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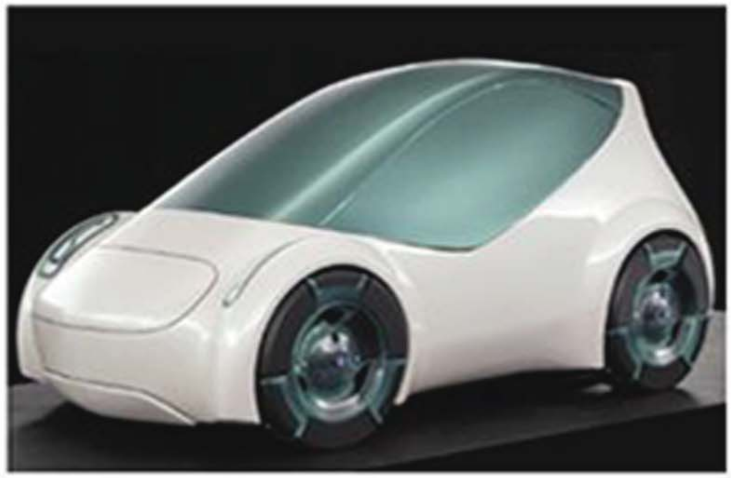
The 5th Annual Dayton Engineering & Science Symposium

Autos: New Players, New Products, a New Beginning



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WELCOME

On behalf of the Organizing Committee, we would like to welcome you to the 5th Annual Dayton Engineering Sciences Symposium (DESS). Sponsored by the Dayton Section of the American Society of Mechanical Engineers (ASME), the symposium is intended to facilitate communication between members of the regional technical community, and to provide a forum for students, engineers, and scientists to present their work and sharpen their technical presentation skills.

This year's symposium features over 130 technical presentations spanning a broad range of engineering and science. This year's keynote speaker is Dr. Jay Baron, president and chief executive officer for the Center for Automotive Research (CAR), and director of CAR's Manufacturing, Engineering and Technology group. CAR is a nonprofit organization, focused on important industry and societal automobile trends and conducts industry research, develops new methodologies, forecasts industry trends and advises on public policy. Dr. Baron's talk is titled, "Autos: New Players, New Products, a New Beginning," which is sure to be thought provoking during these uncertain times for our nation's and our region's auto industry.

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

John Leland, Symposium Chair
Ravi Penmatsa, Symposium Co-Chair
Sivaram Gogineni, Executive Advisor

DESS COMMITTEE

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KEYNOTE SPEAKER

Jay Baron, Ph.D.

President and CEO
Center for Automotive Research and
Director Manufacturing, Engineering and Technology
Center for Automotive Research

Jay Baron is president and chief executive officer for the Center for Automotive Research (CAR), and director of the Manufacturing, Engineering and Technology group.

Prior to becoming president of CAR, Dr. Baron was Associate Research Scientist and manager of Manufacturing Systems with the Office for the Study of Automotive Transportation at the University of Michigan Transportation Research Institute. He also worked for Volkswagen of America in quality assurance and as a staff engineer and project manager at the Industrial Technology Institute in Ann Arbor and the Rensselaer Polytechnic Institute's Center for Manufacturing Productivity in Troy, New York.

Dr. Baron's manufacturing background includes systems involving machining, sheet metal fabrication, and assembly. His recent research has focused on developing new methods for the analysis and validation of sheet metal processes including tool and die making, tool tryout, and sheet metal assembly processes. He also developed functional build procedures that result in lower tooling costs and shorter development lead times, while improving quality—particularly with sheet metal assemblies.

Dr. Baron has been researching new technologies in the auto industry. He has studied at plants in Europe, Japan, and North America; looking at body shop manufacturing systems, design and flexibility, and evaluating the manufacturing capability of evolving technologies. He completed investigations on the state-of-the-art of tailor welded blank technologies, weld-bond adhesives, low-volume manufacturing technologies, and analysis of car body sub-system performance and construction methods.

Dr. Baron holds a Ph.D. and a master's degree in industrial and operations engineering from the University of Michigan and an M.B.A. from Rensselaer Polytechnic Institute.

