DESS 2011 - Book of Abstracts

SESSION 1: Structures/Solid Mechanics I	8:00 - 9:40 AM	Room 156A

Chair: Dr. Benjamin P. Smarslok, Air Force Research Laboratory

8:00 AM - DESS11-0076

Significance of Geometric Nonlinearity in Structures with Restrained Thermal Expansion

Josh Deaton
Wright State University

Ramana Grandhi
Wright State University

Modern day aerospace thermal structures, including engine exhaust-washed structures for embedded engine aircraft and integrated thermal protection systems for high-speed flight and atmospheric reentry vehicles, experience high temperature environments with no sufficient design prescription to allow for thermal expansion to occur. Since the majority of these structures are characterized by plate- or shell-like geometry, the case of restrained expansion leads to out-of-plane deformation that may exhibit geometrically nonlinear behavior due to the configuration dependency of thermal loading. Thus, it becomes important include the effects of deformation on the structure's stiffness and loading to properly account for follower forces and stress stiffening behavior in analysis. In this presentation, the effects of geometric nonlinearity on structures with highly restrained thermal expansion are investigated. Emphasis is placed on investigating potential trends or metrics to identify when geometric nonlinearity must be considered in typical aerospace thermal structures to aid in future design and optimization.

8:20 AM - DESS11-0092

Fatigue Crack Detection Using Guided Waves

John E. Little II
Air Force Research Laboratory

Detection of fatigue cracks in metal structures is an important task for maintaining safety in aircraft and other structures. This work describes a method for crack detection in aluminum dogbone test coupons using guided waves. Guided waves are generated and sensed by piezoelectric transducers bonded to the coupons. These waves are affected by the mechanical and geometric features along the propagation path. Therefore, when the waves travel through a portion of a coupon with a crack, response signals are affected. A baseline response signal will be compared to response signals collected at intervals between fatigue cycling for crack detection purposes. This presentation will show plots of response signals for crack lengths ranging from 0 to over 1 inch. Additionally, a damage index based on the correlation coefficient between the baseline and test signals will be shown to be a reliable indicator of crack length.

8:40 AM - DESS11-0085

Investigation of Curvature Effects in Laser Peening using 3D FE Models

Anoop Vasu
Wright State University

Ramana V Grandhi
Wright State University

Laser Peening (LP) is a surface enhancement technique which can impede crack initiation and propagation by inducing favorable compressive residual stresses. High stress concentration along the curved portion of a structural component is a common cause for crack initiation, which can lead to fatigue failure. Most fatigue cracks nucleate near the surface and propagate into the component. In this work, a 3D finite element model is created using ABAQUS to simulate the non-linear dynamic response for curved geometries. Concave and Convex curvature models are constructed and compared with flat geometry. Results obtained shows that curvature can play an important role in residual stress prediction and should be considered to determine the fatigue life of components with complex geometries.

9:00 AM - DESS11-0096

The Effect of a Graded Layer on General Bimaterial Interfaces

Craig Baudendistel
Wright State University

Dr. Nathan Klingbeil
Wright State University

The proposed research incorporates a grading of material properties between two dissimilar layers with which to eliminate an abrupt step change that is typically modeled in bimaterial interface problems. A smooth change allows for the use of well-known fracture mechanics equations to define the mode that in general, is ambiguous when an elastic mismatch is present. Not only would a graded layer model provide a concrete definition of mode for any layered geometry, it would help estimate fatigue properties based on the total plastic dissipation ahead of a propagating crack in ductile metals. In addition, a four-point-bending specimen is being used to validate this energy-based crack growth theory for a mixed-mode case. Successful validation would serve to decrease the evaluation time needed for next generation materials that could be used in applications where advanced properties are required. Also, minimal testing decreases costs associated with the implementation of these new-age materials.

9:20 AM - DESS11-0119

Fatigue Crack Modeling and Analysis in Beams

Phillip Cooley
Wright State University

Dr. Joseph C. Slater
Wright State University

Oleg V. Shiryayev
Petroleum Institute Abu Dhabi

Crack identification in critical aircraft components is often expensive and time consuming. It is the goal of this research is to use vibration features to develop faster and more reliable methods for identifying cracks in simple structures that can then be applied to more complex geometries such as bladed disk assemblies. The closed form response of a cracked spring hinge-free beam to base excitation is obtained by treating the crack as a point bending moment. Nonlinearities introduced by cracks are magnified and used to generate spectral crack signature profiles for identification of crack location and severity. Closed form results are validated against simulation data, and future experiments will be used for calibration and further validation. Successful crack characterization with this method is expected to contribute to the development of an automated Structural Health Monitoring (SHM) system for the detection of fatigue cracks in aircraft engines.

SESSION 2: Materials I	8:00 - 9:40 AM	Room 156B

Chair: Prof. Anthony N. Palazotto, Air Force Institute of Technology

8:00 AM - DESS11-0014

Quantifying the Effects of Spatial Resolution on the Accuracy of 3-D Microstructural Feature Characterization

Gregory Loughnane
Wright State University

Ramana Grandhi, Raghavan Srinivasan
Wright State University

Michael Uchic, Michael Groeber
Air Force Research Laboratory

Matthew Riley
University of Idaho

Megna Shah
UES Inc.

An integral part of the development of microstructure-property relationships is the characterization and representation of microstructure in three dimensions (3D). The choice of spatial resolution for experimentally-collected 3D microstructural data used for characterization is often governed by general rules of thumb based on ad hoc estimates of fidelity requirements. For example, in serial sectioning experiments it is generally accepted that one would like a minimum of 10, but preferably at least 20 sections through a microstructural feature to accurately describe its size and shape. However, the desire to collect high resolution serial section data is tempered by the cubic growth in collection time with increasing spatial resolution. This work aims to quantitatively determine the minimum number of sections relative to the mean feature size to achieve a user-defined accuracy for selected characterization parameters, such as the equivalent sphere diameter.

8:20 AM - DESS11-0023

A Relational Grade Analysis Approach to Optimize Carbon Based Supercapacitor Materials

Priem Cyril
University of Dayton

C. Priem, B. Alresheedi, L. Li, K. Lafdi
University of Dayton

Supercapacitors are energy storage devices. They use electrolytes and configure various-sized cells into modules to meet the power, energy, and voltage requirements for a wide range of applications. Carbon based supercapacitors seems to improve greatly the energy density. Their performance are based on the carbon type, crystallinity and surface area using subsequent carbonization and activation processes. In this study, we used mathematical approach based on relational Grade analysis and the Grey Systems theories to carefully select the key materials parameter responsible for the capacitance improvement. Using nanostructured carbons seems to provide high conductivity and high BET surface area to reach maximum capacitance values.

8:40 AM - DESS11-0032

Bio-friendly Metal-Intercalated Polymers for Antimicrobial Applications

Nicholas Jones
University of Dayton

Marlin Vangsness
University of Dayton Research Institute

Yiling Hong, Khalid Lafdi
University of Dayton

Hydroxyapatite is a commonly used biocompatible agent in medical implants because it is known to be nontoxic. Silver has long been known to possess antimicrobial qualities, but its use in medical settings has been limited due to its toxicity in the human body. In hard-tissue implants bacterial infection and host acceptance are always chief concerns, so it would be preferable to create a material which combines the biocompatibility of hydroxyapatite with the antimicrobial activity of silver so that it is toxic to bacteria but not to humans. Antimicrobial testing was carried out to determine the toxicity of silver-intercalated hydroxyapatite to Pseudomonas. In preliminary tests, cultures containing 3mg of 20% silver-intercalated hydroxyapatite in 10 ml tryptone soy broth (TSB) showed no appreciable bacterial growth (average ATP reading of 54) after 72 hours, while cultures containing the same concentration of hydroxyapatite were overgrown (average ATP reading of 74,000) within the same period.

9:00 AM - DESS11-0122

Low Temperature Melting Elements (Ag, Cu) Nanorods Thin Films grown using Oblique Angle Deposition on Crystalline substrates

Piyush Shah
Wright State University

Xiaoxu Niu, Andrew Sarangan
University of Dayton

Adatom surface mobility's of low melting temperature elements such as Silver, Copper, Gold etc. are significantly higher which prohibits and negates the effect of atomistic shadowing for the growth of nanostructured nanorods thin films on crystalline substrates. It is known that nanorods thin films exhibit novel optical, electrical, and magnetic and other physical properties. Silver nanorod thin films have shown the potential to be considered for future metamaterials development. In this research, we discuss a technique to minimize the high surface mobility effects for growth of silver and copper nanorods thin films on crystalline substrates (Si).

9:20 AM - DESS11-0112

Fabrication of Metal Nanoparticles on Hierarchical Carbon Nanostructures for Advanced Catalysis

Hema Vijwani
Wright State University

Sharmila M. Mukhopadhyay, Abinash Agrawal
Wright State University

The effectiveness of catalysts can be significantly enhanced if surface area in a given volume is increased by the creation of hierarchical nanostructures. This concept is demonstrated here in the Palladium-graphite system. Pd nanoparticles are deposited on porous carbon-foam substrates whose surface area has been increased by orders of magnitude through the attachment of carbon-nanotubes. This type of structure can lead to unprecedented miniaturization of catalytic devices since a very small amount of precious metal can be used to provide high level of surface activity in very compact volume. Potential devices include sensors, water-purification systems, fuel-cell electrodes and hydrogen storage devices. In this project, fabrication issues of these structures will be presented along with microstructure and spectroscopic analysis. Electrochemical behavior and water purification capabilities of these structures are being investigated in collaboration with other groups, and initial results are very encouraging, indicating extensive application potential of these structures.

SESSION 3: CFD/ Fluid Dynamics I	8:00 - 9:40 AM	Room 156C

Chair: Dr. Scott Stouffer , University of Dayton Research Institute

8:00 AM - DESS11-0030

A Pressure-Correction Based Galerkin Projection Method For Flapping Wings

Zongxian Liang
Wright State University

Haibo Dong
Wright State University

Philip Beran
Air Force Research Laboratory

Direct numerical simulation (DNS) and POD-Galerkin projection using a general pressure correction method are conducted for a flapping wing in pitching and plunging motion with a pitching amplitude of 10º, 20º and 30º. POD analysis shows that most turbulent kinetic energy (95%) is contained by the first four modes. The importance of pressure correction for Galerkin projection is discussed in terms of the reduced prediction error. It also shows the effectiveness of current POD-Galerkin projection method for developing reduced order models of two-dimensional flapping wings.

8:20 AM - DESS11-0031

Computational Study of a Pilot Flame Ignition Strategy in a Stratified Charge Rotary Engine

Zachary Votaw
Wright State University

A 3D computational model of a rotary engine, similar in size to that of the AR741 engine used in the US Army's RQ-7 Shadow, is applied to investigate the ignition and combustion quality of a diesel stratified fuel charge by pilot flame ignition as opposed to spark ignition. Some research has indicated that a pilot flame approach to ignition provides better ignitability, especially for lean mixture ranges (T. Muroki, 2000). In the 3D rotary engine model, the diesel fuel charge in the main combustion chamber is ignited with a pilot flame issuing from a pre-combustion chamber attached to the exterior of the rotor housing. Ansys Fluent software is utilized for conducting CFD analysis on a variety of models for determining the potential gains of employing the pilot flame ignition system.

8:40 AM - DESS11-0039

The Role of Flexibility in Dragonfly Turning Flight

Chengyu Li
Wright State University

Haibo Dong, Samane Zeyghami
Wright State University

Clever maneuver, for capturing food or avoiding predation by natural enemies, can be commonly observed in insect flights. In this work, an integrated study combining high-speed photogrammetry and direct numerical simulation (DNS), for a freely flying dragonfly (Erythemis Simplicicollis) in 110 degree turn, is used to reveal both aerodynamic and dynamic roles of its body and wings. Quantitative measurements have shown the significant difference of deformation between all wings as well as up to 18 degree bending of the tail. Unsteady 3D vortex formation and associated aerodynamic forces calculated from high-fidelity simulations are used to illustrate how the turn is accomplished within three dragonfly wing beats. This work is supported by NSF CBET-1055949.

9:00 AM - DESS11-0042

A Study of Effect of Wing Damage on Insect Flight Agility

Zhe Ning
Wright State University

Haibo Dong, Samane Zeyghami, Kuo Gai
Wright State University

In this work, how the insect flight behavior contributes to its adaptability to limited performance condition is studied through a combined experimental and computational study. High speed photogrammetry is used to collect the data of dragonflies' takeoffs with intact and damaged wings along the chord and span separately. Then the effect of the spanwise and chordwise wing damage is investigated. Results show that both changes have different effects on the wing and body kinematics and the merit of maneuverability. A new theory will be introduced to explain the wing damage tolerance behavior of the dragonfly flight.

9:20 AM - DESS11-0040

Development of a Graphical Software Tool for Proper Orthogonal Decomposition

Cody Lafountain
University of Cincinnati

Kelly Cohen, Awatef Hamed
University of Cincinnati

This project describes the continuing development of a graphical software tool to perform fast Proper Orthogonal Decomposition (POD). POD is a mathematical method used to develop reduced-order models of complex phenomena. The software, called ssPOD, is written in MATLAB and uses optimized matrix manipulation routines to quickly calculate the POD modes and time coefficients for use in model construction. The software shows good correlation with an existing code. Current uses being studied include spatial analysis of supersonic cavity flows as a precursor to developing more effective active flow control systems and removing smoke from video for use in Unmanned Aerial Vehicles (UAVs) providing real-time support to wildfire fighters on the ground. The software is written such that it can be used with many types of input data for disparate applications. The eventual goal is to release the software for free academic use.

SESSION 4: CFD/ Fluid Dynamics II	8:00 - 9:20 AM	Room 157A

Chair: Dr. Roger L. Kimmel, Air Force Research Laboratory

8:00 AM - DESS11-0044

Investigating the Possibility of Actively Controlling Descent for MAV Applications

Zachary Gaston
Wright State University

Hui Wan, Haibo Dong
Wright State University

While it is relatively easy to design a MAV that, by default, would descend in either flutter or tumble, having active control would be beneficial in increasing the agility of the MAV. For some applications, such as deployment from a larger vehicle, fluttering motion is more favorable. However, if the MAV is performing an evasive maneuver tumbling would be more favorable. To this end, we intend to find a new set of control parameters for correcting the descent of flat plates. A 2D implicit immersed-boundary method based DNS tool for simulating freely moving objects at low Reynolds numbers is used to examine the trajectories of small bodies dropped in air. Through this investigation, we hope to find a realistic method for actively transitioning between flutter and tumble that can be implemented in future MAV design.

