying differences in PM and skeletal muscle.

**Review Of Biomechanics And Design Issues for Total Ankle Replacement Models**

Junitha Michael
*Dr.Tarun Goswami*

Only two Total Ankle replacement (TAR) are approved by FDA namely Agility total ankle system by Depuy Orthopedics Inc., Warsaw, IN and Topez Total Ankle replacement by Topez Orthopedics, Inc. The long-term survivability of these two designs is not up to the expectations because of the inability to restore adequately the critical mutual function of the ligaments and the articular surfaces. A four bar linkage mechanism is proposed to simulate the mechanics of the intact and replaced ankle joint. Based on previously validated mathematical models, elementary objects were used to model ligaments, articular surfaces, retinacula, and muscle-tendon units. The newly proposed convex-tibial ligament-compatible prosthesis was found to restore the mobility and physiological function of the ligaments. This prosthesis provides congruence of the components throughout the range of flexion. This study is a part of early work conducted by the Senior author which will be followed up for a Doctoral research.

**Industrial and Human Factors III:** 3:20-4:00 PM Room E163B

**Emergency Severe Wound Containment Treatment Device Evaluation: An Effective Deployment Feasibility Experiment**

Mitchell Roth
*Boonshoft Museum of Discovery*

Suffocation due to space suit damage has precluded the need for severe hemorrhage trauma procedures to date. During extraterrestrial construction necessary for bases on the moon or beyond, personnel will work with larger equipment and possibly in areas without space suits. The probability of trauma increases with the scale of projects. Body fluids released in weightlessness have great potential to compromise mission objectives and personnel. Both initial wound treatment and fluid containment under microgravity conditions show a need for quickly available and effective means. To minimize expenditures, this means must be effective despite limited medical training, experience, or treatment proximity. Challenges to physical interaction of mission personnel and equipment can also be considerable; the basic deployment characteristics of trauma treatment need to be established. This test was designed as a "best case" scenario to focus on device functionality in ideal conditions to form a baseline for further evaluations.

**Evaluation of a Multimedia Job Performance Aid**

Kristie Nemeth
*University of Dayton Research Institute*
*Laurie Quill*
*University of Dayton Research Institute*
*Christopher Mooney*
*Kelley's Logistics Support Systems*
*Robert Fudge*
*Kelley's Logistics Support Systems*
*Justin Adams*
*Air Force Research Laboratory*

As part of a Small Business Innovation Research Project (SBIR) for the Air Force, a multimedia job-aiding training tool was developed to support learning of flightline maintenance task information. A comparative evaluation was conducted between the traditional presentation of maintenance task information (standard electronic Air Force technical manual), and a learning enhanced information presentation (JATT software presentation). Preliminary results show that the learning enhanced presentation allowed participants to complete maintenance tasks faster, with fewer errors and assists.

**Electronics and Sensors:** 4:00-5:20 PM Room E163B

**Feature Extraction Algorithm for 3D Scene Modeling and Visualization Using Monostatic Synthetic Aperture Radar**

Julie Jackson
*The Ohio State University*

*Randolph L. Moses*
*The Ohio State University*

We present a feature extraction algorithm to detect scattering centers in three dimensions using monostatic synthetic aperture radar imagery. We develop attributed scattering center models that describe the radar response of canonical shapes. We employ these models to characterize a complex target geometry as a superposition of simpler, low-dimensional structures. Such a characterization provides a means for target visualization. We present an algorithm to detect canonical scattering structures amidst clutter and to estimate the corresponding model parameters, such as size and orientation. We employ full-polarimetric imagery to accurately classify canonical shapes. Interformetric processing allows us to estimate scattering center locations in three-dimensions. We apply the algorithm to scattering prediction data of a simple scene comprised of canonical scatterers and to scattering predictions of a backhoe.

**Change in the Dynamic Response of Pressure Transducers from Elevated Temperatures**

Steven Page
*Wright State University*

*Mitch Wolff*
*Wright State University*

A continuous effort to increase turbine engine efficiency has lead to a need for better optimization of turbine blades. Measuring the flow around high-pressure turbine blades is uncertain do to extreme temperature and uncertain effects of that temperature on the transducers dynamic response. The Wright State University Shock tube facility has been adapted to test pressure transducers at a one megahertz frequency range and temperatures exceeding 500 Celsius. A pressure transducer supplied by NASA has been tested. The results show changes in the resonant frequency location of two percent with temperature.

**Near-field Scanning Optical Microscopy**

Weibin Chen
*Electro-Optics Graduate Program, University of Dayton*

*Lirong Sun*
*Electro-Optics Graduate Program, University of Dayton*

*Andrew Sarangan*
*Electro-Optics Graduate Program, University of Dayton*

*Qiwen Zhan*
*Electro-Optics Graduate Program, University of Dayton*

Near field scanning optical microscopy (NSOM) has stimulated continuous research interest recently. The general aim of near field optical microscopy is to extend spatial optical resolution beyond the diffraction limit. Unlike other scanned probe techniques such as scanning tunneling microscopy and atomic force microscopy, which aim at surface configuration of sub-wavelength structure, near field scanning optical microscopy optically resolves the temperature and stress distribution in sub-wavelength devices. We describe the characterization of a silicon micro-optics structures with near-infrared near field scanning optical microscope. A novel silicon micro-optic device is designed and fabricated to improve the fill factor of detector arrays. In order to verify the design and fabrication, the optical field transmitted through the micro-optic device needs to be measured. Using a tuning fork feedback, both topographic and optical images of the silicon micro-optical devices are collected simultaneously. The optical image allows direct performance assessment of the devices.

**Analysis of MUSIC for Angle of Arrival Estimation of Continuous Wave Interference**


Greg Distler
*Miami University*

*Matt Brenneman*
*Miami University*


Weak signals are subject to various types of interference. This can either be unintentional noise or intentional jamming from an outside source. If the direction of the source can be determined, beam forming or null steering can be used to eliminate the interference. MUSIC is a commonly used eigenstructure method of angle of arrival (AOA) estimation. This method works well in certain situations, but there are factors that can affect its performance. In this presentation, several of these signal characteristics will be analyzed so we can search for the limitations of MUSIC. The three main factors that were analyzed were signal power, length of signal data collected, and error in estimating the frequency. A continuous wave (CW) signal was used as the simulated signal, and these three factors were varied to provide a good analysis of the limitations of MUSIC.