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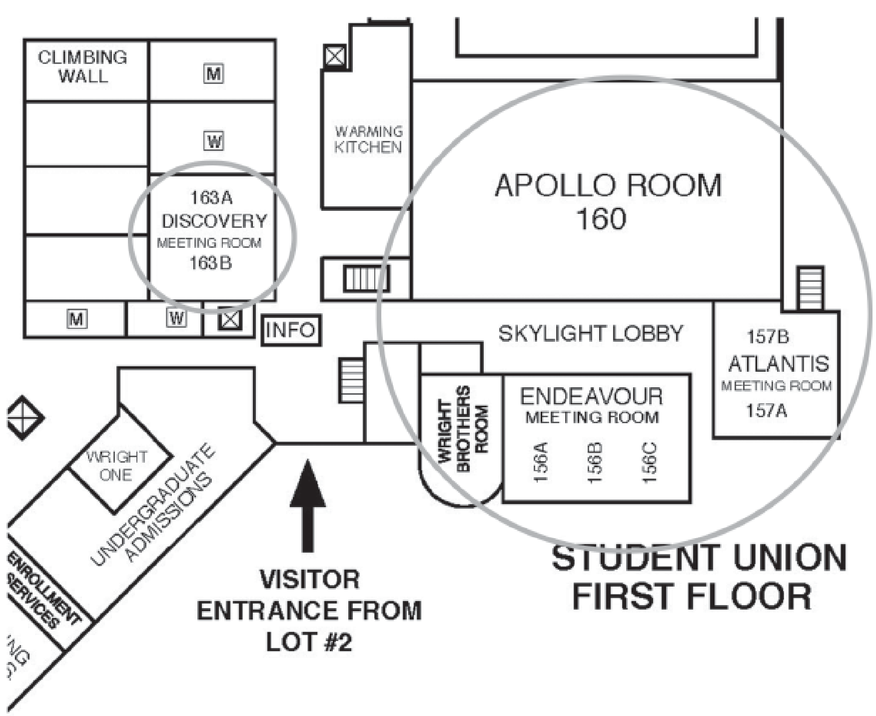
Room Locations



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

Chair: Eric Tuegel, AFRL

8:00 AM - DESS09-0049

Computer Simulations on Alloy AL7075-T6 Tensile Data using Johnson-Cook Material Models

Anoop Vasu

University of Dayton, Mechanical Engineering Department

A computer model is created in ABAQUS that simulates tensile testing on a Split Hopkinson Pressure Bar. Tensile strength and failure experiments are carried out for alloy Al7075-T6 at three strain rates at ambient temperature. Johnson-Cook (J-C) Strength and Fracture Material Constants are determined for AL7075-T6 and used as input into the computer model. The Johnson-Cook Material Models produce simulations that are in good agreement with experimental results once optimization is complete. Simulations determined the J-C strain rate sensitivity constant “C” and fracture constant “D3” to be decisive in achieving data replication. Without adjustment their as-measured values produced both larger than measured stress and strain-to-failure in the Al7075-T6 tensile simulations.

8:20 AM - DESS09-0057

Study of 2.5D Microstructural Modeling Techniques used for Material Property Identification

Peter Phillips

University of Dayton Research Institute

Advances in digital image correlation (DIC) techniques allow for the study of full-field surface deformations on a microscopic scale in metal alloys. Finite element-based microstructural models can be used for property identification using numerical optimization techniques. However, the exact microstructure in the interior of the specimen is not known, and DIC data is available only from the visible surface for comparison. A study was conducted to determine the effects that various subsurface microstructural FE modeling techniques have on the reduction of displacement errors on the surface of microstructural models. Multiple FE models with varying geometries and properties through the thickness (2.5D Models) were developed using surface geometry from a FE model created using known three-dimensional geometry through the thickness. Displacement errors were compared and optimizations of the linear elastic orthotropic material properties were conducted on the 2.5D models to determine which techniques are best suited for material property identification.