8:20 AM - DESS11-0041

Wing Kinematics and Deformation in Cicada Forward Flight

Kuo Gai
Wright State University

Haibo Dong
Wright State University

Comparing to other insects, Cicada can produce much higher lift due to its large body weight. This is import for design a micro air vehicle which can carry large payloads. However, it's lack of literatures on discussing how cicadas use their wings for accomplishing different flights. In this work, a high-speed photogrammetry system is first used to observe and record cicada wing kinematics and deformation in a cruising flight with 40Hz wing flapping frequency. Accurate 3D surface reconstruction technology is used to reveal the secret of chord-wise and spanwise flexibility of cicada wings during the flight.

8:40 AM - DESS11-0126

Aerodynamic Shaping of Spherical Turrets to Mitigate Aero-Optic Effects

Sivaram Gogineni
Spectral Energies LLC

Grady Crahan, R. Mark Rennie, Larry Rapagnani, Eric J. Jumper
University of Notre Dame

Donnie Saunders, Dr. Michael Stanek
Air Force Research Laboratory

Abstract Not Submitted...

9:00 AM - DESS11-0091

Effect of Duty Cycle, Frequency, and Temperature on a Supersonic Jet Controlled by LAFPAs

Rachelle Speth
The Ohio State University

Datta V. Gaitonde
The Ohio State University

Numerical and physical parameters influencing an ideally-expanded Mach 1.3 jet excited by m=+/-1 flapping mode are investigated. Localized Arc Filament Plasma Actuators (LAFPA) placed around the perimeter of the circular nozzle. The actuators are modeled with a proven surface heating method. The baseline control case corresponds to flapping mode excitation at the column mode frequency (Strouhal=0.3), a duty cycle of 20% and a plasma actuator temperature 5T_infinity. Analysis was performed using time and phase-averaged results. The simulations indicate that the response of the jet is relatively insensitive to actuator temperature within reasonable limits. The higher duty cycle exhibits strengthened coherent structures, slightly higher jet growth along the flapping plane, but the overall dynamics remains the same. As frequency increases the number of features observed in the phase-averaged data increases and the rate of decay of the centerline velocity is reduced. These frequency observations are also observed in the experimental results.

SESSION 5: Undergraduate Research	8:00 - 9:40 AM	Room 157B

Chair: Maj. Michael Pochet, Air Force Institute of Technology

8:00 AM - DESS11-0007

FLIP - Fuzzy Collaborative Robotic Pong

Sophia Mitchell
University of Cincinnati

Kelly Cohen
University of Cincinnati

There are a growing number of aerospace applications demonstrating the effectiveness of emulating human decision making using fuzzy logic. Main research challenges include situational awareness and decision making in an uncertain time critical spatio-temporal environment. In this effort, a Matlab simulation environment of the classic arcade game PONG is utilized and a fuzzy logic system has been created that uses real-time reasoning and awareness to represent a single a human player. A second fuzzy system was then created that uses real-time collaboration as well as fuzzy reasoning and awareness capabilities to play two human players. This collaboration strategy is based on the researcher's experience and learning lessons from watching two recent professional tennis matches. After an iterative process of tuning the system, both the singles and doubles games proved difficult for human players to beat. The results demonstrate the effectiveness of the fuzzy logic collaborative robotic system.

8:20 AM - DESS11-0024

The effect of the crystallinity and surface chemistry of carbon nanomaterials on the kinetics of fibroblast cell growth

Kevin Donnelly
University of Dayton

J. Czarnecki, K. Lafdi, P. Tsonis
University of Dayton

Tissue engineering is a field which hopes to improve, restore, and replace biological functions to people with diseased or damaged tissue. A key part of tissue engineering research is the construction and testing different tissue scaffolds and scaffold materials. Carbon nanomaterials are promising candidates as tissue scaffold materials because of their excellent material properties: tunable mechanical strength, biocompatibility, and surface characteristics. This study examined carbon nanomaterial crystalinity, surface chemistry, and size as tunable parameters for improving tissue scaffold materials. The results from WST-1 and MTT cell proliferation assays showed that fibroblast growth increased with increased heat treatment temperature and cell growth decreased with oxygen functionalization.

8:40 AM - DESS11-0059

Computational Investigation of a Fault Tolerant Soccer Free Kick Strategy

Brent Vorst
University of Cincinnati

Nicholas Schwartz, Kelly Cohen
University of Cincinnati

In the game of soccer, a large percentage of goals are scored from free-kicks. The most effective free-kick strategy is to curve the soccer ball around a setup wall and into the top corner of the soccer goal. Using previously derived equations of motion, the curved flight of a soccer ball was modeled using MATLAB and Simulink. This model was then used to determine the appropriate initial conditions that results in a goal, given a specific free-kick scenario. In addition, the various tolerances for each initial input were calculated to better examine the required accuracy to score a goal using the strategy above. The results show that the kicker must be very accurate to the optimal trajectory in order to score a goal. While this shot is difficult to perform, training devices could be developed to increase the chances of performing this shot using the model and obtained results.

9:00 AM - DESS11-0063

Statistical Clutter Characterization for Bistatic Radar

Julie Jackson
Air Force Institute of Technology

Brian Roadruck, Aaron Evers
Air Force Institute of Technology

Radar signal echoes are comprised of both target signatures and unwanted background clutter. Examples of clutter are trees, grass, and pavement. Clutter characterization for monostatic (co-located transmitter and receiver) radar has been studied extensively. However, relatively little is known about clutter returns in the case of bistatic (spatially-separated transmitter and receiver) radar. To distinguish targets from background, the clutter signatures must be known or approximated. This research performs a small-scale experimental data collection and analysis. Ground clutter returns are measured as a function of bistatic angle between the transmitter and receiver. Clutter returns are a function of material type, radar orientation, and overlap of the antenna beams. Thus, even for a constant scene, the clutter data cumulative distribution function varies. Statistical evaluation indicates that two types of material—compact dirt and thatch grass—contribute to the clutter return measured in these experiments.

9:20 AM - DESS11-0064

Utilizing Fuzzy Logic to Improve the Performance of a Semi-Active Base Isolator

Rachel Schwind
University of Cincinnati

Chezarae Hair, Sanooj Edalath, Dr. Kelly Cohen
University of Cincinnati

Brian Schwing
The Ohio State University

Recent events have shown how devastating earthquakes can be. Many of the deaths, injuries and monetary losses are due to structure collapse. There are various ways to mitigate the damages that structures sustain due to the ground vibrations caused by earthquakes, such as stronger structures and control systems. This research focuses on a semi-active base isolation system which uses a fuzzy logic based control system. The base isolation system model used has a supplemental damper which uses fuzzy logic to adjust the damping in real time. Three independent fuzzy logic systems were developed for three different earthquakes, El Centro, Kobe and Northridge. The results from each of the fuzzy systems were compared to the results from the base isolation system with the supplemental damper being tuned to the optimal passive results. Each of the systems showed some improvement over the optimal passive system showing promise for future research.

SESSION 6: Heat Transfer/Thermal Sciences	8:00 - 9:40 AM	Room 163A

Chair: Dr. Larry W. Byrd, Air Force Research Laboratory

8:00 AM - DESS11-0002

Exploring the Differences in Pressure Side Film Cooling Heat Transfer on a Flat Plate and 3-D Turbine Inlet Vane Using Conjugate CFD

Jamie Johnson
Air Force Institute of Technology

Paul I. King
Air Force Institute of Technology

John P. Clark, Peter J. Koch
Air Force Research Laboratory

Laboratory experiments and simplified CFD simulations often use flat plates to model the flow in turbomachinery components. Naturally, pressure and heat transfer phenomena are quite different between a flat plate and a vane due to curvature and boundary layer differences. To help assess the appropriateness of ongoing flat plate experiments, heat transfer characteristics on a full-scale flat plate pressure side film cooling array model and a full-scale 3-D fully-cooled inlet vane are obtained using conjugate Reynolds-Averaged Navier Stokes CFD studies that incorporate conduction effects from the solid along with convective heat flux from the fluid. Streamwise and spanwise distributions are given to emphasize parts of the vane pressure side which have heat transfer effects not seen by the flat plate model. Detailed contours of the cooling holes at different locations on the plate and vane are also compared.

8:20 AM - DESS11-0050

Film Cooling Heat Release Effects in a Reacting Flow

Michael DeLallo
Air Force Institute of Technology

Marc D. Polanka
Air Force Institute of Technology

David L. Blunck
Air Force Research Laboratory

A recent area of concern in film cooling involves reacting main stream flows and the increase in heat release on the surface of film cooled turbine components. The current research effort extends the work previously done at AFIT to understand how various film cooling configurations on a flat plate interact with a reacting main stream flow. This investigation extended the work performed on the fan shaped hole by looking at additional geometries including trenched and ramped configurations. Furthermore, this work specifically looked at the addition of adding an upstream row. The ability of either an upstream set of normal holes or an upstream slot injection scheme was evaluated to protect the downstream cooling flow. Results are presented in terms of surface temperature and heat flux to outline the downstream heat release. Data suggests the method and volume of coolant injection has significant impact on downstream temperature profiles.

8:40 AM - DESS11-0051

Thermal Characterization of Carbon Based Nanofluids Using Pipe Flow Experiments

Lawrence Funke
University of Dayton

M. Boehle, D. Debrosse, O. Al Samarrai, K. Lafdi
University of Dayton Research Institute

C. Leer
Applied Science Inc.

The performance of carbon nanofiber/ethylene glycol dispersions as thermal management nanofluids was investigated. Nanofluids were prepared using varying concentrations of nanofiber in as grown state, as well as low and high temperature heat treated nanofibers. A transient hot wire method was used to determine the static thermal conductivity of the fluids. Pipe flow testing was performed to determine the convective heat transfer coefficient of the nanofluids in a dynamic flow. The high temperature heat treated nanofibers provided the highest static conductivity but did not perform as well in the dynamic test due to mechanical fiber degradation. The low temperature heat treated nanofiber provided the best dynamic thermal performance as it provided the conductivity enhancement of heat treatment, while maintaining sufficient ductility to prevent mechanical fiber damage.

9:00 AM - DESS11-0019

Static and Dynamic Thermal Characterization of Carbon Based Nanofluid

Omar Al Samarrai
University of Dayton

S. Larnaud, M. Boehle, Khalid Lafdi
University of Dayton

C. Leer-Lake
Applied Science Inc.

A new nanofluid heat transfer fluid system was developed. The nanofluid can be described as a liquid suspension of nanometer-sized solid carbon particles or fibers, where the particle or fiber diameter is in the range of tens to hundreds of nanometers. This study focuses on both the static convective heat transfer enhancement and the thermal resistance enhancement of nanofluids under shear. The nano-fiber type, volume concentration, and dispersant concentration were investigated at various shear rates. Experiments were performed at particle volume concentrations from 0% to 1.2% and shear rates from 0 to 600s-1. The thermal resistance of the test suspensions decreased with increasing shear rate. The shear rate dependent thermal resistance was strongly affected by both nano-fiber type and volume concentration in shear flow fields. Dispersant concentration was also shown to effect thermal resistance due to its effect on the quality of the nanofluid dispersion.

9:20 AM - DESS11-0029

Transient Heat Exchanger Analysis

Jayme Carper
Wright State University

Dr. Rory Roberts
Wright State University

Information regarding heat exchanger performance is rarely available, and transient data is even harder to come by. Although a steady-state model can be used to predict states, a transient model would provide the ability to study system level interactions, as well as time effects. Ultimately, a computational thermal emulator will be built that will utilize experimental data from a generator cooling loop at AFRL, as well as data generated from a heat exchanger characterization test loop that will be built at WSU. This test loop will provide the ability to test a larger operational envelope of heat exchangers than what is currently possible at AFRL, while also providing necessary instrumentation for required data collection. The data collected from both experiments will be used in a new validation and verification technique for the transient thermal model.

SESSION 7: Design & Optimization I 8:00 - 9:40 AM Room 163B

Chair: Prof. Mitch Wolff, Wright State University

8:00 AM - DESS11-0035

New Techniques in Camera Calibration

Juan Jurado
Air Force Institute of Technology

Ken Fisher
Air Force Institute of Technology

Digital camera calibration has become increasingly important as the number of camera-equipped ground and air vehicles has risen in the United States military. Camera calibration is the process of accurately modeling the lens distortion of individual cameras as well as relative translation and rotation between various cameras on a single platform in order to relate the physical properties of a scene and its image. Although current calibration techniques such as the use of a planar chessboard pattern are accurate, they are unnecessarily slow, require extensive user interaction and are prone to user-induced error. The Advanced Navigation Technology (ANT) center at the Air Force Institute of Technology has developed a fully automatic camera calibration technique that produces comparable results in terms of reprojection error, eliminates the need for user interaction and lends itself for advanced calibration problems such as calibrating multiple-camera platforms with non-overlapping fields of view.

8:20 AM - DESS11-0052

Effectiveness of Systems Engineering Tailored for the Science and Technology (S&T) Environment: Improvement of USAF Airdrop Accuracy

Robert McCarty
SynGenics Corp.

Dr. Keith Bowman
Air Force Research Laboratory

Ms. Carol Ventresca, Ms. Stephanie Globus
SynGenics Corp.

The US Air Force (AF) aerial delivery operations in support of world-wide US Army ground forces have seen a dramatic increase in sortie generation and airdrop delivered tonnage, mandating the need to improve airdrop accuracy for critical resupply and humanitarian aid missions. To address this urgent AF need, the Air Force Research Laboratory (AFRL) applied their S&T Systems Engineering (S&T SE) process to evaluate airdrop operations, and then launched multiple technology research projects in early 2011. This presentation will show the effectiveness of SE in the S&T environment by outlining the entrance criteria for an AFRL project, highlighting the importance of the Integrated Product Team (IPT) formed for the planning project, and summarizing application of the S&T SE process steps used to formulate the initial project development plan. It will be shown that SE can prove to be a viable process for decision analyses at all levels of S&T.