8:40 AM - DESS09-0083

Effect of a Graded Layer on the Plastic Dissipation During Fatigue Crack Growth of a General Bimaterial Interface

Craig Baudendistel
Wright State University
Dr. Nathan Klingbeil
Wright State University

Layered material systems are becoming more prevalent in many engineering applications. While these systems can have unique material properties, fatigue failures can occur along the interface between the layers. An energy-based fatigue crack growth law has been used in recent analytical models for mixed-mode fatigue of a plastically mismatched bimaterial interface. The scope of the current research is to extend these models to include a grading of material properties along an elastic/plastic mismatched interface and explore its effect on the plastic dissipation. These models would allow for more accurate prediction of fatigue crack growth rates in layered material systems. In addition, experimental studies are ongoing to validate the proposed energy-based crack growth law for mixed-mode loading using a four-point-bend specimen. Successful correlation between monotonic fracture toughness and fatigue crack growth rates through the energy-based theory is the primary goal of these tests and can provide advances in future material development.

9:00 AM - DESS09-0099

Reliable Residual Stress Fields Induced by LP Considering the Uncertainty of Laser Pressure Pulse Duration

Jongbin Im
Wright State University
Ramana V. Grandhi
Wright State University

This paper focuses on the uncertainty of laser pressure pulse duration and its effects on residual stresses induced by laser peening (LP). The laser pressure generated on components has a typical shape that consists of duration (nano seconds) expressed in x-axis and pressure magnitude expressed in y-axis. In this work, we use seven points to make the pressure shape. In seven points, we select two points that are more sensitive than others for residual stress results. Nine LP simulations are adopted to investigate the uncertainties of two points. From the LP simulations, we obtain the residual stresses and quantify the uncertainty of residual stresses using probability approach. From the probability analysis, we suggest the reliable bounds of residual stresses induced by LP based on pressure pulse duration uncertainty.

9:20 AM - DESS09-0096

Relaxation of Shot-Peened Residual Stresses in a Nickel-Base Superalloy

Dennis Buchanan
University of Dayton Research Institute
Reji John
Air Force Research Laboratory
Robert Brockman
University of Dayton Research Institute

Creep tests on shot-peened nickel-base superalloy specimens, subject to applied stresses near yield, have been performed at 650°C on IN100 to characterize the residual stress relaxation behavior. Retained residual stress depth profiles show that yielding during the initial loading produces the largest change in the residual stress profile. For sustained loads above yield, a continual relaxation of residual stresses occurs with increasing exposure time. However, for stresses below yield the retained residual stress profiles are similar to specimens subject to thermal exposure alone. Baseline virgin samples subject to room temperature plastic deformation and tested under elevated temperature creep conditions display a creep rate dependency on prior plastic strain. These prestrain experiments simulate the deformation experienced by the material during shot-peening and form the basis of a coupled creep-plasticity constitutive model. The model successfully predicts the retained residual stress profiles of shot-peened IN100 specimens subject to elevated temperature loading histories.

SESSION 2: Micro Air Vehicles	8:00 - 9:40 AM	Room 156B

Chair: Michael OL, AFRL

8:00 AM - DESS09-0027

Flapping Wing Micro Air Vehicles

Jaderic Dawson
WSU/MME
Jeremy Crank, Boe Evans, Alex Feist
WSU MAV Team
Dr. George Huang
Chair of the Mechanical/Materials Engineering Department at WSU

The development of small Unmanned Arial Vehicles (UAVs) has proven its value over the past couple years. Such vehicles save lives and money by providing real-time intelligence to ground troops, and rescue operations without putting lives at risk. These UAVs have been great for large-scale events such as explosions, and tracking the movements of large groups or individuals out in the open, but their benefit is relatively small when it comes to areas under cover, inside buildings or in caves. This is where Micro Air Vehicles (MAVs) are coming into play. Here at Wright State we are working on flapping wing micro air vehicles that are the best in the world. Through the dedication and support of Dayton's top micro manufacturing companies and utilizing the powerhouse of technology and scientific engineers that WSU has to offer we will soon make Dayton the center of a new era of flight.

8:20 AM - DESS09-0056

Modeling of Perching Manoeuvres with Micro Air Vehicles

Darrel Robertson
University of Dayton Research Institute
Gregory Reich
Air Force Research Laboratory
James J. Joo, Franklin Eastep
University of Dayton Research Institute
Patrick Hammer
University of Dayton

Interest in the development of bird-like micro air vehicles (MAVs) has emerged in recent years. The aim of our current research is to develop a vehicle that can land by perching on a rooftop, tree, or rough ground, enabling a wide range of observation missions. When perching, birds typically rotate their wings up to 90 degrees in order to increase drag to reduce horizontal flight speed and reduce lift. Our research involves the development of fast, accurate, and robust reduced order models of the transient aerodynamics in extreme manoeuvres where highly three-dimensional flow can occur due to wing planform changes, or other physical reconfigurations of the vehicle. These models are then being used to optimize trajectories and as part of a design tool to guide the design of the vehicle including planform, actuation, and sensor design.