8:40 AM - DESS11-0074

Towards Proof-of-Concept Flight Demonstration of the Modus VTOL Concept

Kelly Cohen
University of Cincinnati

Frank Black, Dan Kelleher
Modus Recte, Inc.

Wei Wei
University of Cincinnati

The Modus Aircraft is a highly capable multi-mode (CTOL and VTOL) aircraft with significant range, speed, altitude, signature, and cost improvements over current vertical flight aircraft. The Modus aircraft concept is based on a fixed disk which replaces the main rotor of a conventional rotorcraft and from within this disk a pair of counter-rotating series of blades emerge for take-off and landing. The protruding blades operate on the periphery of the disk shaped lifting surface which is where most of the effective lift develops. In the forward flight mode, lift is generated by the disk shaped lifting surface. Since we do not have a main rotor for forward flight a much larger flight envelope is anticipated. The current effort is focused on developing a proof of concept flying demonstration which includes transition.

9:00 AM - DESS11-0075

High Altitude Balloon Dynamics Characterization

Matthew Urbaniak
University of Cincinnati

This presentation will cover work performed in small high altitude balloon flight at the University of Cincinnati. The main focus will be work performed as a graduate student in the area of balloon dynamics characterization. The effort was a three phase plan. The first consisted of simulation of balloon payload motion. The second entailed the design and construction of a measurement and data collection unit for balloon flight. The final phase compared the motion during a flight test to the predicted motions. The presentation will combine a brief overview of the balloon program but will focus on the graduate students' work. It will highlight the lessons learned and provide suggestions of how the data collection effort can be improved.

9:20 AM - DESS11-0118

Classifying Ohio Counties Based on Highway Traffic Related Pollution

Ramanitharan Kandiah
Central State University

Traffic on Highways is one of the largest air and noise polluter to any community. Quantifying the pollutants with respect to their geographical locations is important to take proper actions. This study presents a Self Organized Map (SOM) based approach with the emission parameters obtained from Motor Vehicle Emission Simulator (MOVES 2010a) in the county level. The Ohio counties were classified according to five air pollutants with respect to the population, the total highway length and the area of the country. The second part of the presentation elaborates the methodology of the ongoing road segment level (project level study) to quantify the air pollution and noise pollution resulted from highway vehicles that can be used in correlating the public health with the on-road vehicle emissions in the future.

SESSION 8: Human Factors/Biomedical	9:50 - 11:30 AM	Room 156A

Chair: Prof. Julie A. Skipper, Wright State University

9:50 AM - DESS11-0036

Influence of Crystallographic and Topographic Parameters on Osteoblast Growth

Jerry Czarnecki
University of Dayton

S. Jolivet, J.S. Czarnecki, M.E. Kundrat, K. Lafdi, P.A. Tsonis
University of Dayton

Due to the rapid progress being made in tissue development, carbon-based biomaterials are expected to play an important role in clinical applications. The goal of this study was to determine the influence of crystallographic and topographic parameters of carbon fiber materials on osteoblast cell proliferation. Three types of fibrous carbon materials were characterized by using X-ray diffraction, Raman spectroscopy, atomic force microscopy (AFM) and BET techniques. Materials were subjected to in vitro testing and assay analysis and the effects of varying crystallinity, orientation, surface roughness, surface area and physisorption were explored. Results indicated that osteoblast attachment and growth increased with higher crystallinity, orientation and by varying surface roughness and surface area. A Cellular Automata model was established to simulate the cell growth as a function of material properties and provide a tool for further scaffold design.

10:10 AM - DESS11-0037

The Effect of BET Surface Area and Surface Chemistry on the Biological Response of Carbon Materials

Jerry Czarnecki
University of Dayton

J.S. Czarnecki, S. Jolivet, M.E. Kundrat, K. Lafdi, P.A. Tsonis
University of Dayton

Carbon materials are attractive candidates for tissue scaffold applications because of their biocompatibility and mechanical properties. Surface modification through activation and functionalization may enhance biological response and lead to the development of tunable tissue scaffolds constructs. Three types of carbon fibers and two types of carbon nanofibers were used in this study. Carbon materials were subjected to CO2 activation, oxygen, amine and molecular grafting functionalization. Materials were characterized by X-ray diffraction, Raman spectroscopy and BET techniques. In vitro studies were performed in order to investigate the cellular attachment and growth on carbon surfaces. Results showed that cell proliferation is strongly dependent on BET surface area. Amine-based grafting molecules inhibited cell proliferation. However, both oxygen and acid-based grafting molecules promoted cell growth. This effect was more pronounced with longer grafting molecules.

10:30 AM - DESS11-0053

Cell uptake and Toxicity of Superparamagnetic Iron Oxide Nanoparticles Functionalized for Nuclear Targeting Applications

Christin Grabinski
Air Force Research Laboratory

Carol Garrett, Amanda Schrand, Saber Hussain
Air Force Research Laboratory

Jatuporn Salaklang, Alke Fink, Heinrich Hofmann
Ecole Polytechnique Fédéral Lausanne

Superparamagnetic iron oxide nanoparticles (SPIONs) are used in medical imaging, drug/gene delivery, and separation applications due to their unique superparamagnetic properties. For many of these applications to be successful, intracellular targeting of SPIONs is necessary. The aim of this project is to investigate the cellular interactions of functionalized SPIONs after exposure to HeLa cells. The results of this study provided crucial information for understanding fundamental interactions of SPIONs with cells in vitro that can be used to support advancements in nanotoxicology and intracellular targeting applications.

10:50 AM - DESS11-0105

Static Posturography as a Quantitative Assessment Tool for Multiple Sclerosis

Daniel Petit
University of Dayton

Dr. Kimberly Bigelow
University of Dayton

The evaluation of various physiologic time series to differentiate between health and disease has started to become a common alternative to traditional clinical based, qualitative examinations. Understanding disease and level or type of impairment through a more quantitative approach may allow for more precise rehabilitation therapies focused on targeting the systems that require the most attention. This particular work sought to understand the effectiveness of several different analysis techniques of postural sway in Multiple Sclerosis, a neurodegenerative disease known for its impairment of the motor and sensory systems within the body. Three primary conditions were investigated where subjects stood on a stationary balance plate with either nothing over the plate or one of two types of foam placed on top in order to understand how the choice of foam could affect postural sway.

11:10 AM - DESS11-0077

Variations in In Posturography Testing Methods: Effect of Talking, Visual Fixation, and Time on Plate on Sway Measurements

Christopher Denzinger
University of Dayton

Erin Sutton, Deborah Kinor, Alexander Jules, Kimberly Edginton Bigelow
University of Dayton

Posturography, the measurement of postural stability using a force plate, is a common clinical method for testing balance related problems. However, due to the large number of clinicians practicing posturography methods, there is variation in testing procedures. In this study, three of these testing variations were studied: the effect of a subject talking during the test, the time on the balance plate before initiation of data collection, and the presence or absence of a visual fixation point. Through a series of eight trials, subjects were tested on a force plate varying each of these factors at two levels (presence and absence). Results indicate a brief period of talking during the test had little effect on balance. However, the presence of a visual target and the presence of a stabilization period significantly affected the subject’s balance.

Chair: Dr. Jamie Gengler, Spectral Energies LLC

9:50 AM - DESS11-0088

Key Factors Influencing the Structure and Electrochemical Performances of LiFePO4/C Composite in Sol-Gel Synthesis

Chuang Guan
Wright State University

Hong Huang
Wright State University

Olivine structured LiFePO4 is a promising cathode material for the next generation of lithium ion batteries for its low cost, environmental benign, good cycle performance and safety, etc. However, its intrinsic poor electronic conductivity and diffusion capability of lithium ion greatly hinder its applications requiring high power rechargeable batteries. Carbon coated LiFePO4 nanomaterials (LiFePO4/C) can effectively improve the electronic conductivity and reduce lithium-ion diffusion length. In this research, the low-cost sol-gel method was used to synthesize LiFePO4/C nanomaterials. The effects of the synthesis technique and parameters including the iron source, chelating agents, the PH value of the sol, pre-treatment of the dried gel, the sintering temperatures on the structure and electrochemical properties of the LiFePO4/C were systematically investigated by means of XRD, SEM, and electrochemical characterizations. LiFePO4/C nanocomposites, synthesized at optimal conditions, exhibited high reversible Li storage capacities of 152mAh/g, good cycle life, and relatively high rate capability.

10:10 AM - DESS11-0113

Nanoscale Hierarchical Reinforcement for Robust and Durable Composites

Anil kumar Karumuri
Wright State University

Sharmila Mukhopadhyay
Wright State University

Interfacial delamination is the primary limitation in common composite systems. Replacing a planar interface with a multi-scale hierarchical architecture may be the answer to preventing such failures. These types of interfaces are seen often in biological structures, but seldom created in synthetic composites. In this study hierarchical interfaces were created by strong attachment of carbon nanotubes (CNT) on larger carbon core structures prior to infiltration with polymeric matrix. The presence of nanostructures suppresses interfacial delamination and improves the mechanical performance of composite significantly. Enhanced durability and toughness is demonstrated in multiple types of composite geometry, and has been attributed to the transfer of stresses away from the planar interface. This paper will present some of the experimental results and modeling approaches to understand and refine this behavior.

10:30 AM - DESS11-0108

The Impact on Phthalocyanine as a Thermoelectric Material When Doping With Iodine.

Evan Kemp
University of Dayton

Douglas Dudis
Air Force Research Laboratory

Joe Shumaker, Chenggang Chen
University of Dayton Research Institute

Nick Gothard
Universal Technology Corp.

Thermoelectric technologies show great promise in the fields of energy harvesting, solid-state cooling, and thermal management, but more efficient materials are required with higher figures of merit (ZT). Iodine Doped Phthalocyanines are promising thermoelectric materials given their high electrical conductivity at room temperature, which varies up to two times the room temperature value as it reaches low temperatures, and their chemical and thermal stability. The overall performance of doped Phthalocyanines as thermoelectric materials also depend on the thermal conductivity and Seebeck coefficient, where Phthalocyanines have shown to have a thermal conductivity on the order of 0.3 W/m*K. The effects of the Iodine doping on the properties of the Phthalocyanine were measured by PPMS using a pressed powder pellet, results showing an increase in the both electrical conductivity and the overall ZT value. Pthalocyanines have a growing potential for use in thermoelectric cooling applications as initial results indicate.

10:50 AM - DESS11-0121

Novel Lithographic Processing Technique for Nanorods Thin Films grown Using Oblique Angle Deposition Method

Piyush Shah
Wright State University

Howard Knachel, Andrew Sarangan
University of Dayton

It is known that exposing structured thin films (STF) grown using oblique angle deposition (OAD) to liquids such as DI water or any common solvents permanently deforms the physical structure of the thin films and alters their properties. This is a severe limitation of STFs because the films cannot be patterned into useful devices using conventional wet lithographic processes. In this work, we overcome this challenge and propose to demonstrate conventional i-line lithography technique for patterning STF's grown using OAD technique. The ability to selectively fabricate STF in chosen areas of the active devices will be beneficial for numerous applications. It is shown that the structure of these thin films is preserved after lithographic processing. Processing limits in terms of dimensions of the devices or patterns that may possibly be fabricated are discussed.

11:10 AM - DESS11-0022

Atmospheric Growth of Silicon Nanowires by Chemical Vapor Deposition

Qiong Jiang
University of Dayton

L. Li, K. Lafdi
University of Dayton

M. Rummeli, A. Bachmatiuk
Leibniz-Institute for Solid State

J. Boeckl
Air Force Research Laboratory

Silicon nanowires are attracting significant attention from the solar and electronics industries due to the drive for more efficient solar panels and ever-smaller electronic devices. In this study, we focused on silicon nanowires growth at atmospheric pressure and a relatively low temperature by catalyst-assisted chemical vapor deposition (CVD). In contrast to the common approach of using vacuum environment, the atmospheric growth opened an opportunity for a larger scale and lower cost growth of nanomaterials. Growth kinetics study showed that diameter of the silicon nanowires as well as their length increased with growth time. Initially, the silicon nanowire core was very crystalline but as the reaction time increased, the diameter increased with amorphous skin. The formation of silicon nanowires depended upon on the presence of catalyst. In the absence of the catalyst, only an amorphous silicon coating was produced.

SESSION 10: CFD/ Fluid Dynamics III	9:50 - 11:30 AM	Room 156C

Chair: Prof. Zifeng Yang, Wright State University

9:50 AM - DESS11-0084

Overview of Serpentine Inlet and Transonic Fan Interaction Research Program

William Copenhaver
Air Force Research Laboratory

Steven Puterbaugh, Darius Sanders, Chase Nessler, Michael List
Air Force Research Laboratory

Compact serpentine diffusers (inlets) include highly curved surfaces which, in combination with a significant amount of diffusion, generate unsteady vortical flow structures of the scale of the fan blade spacing. These structures impinge on the front fan stages of the turbine engine creating significant inlet/fan interaction. The scientific/technical challenges addressed in this program are the ability to 1) experimentally resolve a highly unsteady velocity field at the AIP of a coupled S-diffuser transonic fan configuration, 2) describe the impact of identified flow structures on fan performance, 3) develop methods in both the fan and diffuser to minimize the influence of the vorticity on propulsion system performance. In this effort, experimental and computational approaches will be applied to isolate the impact of unsteady vortical flows (flow angularity) entering the fan.

10:10 AM - DESS11-0087

The Generation of Freestream Turbulence for Study of Effects on Distortion Patterns in the Serpentine Diffuser

Jesse Johnson
Air Force Research Laboratory

Research is being done at the Air Force Research Laboratory to quantify the flow distortions caused by the “S” shape of the serpentine diffuser. It is desired to observe the effects that varying the freestream turbulence entering into the mouth of the diffuser has on the distortion patterns inside of the diffuser. There are various methods that have been used to generate turbulence for research. The simplest of those methods is to use a coarse grid or screen that trips the flow. By adjusting the grid bar diameter and spacing, one can manipulate the amount of turbulence that is generated. Care must be taken in placement of grids to provide enough distance upstream of testing to allow for turbulence to become isotropic. Isotropic turbulence is desirable to help facilitate computational comparison. This experiment represents the first attempt to observe the effects of freestream turbulence on serpentine diffuser flow physics.

10:30 AM - DESS11-0058

Assessment of Laminar-Turbulent Transition Models for Use in TURBO

Rebecca Howard
Air Force Research Laboratory

Turbomachinery flows are often subject to boundary layer transition. In order to enhance the capability of the TURBO CFD code, a transition model is desired for implementation in the solver. An assessment was conducted of three popular models for predicting laminar-turbulent transition. The model formulations are described, and the implementation of each model is explained. Each model is discussed in terms of its applicability to turbomachinery flows and its suitability for use with a RANS-based CFD code. Compatibility criteria are as follows: for use in TURBO, the model must be three-dimensional, unsteady, compressible, and should be formulated as transport equations. Application to serpentine diffusers and compressors requires a compressible flow model in three dimensions, which is able to predict multi-moded transition. Based on assessment of the models with respect to these criteria, recommendations are made for implementation of a transition model into the TURBO solver.

10:50 AM - DESS11-0094

Impact of Spatial Multi-Frequency Distortion Patterns on Fan Performance

Michael List
Air Force Research Laboratory

Modern aircraft engines are subject to flowfield nonuniformities due to maneuvers, boundary layer formation, separations, and secondary flows. Distortion which reaches the fan face reduces stall margin and affects fan performance as nonuniformities develop in the turbomachinery. It is desired to understand the impact of modern inlet design on a particular fan stage and thus simulation of an isolated modern serpentine diffuser has been conducted to quantify corresponding distortion patterns. A spatial Fourier decomposition in the tangential direction at the diffuser exit plane showed that over most of the aerodynamic interface plane the 1/rev thru 5/rev frequencies are dominant. Presence of these combinations of multiple-per-rev frequencies has not been heavily investigated in traditional analysis or experiment. The impact of the multi-frequency, steady state total pressure distortion pattern was investigated for a fan stage showing a decrease in pressure ratio, mass flow rate, and efficiency relative to the clean inlet.

11:10 AM - DESS11-0010

Modeling and Simulation of a Dynamic Turbofan Engine Using Simulink

Scott Eastbourn
Wright State University

Dr. Rory Roberts
Wright State University

A dynamic, high-bypass turbofan engine model has been developed in the modeling and simulation environment of MATLAB/Simulink. Individual elements, including the fan, compressor, combustor, high pressure turbine, low pressure turbine, and nozzle, have been combined to investigate the behavior of a turbofan engine throughout a specified aircraft mission. Special attention has been paid to the development of transient capabilities throughout the model. Capturing these dynamic behaviors not only increases model fidelity, but also eliminates algebraic constraints while reducing simulation time through the use of advanced numerical solvers. This lessening of computation times is the primary motivation behind the research and is paramount for conducting future aircraft system-level design trade studies efficiently. Preliminary results for each component are compared to the previous tip-to-tail engine to verify accuracy. The new engine is then integrated with the full tip-to-tail model in an effort to quantify the desired computational time improvements.

SESSION 11: Manufacturing	9:50 - 11:30 AM	Room 157A

Chair: Dr. Ravi Penmetsa, Air Force Research Laboratory

9:50 AM - DESS11-0008

Effects of Inaccuracies in Small Non-homogeneous Fiber Specimens

Theodore Szelag
Air Force Institute of Technology

Maj. Ryan O'Hara, Dr. Anthony Palazotto
Air Force Institute of Technology

Inaccuracies in the fiber orientation can have a substantial change in the material properties, an effect that is even significant when dealing with short fibers and thin composite specimens. Experimental vibration data of a micro-air vehicle wing manufactured using a three-ply 0/90/0 small non-homogenous fiber composite provided results that varied up to 40 percent from analytical results. An analysis was performed on the material to verify that it matched specified material properties. Inaccuracies in the manufacturing of the wing were taken into account; specifically ply orientation, cut angle and material thickness were examined. It was determined that a misalignment in fiber orientation of less than 5 degrees combined with resulting short fiber effects was the main contributor to the difference between analytical and experimental results. Causes of such inaccuracies should be taken into consideration for future work in order to prevent failure and improve performance of such designed structures.

10:10 AM - DESS11-0005

Fabrication of Micro Abrasive Tools by Pulse Electroplating

Anuj Dabholkar
University of Cincinnati

M.M. Sundaram
University of Cincinnati

Accurate and robust micro abrasive tools are essential for the micromachining of highly complex features in advanced engineering materials including composites and ceramics. Techniques such as powder metallurgy, sol-gel method, physical and chemical vapor deposition have been used for fabrication of such tools in the past. However, aggregation of abrasives within the binder remains to be an unresolved research issue. Uniform distribution of abrasives within the binder is essential for achieving fine surface finish during micromachining. This work presents pulsed current electro deposition method to achieve codeposition of 2~4 micron diamond abrasives in pure nickel matrix, for in-house fabrication of sub-100 micron diameter micro abrasive tool. Proposed method is capable of better control over aggregation tendency of abrasives. Scanning electron microscope (SEM) and electro-dispersive spectroscopy (EDS) studies reveal more uniform distribution with sufficient chip pockets within binder matrix of the micro abrasive tools fabricated.

10:30 AM - DESS11-0015

Optimizing control for pulse electrochemical micromachining

Abishek Balsamy Kamaraj
University of Cincinnati

Rachael Dyer, M. M. Sundaram
University of Cincinnati

Pulse electrochemical micromachining(PECMM) is a non-conventional manufacturing method suitable for production of micro-sized components on wide range of conductive materials. PECMM improves dimensional accuracy and simplifies tool design in machining hard, high strength, and heat resistant materials into complex shapes. Extremely small interelectrode gaps, of the order of few microns, are required for better dimensional accuracy. However, excessively small interelectrode gaps may lead to complications like short-circuiting. This imposes the need for better control of the process. In this study a feedback controlled robust PECMM system was developed using commercial graphical programming language LabVIEW. The system performance was analyzed based on the improvements in the machining accuracy, on micromachining of tungsten carbide, when compared to a manual or uncontrolled process. In this presentation, effects of several process parameters such as feed rate, return velocity, electrolyte, tool movement, and optimum process parameters required to machine tungsten carbide will be discussed.

10:50 AM - DESS11-0065

Laser Fabrication of Flapping Wing Micro Air Vehicle (FWMAV) Components for Insect Inspired Design

Chris Taylor
Mound Laser & Photonics Center Inc.

Mound Laser & Photonics Center (MLPC) along with doctoral students from Air Force Institute of Technology (AFIT) has demonstrated that laser-based manufacturing provides the precision and flexibility to fabricate the intricate parts needed for Flapping Wing Micro Air Vehicles (FWMAVs) in a timely and repeatable matter. FWMAVs are often insect inspired designed small flying vehicles. MLPC has been able to create wings that closely resemble their organic counterpart. In addition to wings MLPC has manufactured all components required to make FWMAVs. The fuselage and the transmission trains were constructed from carbon and kapton. Piezo-electrical material and ceramics are the foundation for the control and power generation of the device. MLPC has developed novel manufacturing to explode the use of ultrafast laser to create these highly precise FWMAV components.

11:10 AM - DESS11-0124

Surveillance for Intelligent Emergency Response Robotic Aircraft (SIERRA) Project Manufacturing Improvements

Robert Charvat
University of Cincinnati

Bryan Brown, William Banks, Dr. Kelly Cohen, Dr. Manish Kumar
University of Cincinnati

The Surveillance for Intelligent Emergency Response Robotic Aircraft (SIERRA) Project is focused on providing a tactical Unmanned Aerial System (UAS) for the benefit of wildland firefighting. The current research effort concerns the application of UAS technology to reduce the level of damage associated with wildland fires. The University of Cincinnati in collaboration with the state of West Virginia Forestry is currently developing UAS technology for wildland fire use. This past Spring 2011 students visited MARCUS UAV Inc., a UAS manufacturer in Georgia for the purpose of UAS Training as well as to understanding their manufacturing needs and to understand how academic research could contribute to the development of more functional wildland fire UAS equipment. Research conducted by Undergraduate students during the summer of 2011 was able to demonstrate that manufacturing changes to the airfoil could produce improvements in performance.

SESSION 12: Engineering Education 9:50 - 11:10 AM Room 157B

Chair: Vincent M. Raska, Air Force Research Laboratory

9:50 AM - DESS11-0009

Reflections from an NSF RET program - Engineering Innovation and Design for STEM Teachers

Renee Beach
University of Dayton

Sandi Preiss
Dayton Regional Stem Center

Margaret Pinnell, Rebecca Blust
University of Dayton

Suzanne Franco
Wright State University

The University of Dayton (UD) School of Engineering facilitated an intensive six-week National Science Foundation (NSF) sponsored summer program for 10 STEM teachers and 5 pre-service teachers entitled Engineering Innovation and Design for STEM Teachers. The program focused on providing the participants with a better understanding of engineering innovation and design so the participants would be well equipped to transfer their new knowledge to their students through engineering classroom activities and innovative pedagogy. The program was facilitated in collaboration with UD's Innovation Center and School of Education and Allied Professions, the Dayton Regional STEM Center, and local industries to expose the participants to the engineering method through team-based industry-supported design and innovation projects, while developing inquiry based curriculum. Preliminary results indicate that the six-week experience fostered changes in participant's awareness of the engineering design philosophy, awareness of the variety of STEM careers, networking abilities among higher education and community partnerships.

10:10 AM - DESS11-0071

Linking Science and Sports for STEM Education: The case of the Soccer Ball, Gravity, and Friction

Adedeji Badiru
Air Force Institute of Technology

With a better understanding of science and mathematics, an athlete or a student can achieve sports excellence. Conversely, an interest in sports can be leveraged to encourage better understanding and pursuit of STEM education. This presentation addresses linking science and sports for STEM education using the case of the soccer ball, gravity, and friction. The presentation will specifically address how to use the physics of soccer to enhance engineering education. A video demonstration of extreme soccer ball juggling will be presented to illustrate the role of gravity and friction in sports. Contents of www.physicsofsoccer.com will also be discussed.

10:30 AM - DESS11-0095

Developing Residential, Commercial, and Industrial Assessment Programs in Community Colleges

Robert Gilbert
Sinclair Community College

Environmental issues, U.S. dependence on foreign oil and depleting fossil fuel reserves: all of these issues are increasing awareness for the need for energy efficiency education programs in community colleges. Residential assessment education programs have the assessment protocol of the Building Performance Institute, Building Analyst Professional or RESNET as a guideline for program development. ECO Building Checklist.doc, provides an assessment format for commercial buildings which can be a guide to developing the commercial assessment programs. The State University of New Jersey, Rutgers provides a complete Modern Industrial Assessments, A Training Manual Version 2.0. [2] This presentation demonstrates how these and other resources were used to develop the assessment, educational programs at Sinclair Community College.

10:50 AM - DESS11-0125

STEM Curriculum Development for the High School Environmental Science

Frank Harris
Upper Valley Career Center

Sivaram Gogineni
Spectral Energies LLC

A STEM curriculum for the High School environmental science has been developed based on the interactions with local industry and engineering organizations. During the presentation, the experiences as a summer intern, requirements for developing the curriculum for high school students, and the methodology used will be discussed. Follow up activities and the feedback from the students will also be discussed. This effort was funded by Dayton Defense organizations, professional societies, and AFRL. The authors would like to acknowledge the Dayton Regional STEM Center, Montgomery County ESC, Dayton Defense Organization, and AFRL.

SESSION 13: Diagnostics I	9:50 - 11:30 AM	Room 163A

Chair: Dr. James Gord, Air Force Research Laboratory

9:50 AM - DESS11-0114

2D OH and Temperature of Inverse Diffusion Flames in a Vitiated Cross-Flow using Two-Color PLIF Thermometry

Stanislav Kostka
Spectral Energies LLC

David Blunck, Amy C. Lynch
Air Force Research Laboratory

Naibo Jiang, Sukesh Roy
Spectral Energies LLC

Various means to increase gas turbine engine performance may include increasing turbine inlet temperatures and decreasing combustor length. Such modifications can result in secondary reactions between fuel-rich combustion products, passing into the turbine section, and the turbine blade cooling air. These fuel-rich vitiated inverse diffusion flames can potentially cause structural failure of turbine vanes due to the excessive heat fluxes. In this study two-color OH planar laser-induced fluorescence thermometry measurements were conducted in fuel-rich vitiated flows advecting over a flat plate with various cooling-hole configurations. The OH structures and temperature fields created by the secondary reactions were studied at various equivalence ratios and blowing ratios. Depending on the cooling-hole geometry, increases in the blowing ratio led to changes in the stabilization location of the flames, with some progressing farther downstream, farther from the vane surface, or with increased penetration into the core flow field.

10:10 AM - DESS11-0100

Measurements of multiple gas parameters in a pulsed-detonation combustor using three multiplexed Fourier-domain modelocked lasers

Andrew Caswell
Spectral Energies LLC

Sukesh Roy
Spectral Energies LLC

Scott T. Sanders
University of Wisconsin-Madison

Fred Schauer, James R. Gord
Air Force Research Laboratory

Hyperspectral absorption spectroscopy of water vapor was used to monitor gas temperature, pressure, velocity, and H2O mole fraction in a research-grade pulsed-detonation combustor (PDC) at the Air Force Research Laboratory. The hyperspectral source used is termed the TDM 3-FDML because it consists of three time-division-multiplexed (TDM) Fourier-domain modelocked (FDML) lasers. This source monitors sufficient spectral information in the H2O absorption spectrum near 1350 nm to permit measurements over the wide range of conditions encountered throughout the pulseddetonation combustor cycle. Absorption-feature Doppler velocimetry was accomplished using a novel counter-propagating beam approach designed to minimize common-mode flow noise. The enthalpy flux, which is useful for assessing the performance of auxiliary devices coupled to the PDC, can be calculated from the measurements made using this sensor system.

10:30 AM - DESS11-0083

TDLAS EXPLORER: A Computational Framework for Tunable Diode Laser Absorption Spectroscopy Simulation

Robert Yentsch
The Ohio State University

Dr. Michael S Brown
Air Force Research Laboratory

The challenging nature of hypersonic flight requires rapid, non-invasive monitoring of complex transient phenomena, some of which have the potential to trigger catastrophic consequences. Such measurements could confirm success of planned large-scale unsteady events such as mode-transition, or help detect precursors to undesirable events such as unstart or flameout. An attractive measurement technique for feedback control is based on Tunable Diode Laser Absorption Spectroscopy. Systems have already been tested on the ground in flight-scale hardware (HIFiRE-2 and RC-22) as well as in flight tests (HIFiRE-1). In this presentation, we describe the development and capabilities of a software suite named TDLAS EXPLORER. The software suite can perform parametric investigations of system response to flow fields generated by CFD as well as create synthetic flowfields so that the systems response to certain theoretical events and conditions can be ascertained quickly and easily without having to perform a computationally expensive CFD simulation beforehand.

10:50 AM - DESS11-0103

Simultaneous Slow and Fast Light: Spectroscopic Implications

Anil Patnaik
Air Force Research Laboratory

Sukesh Roy
Spectral Energies LLC

James R. Gord
Air Force Research Laboratory

If a light beam passing through a target sample moves slowly, the interaction time of the beam with the medium and hence its effective optical length increases. This enables the possibility of enhancing spectroscopic signals by 1–2 orders of magnitude. It is observed that both slow and fast light can be realized simultaneously for a pair of weak probes in a doubly driven double-ladder configuration with independent and simultaneous control for group velocities of the pair. It is shown that keys to realization of the simultaneous slow-fast light are electromagnetically induced transparency and Chi^(3)-based gain process. Many interesting parameter domains are identified where concurrent slow-slow and fast-fast light pairs can also be realized. The pair of controlled group velocities could be useful for simultaneous optical-length control of two absorption lines.

11:10 AM - DESS11-0020

Small Internal Combustion Engine Performance Characteristics at Altitude

Steven Crosbie
Air Force Institute of Technology

Marc D. Polanka
Air Force Institute of Technology

Paul J. Litke
Air Force Research Laboratory

The performance characteristics of small internal combustion engines (ICE) operating at altitudes above sea level is not well understood. The changes of atmospheric pressure and temperature that occur naturally at elevated altitudes can drastically affect the way a small engine operates. In order to better understand how small ICE operate at altitude, a test facility was built with the capability to control atmospheric conditions up to 15,000 feet. This presentation outlines the performance of a two-stroke 95cc engine at altitudes between sea level and 15,000ft. Primary measurements include torque and power maps that indicate change in power with respect to altitude variation. Brake mean effective pressure (BMEP) is calculated and brake specific fuel consumption are compared as well. These measurements will help provide a better understanding of combustion phenomena in small ICE and help determine the impact that variations in atmospheric conditions may play in this class of engines.

SESSION 14: Design & Optimization II	9:50 - 11:30 AM	Room 163B

Chair: Dr. Paul Hsu, Spectral Energies LLC

9:50 AM - DESS11-0025

Development of a Statistically Based Validation Process for Computational Simulation

Joshua Craven
University of Dayton

John Doty
University of Dayton

A statistically-based process is being developed for validation of modeling & simulation (M&S) results with experiments. Critical parts of this process are uncertainty quantification, sample size specification, and sample distribution. Standard Monte Carlo (MC) methods rely heavily upon large sample sizes as well pseudo-random number generation (RNG) to determine sample distributions. A newer sampling methodology is presented and discussed based upon quasi-RNG. Results of the pseudo-RNG and quasi-RNG techniques are compared for efficiency and effectiveness using several benchmark cases to quantify the differences in the methodologies. The extension of the more powerful quasi-RNG technique to areas of interest to the aerospace community are discussed.

10:10 AM - DESS11-0061

Thermal Harvesting for Thermally Activated Reconfigurable System Design

Brian Smyers
Air Force Research Laboratory

James Joo, Gregory Reich
Air Force Research Laboratory

Richard Beblo
University of Dayton Research Institute

This presentation describes a reconfigurable system with multi-functional component designs of high-speed delivery of a low-speed Intelligence Surveillance Reconnaissance (ISR) asset. The research focuses on investigating harvesting, transport, and usage of heat energy developed on the surface of the packaged ISR pod with a blunt fuselage shape after release from a transport vehicle. A bi-stable compliant mechanism is designed to change its configuration passively by deploying a folded wing to an unfolded stable position. The induced heat load softens the element of the mechanism, with the element providing a load bearing structure, a heat reservoir and passive actuator attributes to the system. The various methods to induce the thermal heating and material selections including doping of shape memory polymers (SMP) is also explored. The size and shape of the mechanism are investigated to include the flexible link component and the overall energy efficiency of the system is investigated.

10:30 AM - DESS11-0098

An Air Logistics Deployment Simulation Model

John Byrnes
Air Force Research Laboratory

A simulation model of the Air Mobility Command’s (AMC) deployment mission has been developed and will be demonstrated. The model was built with iThink software which is a System Dynamics methodology tool. The purpose is to evaluate the energy efficiency technology of new and legacy AMC transport aircraft from an individual aircraft and also a system of systems standpoint. The new aircraft are advanced technology transport designs, developed within four contracted studies sponsored by the Air Force Research Laboratory. The legacy aircraft are the: C-5, C-17 and C-130 transports and the KC-135 tanker. The model tasks a group of strategic transports (e.g. C-5 or contractor’s equivalent) to transport military payloads from CONUS to a theater military-zone over a given period of time

10:50 AM - DESS11-0001

Comparison of Physics Based Modeling Software Tools on Representative Aircraft Gearbox and Fuel Thermal Management Systems

Tony Corvo
Avetec Inc.

Matthew Rutledge, Karleine Justice
Avetec Inc.

Due to the complexity of modern dynamic systems and the increasing pressure to reduce project development costs, designers require very high fidelity ease-of-use design tools. Fortunately, the modeling and simulation industry has a variety of tools to choose from. However, too often designers stay with products they know rather than explore new tools that will match or surpass their fidelity requirements but also greatly reduce the design/test/redesign cycle time and therefore development costs. Avetec researchers recently completed two detailed modeling and simulation projects using Simulink, Simscape and AMESim design tools. The first project involved modeling an aircraft gearbox and the second an aircraft fuel thermal management system. Modeling in the AMESim environment turned out to be extremely efficient. For example, the gearbox Simulink model took 3 months to complete. With AMESim, where systems are built from extensive component libraries, the effort took two days after two days of training.

11:10 AM - DESS11-0006

Design of a Temporally-Bifurcated Dynamic Electrical System for Maximum Metastable Response with Minimal Thermal Load

Austin Doty
University of Dayton

John H. Doty
University of Dayton

Jose A. Camberos, Kirk L. Yerkes
Air Force Research Laboratory

A new concept is proposed that offers the possibility of dramatically reducing electrical system thermal load while simultaneously improving dynamic system response. Previous work in this area using exergy-based analysis indicated that under-damped dynamic systems offer the potential for approximately 22% faster response and 43% lower thermal load compared to a critically-damped system. A simple circuit is proposed with an analytical solution for the demonstration and validation of the concept. MATLAB and Simulink models are developed to implement the numerical simulations of the concepts. Design of Experiments is utilized to determine the optimal set of input parameters for this electrical system that produces optimal and robust performance. Initial findings indicate that the temporally-bifurcated does, indeed, offer the possibility of improved system performance while simultaneously offering dramatically reduced thermal load. Work is in progress to build such a circuit, and implement the concept in relevant Air Force systems.

SESSION 15: Structures/Solid Mechanics II	1:20 - 3:20 PM	Room 156A

Chair: Prof. Andrew J. Terzuoli, Air Force Institute of Technology

1:20 PM - DESS11-0093

Kinematic Synthesis of Morphing Structures for Design Profiles with Significant Differences in Arc Length

Shamsul Shamsudin
University of Dayton

Dr. Andrew P. Murray
University of Dayton

Preliminary morphing structure designs are being evaluated for their potential use in shape-changing wings, spoilers, extrusion dies, cams, light reflectors, and other entertainments. This presentation will describe research in the design of these morphing structures whose various shapes can be defined by a set of planar curves. The presented approach to morphing structure technology is of interest due to its use of commercially available components, a reliance on well-established design techniques, that it can produce large and predictable motions, and that large loads are readily addressable. Specifically, the concepts used in determining the geometries of a group of rigid bodies, each approximating the shapes of corresponding segments on all of the curves, will be presented. These bodies are then joined together in a chain with hinge and/or sliding joints, and internal structure is added such that the shape change can be driven by a single actuator.

1:40 PM - DESS11-0013

Development of a Wave Rotor to Turbonormalize an Internal Combustion Engines

Brandon Smith
Air Force Institute of Technology

Dr. Marc Polanka
Air Force Institute of Technology

Dr. John Hoke
Innovative Scientific Solutions Inc.

In today's military, COTS (Commercial Off-The-Shelf) components are becoming the norm, especially in the area of Remotely Piloted Aircraft (RPA) engines. Many of the Internal Combustion Engines (ICE) used in today's RPAs were originally designed to power radio controlled aircraft and lawn care implements designed to run at or near sea level conditions. Running these engines in RPAs with operational altitudes in excess of 10,000 feet causes efficiency problems due to a decrease in ambient pressure and air density. By turbo-normalizing the ICE, the pressure seen by the engine can be increased to a level much closer to that of sea level allowing it to run with the same efficiency as it would in its designed purpose. Because a scaled down pressure wave supercharger does not see the same efficiency losses as a turbo charger or supercharger, it makes an ideal candidate to turbo normalize these small engines.

2:00 PM - DESS11-0067

Hermitian Time Interpolation for Membrane Dynamics

Kyle Kolsti
Air Force Institute of Technology

Dr Donald L. Kunz
Air Force Institute of Technology

Stretched membranes can provide effective lifting surfaces for Micro Air Vehicle wings. This research seeks to develop an improved numerical approach for predicting the structural dynamics of such a membrane. Transient membrane responses are simulated using quintic Hermitian interpolation in time, enabling high-order interpolations from velocity and acceleration information at the beginning and end of the time step. For each time step of the implicit time-marching algorithm, the final configuration (displacements and velocities) and the state of stress (in-plane stresses and stress rates) are solved using fixed-point iteration. First, gradient recovery techniques, constitutive relations, and group finite element approximations provide the nodal accelerations. Then, these accelerations and appropriate kinematic constraints produce updated displacements and velocities, and the process is repeated to convergence. The algorithm is adaptable to a wide variety of physical problems. The goal is to demonstrate improved performance over conventional dynamic finite element methods for this application.

2:20 PM - DESS11-0066

Test of Electromechanical Actuation System For Aircraft Flight Control Surface

Street Barnett
Air Force Research Laboratory

Justin DelMar
Air Force Research Laboratory

Zach Lammers
University of Dayton Research Institute

A series of tests on an electromechanical actuator (EMA) were run in an effort to validate a numerical EMA model. A load or force profile was applied to the actuator through a hydraulic press. A position profile, containing stroke and velocity, was commanded to the actuator. The force and position profiles were synchronized through the shared time stamp. Outputs of the experiment were load force, stroke, voltages, currents, and temperatures. These parameters were gathered utilizing NI DAQs in order to describe EMA motor and controller performance. Comparison between input and measured load and stroke was used to access the dynamic control of the experimental setup. Measured power (through voltage and current), temperature, and mechanical output were compared against model prediction.

2:40 PM - DESS11-0127

Study of Strain Energy in Deformed Dragonfly Wings

Hui Wan
Wright State University

Haibo Dong, Yan Ren
Wright State University

Abstract Not Submitted...

3:00 PM - DESS11-0011

The Use of Wave Mechanics as Applied to High Speed Wear

David Huber
Air Force Institute of Technology

Dr. Anthony Palazotto
Air Force Institute of Technology

This research is aimed at developing methods to predict mechanical wear of sliding bodies at high velocities. Specifically, wear of test sled slippers at the Holloman High Speed Test Track at Holloman AFB, NM is being considered. An Eulerian-Lagrangian hydrocode called CTH has been used to allow for a velocity range of 100 to 1500 meters per second. The code performs plane strain analysis of a slipper colliding with a hemispherical asperity. This collision creates a stress wave in the slipper which leads to failed cells and worn material. Several failure criteria were evaluated as possible methods to extrapolate failed material from the sliding body. The Johnson and Cook constitutive model was selected because of its ability to handle high strains, strain rates, and temperatures.

SESSION 16: Materials III	1:20 - 3:20 PM	Room 156B

Chair: Prof. Feng Liu, Wright State University

1:20 PM - DESS11-0017

Efficient Nanomaterials for Transient Power Spikes

Muhammad Omar Memon
University of Dayton

The thermal interface resistance of a system involves more than 50% of the total thermal resistance in current high-power electronic packages. Thin film, labeled "buckypaper", of Carbon nanofiber based materials was processed and optimized. Three different kinds of buckypapers were fabricated, with as-grown, low heat treated and high heat carbon nanofibers. An experimental setup was designed to test processed materials in terms of thermal impedance as a function of load and material density, thickness and thermal conductivity. A transient spike power was carried out using two conditions; uniform heat pulse of 24 Watts, and power spikes of 24-96 Watts. The results show that heat treated CNF was 12% more temperature resistant than direct contact with more than 50% enhancement in heat transport across it.

1:40 PM - DESS11-0018

Supercapacitance performance of Carbon Nanotubes based Composites

Bakheet Alresheedi
University of Dayton

Lingchuan Li, C. Priem, Khalid Lafdi
University of Dayton

Supercapacitors used in conjunction with batteries offer a solution to energy storage and delivery applications in systems where a high power output is required, such as in fully electric cars. The goal of this work is to enhance the current supercapacitor technology using activated carbon Nanotubes (CNTs) based Composite. The composite consists of fuzzy perform (carbon nanotubes grown on a carbon fiber fabric) and infiltrated with carbon matrix. Then subsequent processes of carbonization and activation were carried out. Electrochemical behaviors of the CNT and the composite films for supercapacitor were studied in 1 M H2SO4 solution. The activated carbon formed with the CNTs showed substantially higher contribution to specific capacitance compared with that formed in the absence of the CNTs.

2:00 PM - DESS11-0033

Kinetic Growth of Carbon Micro and Nano-Coiled Based Fibers

Muneaki Hikita
University of Dayton

Khalid Lafdi
University of Dayton

Carbon is the most versatile element with variety of non planar graphitic, curved, coiled and non coiled structures. Carbon coiled fibers exhibit consistent spiral structure that might be an ideal candidate for tunable electronics and bio-activators. In this study, carbon micro and nano-coiled fibers were prepared by chemical vapor deposition (CVD) technique using nickel, iron, tin, indium based catalysts in doped acetylene with thiophene and diluted hydrogen environment. The effects of catalyst type, temperature and time, the flow rate of reactive gases on the growth of carbon coils formation were explored. It is found that the micro-coils quality and their uniformity are strongly depended on the flow rate of thiophene and growth temperature. However, the growth of carbon nano-coils was possible by using sol gel method to prepare iron tin oxide based catalysts. Other types of catalysts were prepared by sputtering and seem lead to the same result.

2:20 PM - DESS11-0048

Characterization of composite materials for application in antenna and waveguide design in small Remotely Piloted Aircraft (RPA) structures.

Gabriel Almodovar
Air Force Institute of Technology

Dr Anthony Palazotto
Air Force Institute of Technology

This study will establish a method to determine the suitability of a composite material operating in a frequency range for application in small RPAs. A graphite epoxy stiffening component will be primarily considered. Different coatings, layers, and films will be applied to graphite epoxy to determine the effects on the material's performance as an antenna/waveguide component. The study will also look at the manufacturing of such components and the variables influencing the desired material characteristics.

2:40 PM - DESS11-0060

Growth, Structure, and Thermal Conductivity of Yttria-Stabilized Hafnia Thin Films

Jamie Gengler
Spectral Energies LLC

C.V. Ramana, M. Noor-A-Alam
University of Texas

John G. Jones
Air Force Research Laboratory

Yttria-stabilized hafnia (YSH) films of 90 nm thick have been produced using sputter-deposition by varying the growth temperature (Ts) from room-temperature (RT) to 400 C. The effect of Ts on the structure, morphology, and thermal conductivity of YSH films has been investigated. Structural studies indicate that YSH films crystallize in the cubic phase. The lattice constant decreases from 5.15 to 5.10 Å with increasing Ts. The average grain size (L) increases with increasing Ts; L-Ts relationship indicates the thermally activated process of the crystallization of YSH films. The analyses indicate a critical temperature to promote nanocrystalline, cubic YSH films is 300 C, which is higher compare to that of pure monoclinic $HfO2$ films. Compared to pure nanocrystalline hafnia, the addition of yttria lowers the effective thermal conductivity. The effect of grain size on thermal conductivity is also explored.

3:00 PM - DESS11-0012

Transport of Silver Nanoparticles in Saturated Porous Media

Jason Flory
Air Force Institute of Technology

Nanosilver is the largest and fastest growing category of nanomaterial. A growing number of studies show that nanosilver may pose significant adverse human and environmental effects. Given the ubiquity of nanosilver and its potential toxicity, it is incumbent upon us to understand its environmental fate and transport. The transport of silver nanoparticles (AgNPs) in a saturated porous media packed column was investigated. Both a conservative tracer and AgNPs were injected into water flowing through a laboratory column packed with water-saturated glass beads (porosity = 0.47) to obtain concentration-versus-time breakthrough curves. It was observed that the total mass of AgNPs leaving the column was smaller than the total input mass, indicating the capture of a fraction of the colloidal AgNPs by the porous media. Silver was also found to pass through the media more readily in low pH solution, probably due to dissolution of AgNPs into ions.

SESSION 17: CFD/ Fluid Dynamics IV	1:20 - 2:40 PM	Room 156C

Chair: Prof. Hui Wan, Wright State University

1:20 PM - DESS11-0082

Fourier Analysis of High Speed Shadowgraph Images around a Mach 1.5 Cavity Flow Field

Ryan Schmit
Air Force Research Laboratory

Ryan Schmit, Frank Semmelmayer, Mitch Haverkamp, James Grove
Air Force Research Laboratory

An examination of a rectangular cavity with an L/D of 5.67 was tested at Mach 0.7 and 1.5 with corresponding Reynolds numbers of 2x106/ft and 2.3x106/ft, respectively. High speed shadowgraph movies were simultaneously sampled with the dynamic pressure sensors at 75 kHz. Fourier analysis was performed on the high speed movies as well as the dynamic pressure data which resulted in determining the locations of dominant cavity frequencies in the flow field. From the high speed shadowgraph movies, observations of the in the cavity flow physics are discussed. Several cavity related issues are examined e.g. How do vortices form in the shear layer? What is the actual starting mechanism for these cavity acoustic tones? How do the cavity acoustic tones affect the shear layer?

1:40 PM - DESS11-0115

HIFiRE-1 Aerothermodynamic Flight Measurements

Roger Kimmel
Air Force Research Laboratory

David Adamczak
Air Force Research Laboratory

The Hypersonic International Flight Research Experimentation (HIFiRE) program is a hypersonic flight test program executed by the Air Force Research Laboratory (AFRL) and Australian Defence Science and Technology Organisation (DSTO). HIFiRE flight one flew in March 2010. Principle goals of this flight were to measure hypersonic boundary-layer transition and shock boundary layer interactions in flight. The flight successfully gathered pressure, temperature and heat transfer measurements during ascent and reentry. HIFiRE-1 has provided transition measurements suitable for calibrating N-factor prediction methods for flight, and has produced some insight into the structure of the transition front on a cone at angle of attack. Pressure and heat transfer measurements in the shock-boundary-layer interaction were obtained. Preliminary analysis of the shock boundary layer interaction shows intermittent pressure fluctuations qualitatively similar to those measured in wind tunnel experiments. A large amount of data was obtained on the flight, and significant data reduction efforts continue.

2:00 PM - DESS11-0045

Wing Gait Analysis and Aerodynamics Performance of Dragonfly Hovering Flight

Yan Ren
Wright State University

Haibo Dong, Hui Wan
Wright State University

High-fidelity numerical simulations are being used to examine the key aerodynamic features and lift production of insect wings. However, the kinematics of the insect's wing and the resulting aerodynamics is highly complex. A more inventive approach is therefore needed to dissect the wing gait and gain insight into the remarkable aerodynamic performance of the insect's wing. The focus of the current investigation is on the aerodynamics of the wing of a dragonfly (Erythemis Simplicicollis) in hovering motion. The three-dimensional, time-dependent wing kinematics is obtained via a high-speed photogrammetry system. Singular Value Decomposition (SVD) is then applied to extract the essential features of the wing gait. Aerodynamics of wings flapping with kinematics synthesized from SVD modes will be discussed in detail.

2:20 PM - DESS11-0047

Influence of Octane number on a Direct injection spark ignition engine

M C Seakher Kasibhatla
Wright State University

Dr. Haibo Dong
Wright State University

The improvement in injection technologies increased manifold and one such technological advancement with significant impact on an engine performance is direct Injection. The main advantages of this technology which makes it stand out over other injection methods are better fuel economy, higher power, reduced emissions and ability to operate on multiple fuels. This paper addresses the performance of a direct injection Rotax Engine using gasoline and its blends in Fluent 13.0. The results from this computational analysis of the Rotax engine fueled with gasoline and its blends are compared to evaluate the fuel flexibility of the Engine. A computational model of the Rotax 914 engine was developed for the current study. Gambit was used for mesh generation and geometry, while Fluent 13.0 was used for combustion simulation. The model used was previously validated by comparing the computational and experimental results of the same engine with port fuel injection.

SESSION 18: Micro Air Vehicles 1:20 - 3:20 PM Room 157A

Chair: Prof. Marc D. Polanka, Air Force Institute of Technology

1:20 PM - DESS11-0003

Evaluation of the Hawkmoth Thorax for Flapping-Wing Micro Air Vehicles

Alex Hollenbeck
Air Force Institute of Technology

Dr. Anthony Palazotto
Air Force Institute of Technology

Dr. Mark Willis
Case Western University

The Hawkmoth (Manduca Sexta) provides an excellent model from which to design a Flapping Wing Micro Air Vehicle (FWMAV). Their flight is powered indirectly by two large muscle groups in the thorax. Energy created in these muscles is transferred to the various plates of the exoskeleton that comprise the thorax. The thorax, in turn, flexes and transfers that energy through a hinge at the base of the wings. The goal of this research is to evaluate this complex biological mechanism and to improve current understanding of the mechanics involved in Hawkmoth power generation and energy transfer. Experiments and research will uncover the engineering material properties of the muscles and the exoskeleton of the thorax, as well as the static and dynamic forcing functions necessary for flight. These values will be used in finite element modeling to enhance existing models and provide a basis for improved biologically-inspired FWMAV designs.

1:40 PM - DESS11-0021

The Use of Photogrammetry to Evaluate Dynamic Characteristics of a Manduca Sexta Wing

Jeremy Murray
Air Force Institute of Technology

Maj. Ryan O'Hara, Dr. Anthony Palazotto
Air Force Institute of Technology

The goal of this research is to develop a way of experimentally comparing the dynamic response of biological wings from the Manduca Sexta (Hawkmoth) with the biologically inspired manufactured wing using a photographic technique. This testing is to be conducted in both open air and in a vacuum to analyze the relative effect of aerodynamics as opposed to inertial effects of a moving body. The specific goal at the outset was to move from still images highlighted with a stroboscope to a high-speed (2500-5000Hz) cameras system to acquire the images allowing for a greater number of data points through the stroke of the wing. The data points from two, simultaneous camera angles are correlated using stereo photogrammetry to produce a three dimensional point cloud for each pair of images. This data will be combined with force balance data to correlate instantaneous wing shape to lift output.

2:00 PM - DESS11-0046

Hardware Integration and Testing of a Hybrid Electric Propulsion System for a Small Remotely Piloted Aircraft

Joseph Ausserer
Air Force Institute of Technology

Lt Col Frederick G. Harmon
Air Force Institute of Technology

This work examines the mechanical and electrical integration and testing of a hybrid electric propulsion system for a small, remotely piloted aircraft. The glider like aircraft will have a range comparable to an ICE only configuration while maintaining the quiet operation of an EM configuration when in EM only mode. The system uses a clutch bearing to link the ICE and EM, allowing the ICE to drive the EM as a generator and regenerate the batteries during flight. The system is controlled by a customized Microchip PIC32 microcontroller. Ground testing has demonstrated the hybrid system will be capable of powering the aircraft, that the EM can provide additional power over that produced by the ICE, and that the torque split strategy implemented on the microcontroller can operate the propulsion system. Flight testing is planned for early November.

2:20 PM - DESS11-0049

Low Effort Control Strategy Applicable to Flapping Flyers

Samana Zeyghami
Wright State University

Haibo Dong
Wright State University

Scientists have been looking for a method that could explain the insects' maneuverability and adept ability to modulate flight forces for decades. However no existing theory is in complete agreement with experimental observations. Introducing a new point of view to the steering muscle activity in fruit fly, a simple flight forces control strategy is proposed which shows strong compatibility with many experimental observations. We have proven that the flight forces can be modulated without direct control of the wing's kinematic parameters. According to the proposed method, the insect is able to perform the desired maneuver by choosing appropriate rate and phase of activation of steering muscles. This strategy is energy efficient and may be responsible for the observed rise in energy efficiency during elevated flight forces production in fruit fly.

2:40 PM - DESS11-0070

Limited Degree of Freedom Closed Loop Control Experiments with Flapping Wing MAVs

Garrison Lindholm
Air Force Institute of Technology

Michael Anderson, Richard Cobb
Air Force Institute of Technology

Flapping wing Micro Air Vehicles (FWMAVs) continues to be a growing field, with research areas in of: unsteady and low Re aerodynamics, micro fabrication, fluid-structure interaction, power storage and electronics, and control. Recently AFIT has begun tethered close loop control experiments using near flight weight prototype FWMAVs. These experiments demonstrate the feasibility to control the FWMAV within isolated degrees of freedom, using a previously developed open loop controller, Bi-harmonic Amplitude Bias Modulation (BABM) that generates forces and moments on 5 of the vehicles 6 degrees of freedom.

3:00 PM - DESS11-0106

Reynolds Number Effects on Power Number and Thrust Number for Flapping Wing Micro Air Vehicles

John Tekell
Air Force Institute of Technology

M. Reeder, R. Cobb
Air Force Institute of Technology

AFIT is conducting research in low Reynolds number aerodynamics for flapping wing MAVs. This research will help elucidate the design trade space between rotorcraft and flapping wings at Reynolds numbers less than 100,000. The range of Reynolds numbers will be achieved by using a flapping mechanism and propeller in water and aqueous glycerin. The current research includes measuring thrust and torque data using a scale and reaction torque cell. The desired data plots to compare a propeller blade and rigid flapping wing will be power number versus Reynolds number and thrust number versus Reynolds number. The results may, or may not, demonstrate a net improvement in efficiency for flapping wing systems. In addition, flow visualization using 2-D PIV will also be performed during this experiment to capture the wake of the flapping wing. The experimental setup, flapping mechanism, and preliminary results of the propeller will be featured in this presentation.

SESSION 19: Renewable & Clean Energy	1:20 - 3:20 PM	Room 157B

Chair: Dr. Tony Corvo, Avetec Inc.

1:20 PM - DESS11-0054

An Experimental Study on Dynamic Wind Loads and the Near Wake of a Wind Turbine Model in ABL Wind

Zifeng Yang
Wright State University

Partha Sarkar, Hui Hu
Iowa State University

An experimental study is conducted to characterize the dynamic wind loads and evolution of the wake vortex and turbulent flow structures downstream a horizontal axis wind turbine (HAWT). In addition to measuring dynamic wind loads (both aerodynamic forces and moments) acting on the wind turbine model, a Particle Image Velocimetry (PIV) system was used to make phase-locked flow field measurements to quantify the time-evolution of the wake vortex and turbulence flow structures downstream of the wind turbine model. The detailed flow field measurements were correlated with the wind load measurements to elucidate the underlying physics associated with power generation and fatigue loads acting on wind turbines.

1:40 PM - DESS11-0068

Computational Determination of Guidelines for the Length of the Heat Exchanger Tube in a Ground Loop Geothermal Heating and Cooling System

Jim Menart
Wright State University

Katie Meyer, Paul Gross, Kyle Hughes
Wright State University

This project investigates the length of tubing needed per ton of heating and cooling for a horizontal geothermal ground loop. GEO2D, an analytical modeling program developed at Wright State University and funded by the U.S. Department of Energy, is utilized to survey various lengths of ground loops in Dayton, OH; Orlando, FL; and St. Paul, MN at thermal conductivities of 0.4 W/m-K, 0.8 W/m-K and 2.8 W/m-K over a time period of 20 years. GEO2D simulates a geothermal heat pump system and solves the unsteady 2D heat transfer between the geothermal ground loop and the surrounding ground by using the finite volume technique. COP, the bulk heat rate, the bulk exit temperature, and input building loads are used to evaluate the geothermal heat pump system performance. The findings of this project will aid in the selection of a minimum loop length to achieve a target COP.

2:00 PM - DESS11-0069

Comparisons of Commercial Ground Source Heat Pump Sizing Codes

Kyle Hughes
Wright State University

James Menart, Paul Gross
Wright State University

Ground source heat pump systems have become progressively more popular due to the increase in energy cost and the demand for sustainable development. Studies show that ground loop heat exchangers being used in North America are being oversized by 10% to 30% - causing the payback period to increase. A more accurate ground source heat pump modeling system will reduce the initial cost in the ground loop. There are a number of commercial programs available to size geothermal loops and this paper will provide a review of these programs. Results from these commercial programs will be compared to the Wright State developed geothermal program called GEO2D.

2:20 PM - DESS11-0109

Characterization of Seebeck Coefficient using PSM

Peter Borton
Air Force Research Laboratory

Michael Check, Nicholas Gothard, David Turner
Universal Technology Corp.

Douglas Dudis
Air Force Research Laboratory

Thermoelectric materials allow for a direct energy conversion between thermal and electrical energy. Current thermoelectric devices are only economically viable in niche markets and are described by a dimensionless quantity commonly known as the Figure of Merit (FOM). Optimization of the FOM is performed by the increasing the Seebeck coefficient and electrical conductivity while decreasing the thermal conductivity. Breakthroughs in the past decade have focused on the reduction of the thermal contribution to increase the FOM. The focus of this investigating will be on the challenges of preparing and characterizing novel materials especially those based on fullerenes. Electrical conductivity, thermal conductivity, and thermopower measurements can be time consuming and tedious. A newer means of Seebeck characterization is through use of a Potential Seebeck Microprobe (PSM) which allows for the scanning of macroscopic samples. PSM results will be compared to the traditional PPSM on results for novel materials.

2:40 PM - DESS11-0116

Algorithmic Approaches to Normalized Energy Consumption

Philip Brodrick
University of Dayton

Kevin Hallinan
University of Dayton

Utility energy reduction programs call for annual energy reduction on the order of 1-2% per year. Measuring such small changes with any accuracy is problematic, given that energy use is fundamentally dependent upon outside air temperature. Three and five parameter models have been previously developed to normalize against temperature. Two different algorithms to further the accuracy and speed of these models are presented: the first is a randomly seeded geometric algorithm, and the second is a gregarious particle swarm optimization algorithm. Both utilize a new method of determining goodness of fit based not only on the coefficient of determination but also on the percent difference between the modeled energy use and the actual energy use. The algorithms are discussed in theory and applied to 1500 artificially created data sets. Proof of concept weather normalization on actual energy data is also presented. Finally, application to various energy reduction programs is discussed.

3:00 PM - DESS11-0120

Residential Energy Reduction Payback Given Spectrum of Energy Effectiveness

Stephenie Ritchey
University of Dayton

Roman Villoria, Kevin Hallinan, Robert Brecha, P. Brodrick
University of Dayton

The U.S. Department of Energy seeks a 30% reduction by 2030 in residential building energy use, which accounts for roughly 25% of U.S. energy use. Research is described that estimates the payback from implementing the most cost effective energy reduction measures for an entire community. It does so by first identifying and prioritizing those measures offering the greatest payback for individual houses and then estimating the potential energy savings if the most effective measure is implemented. It also identifies and ranks the houses with the greatest potential for energy savings and payback. Lastly, this research estimates the cumulative payback for the community if individual efficiency measures are implemented in order of greatest priority and as a function of collective community energy savings.

SESSION 20: Diagnostics II	1:20 - 3:20 PM	Room 163A

Chair: Dr. Robert D. Hancock, Air Force Research Laboratory

1:20 PM - DESS11-0081

High Pressure Femtosecond Coherent Anti-Stokes Raman Scattering (CARS) Spectroscopy

Paul Wrzesinski
National Research Council

James R. Gord
Air Force Research Laboratory

Waruna D. Kulatilaka,
Spectral Energies LLC

Sukesh Roy
Spectral Energies LLC

Femtosecond coherent anti-Stokes Raman scattering (fs-CARS) spectroscopy is emerging as a very promising diagnostic method for combustion environments. This method takes advantage of broad spectral bandwidth, which allows for the coupling of several vibrational modes, and high temporal resolution due to the ultrashort pulse duration. Taking advantage of these characteristics allows for simultaneous observation of the vibrational modes of O2 and CO2 while measuring the dephasing of the Raman coherence. The measurement of the dephasing rate allows for highly sensitive temperature measurements to be performed. Furthermore, the femtosecond pulse duration allows for the measurements to be made independent of molecular collisions, which typically complicate nanosecond-based measurements. High pressure CARS measurements will be highlighted, demonstrating the independence of the Raman-coherence dephasing on molecular collisions.

1:40 PM - DESS11-0090

Gas-Phase Line Thermometry at 1-kHz Using Femtosecond-CARS Line Imaging

Sukesh Roy
Spectral Energies LLC

Waruna D. Kulatilaka, Hans U. Stauffer
Spectral Energies LLC

James R. Gord
Air Force Research Laboratory

We report—for the first time—single-laser-shot, one-dimensional thermometry in flames using femtosecond coherent anti-Stokes Raman scattering (fs-CARS) line imaging. This approach allows nearly collision-free gas-phase temperature measurements at rates of 1 to 10 kHz. Two high-power 800-nm beams are used for the pump and probe beams while a tunable 983-nm beam is used as the Stokes beam for CARS signal generation from N2 Q-branch transitions at ~2330 cm-1. All three laser beams are formed into sheets and crossed in a line through the probe volume. The resultant line-CARS signal at ~675 nm is spatially and spectrally resolved and detected with a CCD camera. Measurements were performed in flat-field flames as well as through sharp thermal gradients of premixed jet flames with adiabatic flame temperatures exceeding 2100 K.

2:00 PM - DESS11-0099

Propulsion Measurements with Single-Beam fs-CARS

James Gord
Air Force Research Laboratory

Dmitry Pestov, Marcos Dantus
Michigan State University

Paul J. Wrzesinski
National Research Council

Sukesh Roy
Spectral Energies LLC

Developments in the optical diagnostics of combustion and reacting-flow environments have been closely linked to advances in ultrafast-laser technology. Historically, this field of study has been dominated by the use of nanosecond (10-9 s) and picosecond (10-12 s) sources. However, femtosecond (10-15 s)-laser sources have recently been successfully applied for gas thermometry, pressure studies, and imaging of turbulent gas flows. Although these experiments reinforce the numerous advantages of broadband-laser sources and optical diagnostics on the femtosecond time scale, they also bring attention to an inherent nuance of ultrashort (spectrally broadband)-pulse propagation—femtosecond pulses are much more susceptible to temporal broadening due to group-velocity dispersion (GVD) than picosecond and nanosecond pulses. The use of femtosecond-laser sources for diagnostics of combustion and reacting-flow environments will be discussed.

2:20 PM - DESS11-0104

Interference-Free, Kilohertz-Rate, Line Imaging of Atomic Hydrogen in Flames Using Femtosecond, Two-Photon, Laser-Induced Fluorescence (fs-TPLIF)

Waruna Kulatilaka
Spectral Energies LLC

Sukesh Roy
Spectral Energies LLC

James R. Gord
Air Force Research Laboratory

We demonstrate—for the first time—interference-free detection of atomic hydrogen (H) in reacting flows at 1 kHz using femtosecond, two-photon-excited, laser-induced-fluorescence (fs-TPLIF) line imaging. Broadband, nearly transform-limited, fs pulses at 205 nm efficiently populate the n=1 → → n=3 transition via two-photon excitation, and the subsequent one-dimensional fluorescence signal at 656 nm from the n=3 → n=2 decay is imaged. Because the TPLIF signal scales as the laser irradiance squared, significantly lower pulse energy is required from fs-duration pulses for TPLIF in comparison to ns- or ps-duration pulses. The reduced laser energy virtually eliminates the single-photon-induced photodissociation of flame radicals generating additional H-atoms in the medium. In the premixed $CH_4/O_2/N_2$ flames investigated, we observed no evidence of photoionization or stimulated emission; two other processes that can further complicate the quantitative detection of H atoms via TPLIF. The current fs-TPLIF approach will be extended for imaging other flame species such as O atom and CO.

2:40 PM - DESS11-0086

Spatially and Temporally Resolved Temperature and Shock-Speed Measurement Behind a Laser-Induced Blastwave of Energetic Nanoparticles

Naibo Jiang
Spectral Energies LLC

Sukesh Roy
Spectral Energies LLC

James Gord
Air Force Research Laboratory

Spatially and temporally resolved temperature measurements behind a blast wave are performed using picosecond (ps) N2 coherent anti-Stokes Raman scattering (CARS) following laser ignition of mixtures containing aluminum nanoparticles embedded in ammonium nitrate. Production-front ps-CARS temperatures as high as 3600 K, obtained for 50-nm-diameter commercial aluminum nanoparticle samples, are observed. Shadowgraph images of the blast-wave propagation are also obtained to determine the shockwave position and the corresponding shock speed. The experimental results are shown to be inconsistent with the predictions of classical point blast-wave theory.

3:00 PM - DESS11-0110

Fiber-Coupled Laser Diagnostics for Temperature and Species-Concentration Measurements in Practical Combustion Devices

Paul Hsu
Spectral Energies LLC

Waruna D. Kulatilaka, Sukesh Roy
Spectral Energies LLC

Anil K. Patnaik
Innovative Scientific Solutions Inc.

James R. Gord
Air Force Research Laboratory

We present recent advances made in fiber-coupled laser-diagnostic methods that are being developed for practical combustion applications. In particular, we describe fiber-coupled, picosecond, coherent anti-Stokes Raman scattering (ps-CARS) spectroscopy and fiber-coupled, nanosecond, ultraviolet laser-induced-fluorescence (ns-UV-LIF) spectroscopy employing long-length, multimode step-index fibers for temperature and species-concentration measurements in harsh combustion environments. Gas-phase single-laser-shot thermometry using fiber-based ps-CARS spectroscopy of N2 and H2 is demonstrated in atmospheric-pressure, near-adiabatic laboratory flames. Also demonstrated is single-laser-shot detection of OH and NO concentration in laminar and turbulent flames at a repetition rate up to 10 kHz employing fiber-coupled planar LIF (PLIF). The effects of delivering intense laser beams at visible and UV wavelengths through long optical fibers (up to 10 m) are investigated. Development of such fiber-based diagnostic systems constitutes a major step forward in transitioning laser-diagnostic tools from research laboratories to practical combustion facilities such as gas-turbine test rigs.

SESSION 21: Design & Optimization III	1:20 - 3:20 PM	Room 163B

Chair: Maj Kenneth A. Fisher, Air Force Institute of Technology

1:20 PM - DESS11-0004

Systems Engineering in Early Development Planning for the Automated Aerial Refueling (AAR) Project

Robert McCarty
SynGenics Corp.

Jacob Hinchman, Daniel Schreiter, Ba Nguyen, Karen Irvin
Air Force Research Laboratory

The Air Force Research Laboratory (AFRL) Automated Aerial Refueling Phase II (AAR II) Program is developing AAR System and Segment level requirements to enable a future Remotely Piloted Aircraft (RPA) to safely refuel via boom and receptacle using the Air Force KC-135 tanker fleet with minimal tanker modifications. The goal of the Preferred System Concept is to develop a design of the AAR System that meets the System and Segment Performance Specifications. AFRL has adopted a systems engineering (SE) approach which has been tailored for Science and Technology (S&T) to lay the groundwork for early development planning activities that could feed acquisition of future transition platforms. Benefits of applying the AFRL S&T SE process to support early development planning through the AAR II Preferred System Concept and System/Subsystem Design Document will be noted.

1:40 PM - DESS11-0016

Feasibility Study of Orbital Maneuvering using Existing Technology

Thomas Co
Air Force Institute of Technology

Jonathan Black
Air Force Institute of Technology

Traditional space operations are characterized by large, highly-technical satellite systems that cost billions of dollars and take decades to develop. There are few studies on the feasibility of maneuvering even within orbital planes in low-Earth orbit using electric propulsion. If it is possible for a user to task a satellite in a timely and fuel-efficient manner, then its mission can be modified to meet requirements based on world events. The existing paradigm on maneuvering is that it is too cost-prohibitive to perform. This paradigm along with traditional space programs have to change and a transition to responsive and rapidly available systems must take place to meet the needs of space users. This research demonstrates that existing satellites can maneuver significantly to change its arrival time over a desired ground target (time-over-target) and provides a feasibility study by comparing the use of low-thrust, highly efficient electric propulsion to traditional chemical propulsion.

2:00 PM - DESS11-0027

Design and Integration of an Optics Payload for a Cubesat

Margaret Blackstun
Air Force Institute of Technology

A Cubesat is a small satellite with dimensions of 10cm x 10cm x 30cm and typically no more than 4kg. This research effort is focused on designing an optics bench for the back end of a Photon Sieve. A Photon Sieve is an ultra-lightweight diffractive imaging lens being developed for space flight in the Physics Department of the United States Air Force Academy. The optics bench has three mirrors, three different lenses, a filter, a camera, and a piezo controlled linear translation stage. The camera and piezo translation stage are controlled by a PC-104 computer. Special attention to environmental space considerations like temperature, vacuum, and vibration are considered in the design. The greatest challenge is designing degrees of freedom into the optics while still fitting inside the limited volume. The bench provides an excellent first cut at this ambitious project.

2:20 PM - DESS11-0111

Hardware Validation of Hybrid Steering Logic for Single-Gimbal Control Moment Gyroscope Array

Jonathan Wright
Air Force Institute of Technology

Dr. Eric Swenson
Air Force Institute of Technology

In this presentation, a series of experiments were conducted to evaluate the performance of the hybrid steering logic (HSL) for a single gimbal control moment gyroscope array (SGCMG). The algorithm is a combination of two singularity avoidance algorithms, singular direction avoidance and local gradient method. HSL determines the type of singularity that the SGCMG configuration is approaching, and then calculates how much of each algorithm to use in order to better escape the approaching singularity. Simulation results have shown HSL to be more effective than either of its two components, so this presentation will concentrate on hardware validation of that claim.

2:40 PM - DESS11-0097

CMOS Ultra-low Power Subthreshold Circuit Design

Jian Chen
Wright State University

Subthreshold operation is emerging as an energy-saving approach to many energy-constrained applications such as portable communication devices, microsensors and medical electronics where ultra-low power has higher priority than speed. In this paper, subthreshold NMOS and PMOS transistors are studied and characterized based on voltage swing, speed and power consumption. A basic inverter circuit is investigated from speed, area and power dissipation stand point to give some insight for potential future applications. The CMOS 90nm technology simulation results show that the operating frequency can reach up to 100MHz when V_dd=0.3V with power consumption of 31nW, minimum transistor sizes and operating frequency can reach up to 25GHz when V_dd=1.2v with power consumption of 26.4µW, minimum transistor sizes. Some detail theoretical discussions are also included in this paper.

3:00 PM - DESS11-0055

Eigenstrain-based Method for Modeling Large-scale Laser Shock Processing

Yongxiang Hu
Wright State University

Ramana V. Grandhi
Wright State University

Efficiently optimizing an LSP process is helpful to reduce development time and cost. But the computation time is extensive due to long duration required to capture the transient response of material after each shock. In the present research, the eigenstrain modeling method is developed to predict the effect of large-scale LSP more efficiently compared with previous methods. In the developed eigenstrain-based method, residual stress and deformation fields are analyzed elastically using the simulated eigenstrain as initial strain, which is incorporated into the model by thermal expansion with a predefined unit temperature field and using different anisotropic thermal expansion coefficients. For the large-scale LSP application, the eigenstrain in one representative cell identified through an explicit analysis is proposed as an approximation of the actual full eigenstrain field for residual stresses and deformation calculation. Compared with the previous methods, this method is proved to be effective and much more computationally efficient.

Poster Session	3:00 - 4:30 PM	160 - Apollo Room

DESS11-0026

Development of a Hybrid Electric Unmanned Aerial System

Jacob English
Air Force Institute of Technology

Michael Molesworth
Air Force Institute of Technology

This effort explores the effectiveness of streamlining the Department of Defense's (DoD) acquisition process through effective utilization of the systems engineering (SE) process in order to meet an accelerated capability need for a small, low-cost, and high-endurance remotely piloted aircraft (RPA). Through a series of pre-acquisition decisions, system design and development, and system testing; a determination of the concept's viability will be made. Coinciding with the AFIT lead development of a small Hybrid-Electric RPA propulsion system, a prototype aircraft and support system will be developed and tested in accordance with an established architectural framework and a tailored systems engineering process. The resultant system will be evaluated against a concept of operations (CONOPS) as a means of determining system usefulness and the effectiveness of utilizing a tailored systems engineering process.

DESS11-0034

Stability and Control Modeling for the Condor HE-RPA

Christopher Giacomo
Air Force Institute of Technology

This project involves modeling the stability and control of the Condor hybrid-electric Remote-Piloted Aircraft (HE-RPA). Due to the high-aspect ratio, sailplane-like geometry of the aircraft, both longitudinal and lateral/directional aerodynamic moments and effects are investigated. The aircraft is modeled using both digital DATCOM as well as the JET5 excel-based design tool developed by Dr. Steven Brand of the US Air Force Academy. The aircraft model data is used to characterize the flight envelope of the aircraft, allowing a detailed assessment of PID autopilot gains that will be verified with autonomous flight test. Model analysis has predicted potential problems in both the long-period longitudinal (Phugoid) and oscillatory lateral (Dutch Roll) modes of the aircraft, which are being corrected by the tuned Procerus Kestrel™ autopilot.

DESS11-0038

Carbon Engineered Scaffolds May Provide An Optimum Balance Of Biologic And Mechanical Properties For Use In Tendon Repair Surgery

Jerry Czarnecki
University of Dayton

J.S. Czarnecki, K. Lafdi, R.M. Joseph, P.A. Tsonis
University of Dayton

Current tissue scaffolds improve healing but have less mechanical strength than native tissues. Carbon scaffolds may optimize the mechanical strength, durability and healing potential not available with current scaffolds. Fibrous carbon-based scaffolds were prepared and were mechanically and biologically compared to a commonly used acellular dermal matrix scaffold control. Results indicated that carbon fiber scaffolds exhibited similar mechanical maximums and capacity to support cell attachment and proliferation in comparison with a control scaffold derived from human dermis. Carbon scaffold engineering shows promise because surface, structure and mechanical properties could be precisely engineered and replicated to meet mechanical and biological requirements.

DESS11-0056

In-Situ Ultrasonic Monitoring of Epoxy-Foam Infiltration and Cure State

Darius Johnson
Air Force Research Laboratory

Michael Gillespie, Cory Snyder, Dr. James Blackshire
Air Force Research Laboratory

The processing of advanced multi-material systems has become increasingly complex with regard to meeting desired performance requirements through tailored material properties. The recent development and use of engineering foam materials, for example, has led to significant improvements in the weight, cost, and performance of dual-use materials that include both thermal protection and structural load bearing properties. In the present effort, the use of in-situ ultrasound is investigated for monitoring the cure state and infiltration level of polymers into metallic foam materials. Computational models and experimental validation studies were accomplished, where the viscoelastic properties of a curing polymer were studied using compressional and shear ultrasonic waves. Ultrasonic time-of-flight reflection and signal amplitude measurements were used to extract wave velocity and attenuation levels, which were related to the material's modulus, dissipation energy, and fill-factor states for the polymer-foam material system during processing.

DESS11-0062

Experiments in the AFIT Radar Instrumentation Laboratory

Julie Jackson
Air Force Institute of Technology

Geoffrey Akers, Brian Roadruck, Aaron Evers, Jose Gutierrez
Air Force Institute of Technology

The AFIT Radar Instrumentation Laboratory (RAIL) mission is to develop new data collection strategies, novel processing algorithms, and informative data products for a variety of radar modes, configurations, and waveforms through cutting-edge research and scholarship. We aim to equip our students with the next generation of smart radar tools and technologies. RAIL hosts a suite of test equipment used in AFIT's radar curriculum and research experiments. The LabVolt Radar Training System enables students to work with radar equipment at safe radiation levels. Tektronix waveform generation and measurement equipment supports efficient data collection and analysis. Research students can take advantage of the test equipment to explore new theoretical concepts with small scale experiments. This poster showcases recent experiments in statistical characterization of radar ground clutter and passive radar imaging using OFDM waveforms.

DESS11-0072

Terahertz Spectroscopic Reflection and Scattering Measurements of Aligned CNT Arrays as a Function of Carbon Nanotube Length

Satya Ganti
Wright State University

Lindsay Owens, Stanley Smith IV, Jason Deibel
Wright State University

Reflectance and scattering measurements were made on vertically aligned carbon nanotube arrays of varying lengths grown on quartz substrate. Measurements are performed with copper as reference using terahertz time-domain spectroscopy. Direct reflection and scattering results indicate a frequency-related dependence on the length of the carbon nanotubes and the angle of incident radiation.

DESS11-0073

Analytical Chemical Sensing using high resolution Terahertz/submillimeter wave spectroscopy

Alyssa Fosnight
Wright State University

Benjamin L. Moran, Ivan R. Medvedev
Wright State University

Molecular ro-vibrational spectral signatures enable chemical sensors that are highly sensitive and selective. These sensors compare favorably to establish techniques for gas analysis. Unlike methods based on mass spectrometry (MS) THz spectrometers do not require calibration and rely on library spectra for quantitative analysis, thus eliminating the need for calibration, usually done via analysis of calibration standards. They interrogate a very large number of resolution elements and approach near 'absolute' specificity of chemical detection. In an ongoing experiment we attempt to perform first of a kind chemical analysis of a TO-14 calibration standard mix of 39 volatile organic compounds diluted in Nitrogen. 22 chemicals in the mixture are spectroscopically active in the THz range. Here we present our most recent results and analysis. This proof of principle study will serve as basis of our future research in chemical sensing with focus on analysis of exhaled human breath.

DESS11-0078

The Effect of Carbon Nanotubes on the Biocompatibility and Electrical Activity in the Growth and Development of Neurons

Tracey Hong
Vanderbilt University

Tiffany Dai, Massoud Kraiche (PhD), Gabriel Silva, (PhD)
University of California, San Diego

Previous studies indicate that surface nanotopography has been shown to improve the growth rate and electrical stimulation of neurons. This would prove to be beneficial in devices such as retinal implants, where biocompatibility and electrical stimulation play a key role in the success of the device. This study is intended to discover the effects of carbon nanotubes on the morphology of neurons. By using scanning electron microscopy (SEM) to compare the physical development of hippocampal neurons and calcium imaging to determine the electrical excitability, we can determine the effects of the carbon nanotubes on the neurons through different stages of their growth.The ongoing experiments aim to verify the increased growth rate of neurons, the early onset of action potential generation, and eventually the engulfing of the nanotubes by the neurons, allowing for more accurate readings of electrical signaling, which is a vital component of retinal prostheses.

DESS11-0079

Crucible Coating Analysis by THz Spectroscopy

Ryan Shaver
Wright State University

Hannah Jones, Jason Deibel
Wright State University

Crucibles are found commonly throughout many industrial and scientific applications which require a containment vessel capable of withstanding temperatures high enough to melt or otherwise adversely affect it. Thin coatings protect the interior walls of the crucible, and play a critical role in its overall life span. Industry needs to be able to quality test their products in a nondestructive manner, while at the same time, gather coating application information in regards to uniformity, thickness, and impurities in the substrate beneath the coatings. Using pulsed Terahertz frequency radiation, it is possible to see through many materials including crucible coatings. Using terahertz “Time of Flight Imaging” along with other TDS (time domain spectroscopy) applications we will show how crucible coatings can be characterized and mapped with spatial resolutions of less than a millimeter and thickness resolutions less than 50 microns.

DESS11-0080

Characterization of Metameterial Devices Using Terahertz Time-Domain Spectroscopy

Hannah Jones
Wright State University

Satya Ganti, Jason A. Deibel
Wright State University

Ronald Coutu
Air Force Institute of Technology

Bending the realm of physics, materials are being synthesized that exhibit unnatural optical phenomenon such as negative refractive indices. Metamaterials are manufactured with sub-wavelength features such that they have special electric permittivity and magnetic permeability properties. This can produce an effective negative refractive index device with high potential for eventual use in invisibility cloaking devices, enhanced light-weight lenses, and more sensitive sensors. Using Terahertz Time-Domain Spectroscopy, we characterize a metamaterial device at multiple incident angles in both transmission and reflection. This analysis can be utilized in designing other metamaterials devices that can produce negative refractive indices at the terahertz regime as well as other electromagnetic frequencies.

DESS11-0102

Fabrication and Optimization of Low Temperature Sintering Die Attach Preforms via the Tape Casting Method for use in High Temperature Environments

Jared McCoppin
Wright State University

H. Vijwani, D. Young
Wright State University

R. Miller, M. Rottmeyer
Air Force Research Laboratory

Die-attach solutions are needed for high temperature electronics applications (500°C and above). In this work, tape casting is utilized to fabricate preforms of nanosilver material. The tapecast preform is devoid of solvent reducing the organics content. The preforms use a polypropylene carbonate/propylene carbonate binder/plasticizer system. A bimodal powder distribution of silver powder having a range of diameters from .6 to 2um, and silver nanopowder having a range of diameters from 30 to 50nm allows effective packing of the particles and decreases shrinkage. This combination of reduced shrinkage and less vapor evolution during burnout may allow tape-cast nanosilver preforms to be utilized on larger dies than are currently feasible by paste-based approaches. Microstructure, thermal, and mechanical characterization is performed on the tapes using SEM, TGA/DSC and tension testing.

DESS11-0107

Thermal Transport across Water-Graphite Interfaces

Daniel Forero
Air Force Research Laboratory

Patrick Shamberger
Air Force Research Laboratory

Thermal management of USAF systems and platforms requires thermal energy storage materials that can rapidly store large transient pulses of heat. Composites of salt hydrates and graphitic foam offer high thermal energy storage capabilities and high thermal conductivities. However, thermal transport across graphite-hydrous salt interfaces may limit the heat transfer through such a composite. Here, laser flash analysis was used to measure thermal diffusivity across graphite-water-graphite stacks and the effective diffusivity of the water layer plus interfaces was determined. The effect of surfactant-water mixtures and two different graphite surface treatments on effective diffusivity were analyzed. For all cases, the measured effective diffusivity was lower than the accepted literature value for bulk water (by 20% in the case of pure water-untreated graphite stack). In the case of the surfactant-graphite mixtures, effective diffusivity is a function of the surfactant concentration. These differences highlight the importance of interfaces to heat transfer within composites.

DESS11-0123

Integrated analysis of cicada freely forward flight

Kuo Gai
Wright State University

Hui Wan, Yan Ren, Zhe Ning, Haibo Dong
Wright State University

Comparing to other insects, cicadas can produce much higher lift to overcome their large body weight. The hidden mechanism may arouse important inspiration in designing a micro air vehicle which can carry large payloads. However, it is lack of literatures on discussing how cicadas use their wings for accomplishing different flights. In this work, a high-speed photogrammetry system and 3D surface reconstruction technology are used to reveal cicada wing kinematics and deformation during a freely forward flight. The aerodynamic performance is studied using our in-house immerse boundary method based Computational Fluid Dynamics solver. The chord-wise and spanwise flexibility of cicada wings during the flight will also be discussed.