8:40 AM - DESS09-0109

Wing-Wake Interactions in Dragonfly Tandem Wings

Hui Wan
Wright State University
Haibo Dong
Wright State University

Bilateral and ipsilateral wing-wing interactions can be commonly observed in insect flights. As a representative example of ipsilateral wing-wing interaction, dragonflies in flight have been widely studied. An important fact is that the flow over their hindwings is affected by the presence of the forewings. Wake capture and phase-change play very important role on aerodynamic performance of the hindwings. In the current study, the high fidelity direct numerical simulations (DNS) of dragonfly tandem wings are employed to capture flow field and vortex structures and understand aerodynamics performances. Proper orthogonal decomposition (POD) analysis is then used to obtain low dimensional dynamic models, by which the most energetic modes are extracted. Furthermore, this approach is very efficient in the sense that it uses the smallest possible number of parameters and thus is suited for optimization and control in the future flapping-wing MAV design.

9:00 AM - DESS09-0100

3D Reconstruction and Visualization of a Hovering Dragonfly

Christopher Koehler
Wright State University
Thomas Wischgoll, Haibo Dong, Zachary Gaston, Hui Wan
Wright State University

Reconstruction, simulation and visualization of insect flight is of great importance for the design of smaller and more efficient micro air vehicles (MAVs). To that end we are working on reconstructing the flapping wing motion of several quad wing insects based on the images taken from three high-speed cameras. The segmentation, point tracking and solid modeling methods used to automate the precise 3D reconstruction of a male blue dasher dragonfly as it takes off and begins to hover will be presented along with new flow visualization techniques designed to highlight the vortices being shed from the flapping wings.

9:20 AM - DESS09-0124

Limits of Quasi-steady Methods in Unsteady Aerodynamics

Michael OL

Air Force Research Laboratory

High-rate unsteady aerodynamics at low Reynolds number is an important subject for so-called “Micro Air Vehicles”, and raises basic questions in the foundations of classical aerodynamics. Traditionally we view disturbances as small, and linearize about some base state. The result is the quasi-steady assumption of how aerodynamic forces vary with the motion time-history of a rigid body. This has worked well for most aeronautical applications. For Micro Air Vehicles and for flyers in nature (birds, insects, bats), the contrary seems to be the case: flow separations are large and quasi-steady methods fail. Here we examine a range of prototypical motions for airfoils and flat plates, assessing how well quasi-steady methods work in prediction of lift coefficient time history. We compare a range of computations and experiments in wind tunnels and water tunnels, finding that the so-called dynamic stall is surprisingly benign.

SESSION 3: Biomechanics 8:00 - 9:40 AM Room 156C

Chair: Oleg Shiryayev, WSU

8:00 AM - DESS09-0097

Statistical Investigation of Failure Modes for Total Ankle Arthroplasty

Grant Roush
Wright State University
Dr. Tarun Goswami
Wright State University

Background: It is imperative to understand the most common failure modes of total ankle arthoplasty in order to appropriately allocate the resources, healthcare costs, enhancing surgical treatment methods, and improve design of the implant. The objective of this study was to investigate the primary mode or modes of failure of total ankle arthoplasty implants so these failure mode/modes can be targeted for future improvement. Methods: The Norwegian Total Hip Arthroplasty Register 2008 was chosen as the primary source of data. Results: It is evident that there is no significant difference between any of the failure modes that are pertinent to the ankle. However, there is significant evidence that the number of ankle arthroplasties are increasing with time. Conclusions: There is no statistical evidence showing which failure mode contributes most to revision surgeries, it is concluded that more information/data is needed in order to further investigate failure modes in ankle arthroplasties.

8:20 AM - DESS09-0094

Dislocation of the Total Shoulder Arthroplasty

Jessica Allen
Wright State University

The shoulder is the third most replaced joint in the U.S. The U.S. Department of Health and Human Services states that the number of shoulder arthroplasties increased by 145% between the years of 1997 and 2005, and are forecasting the number to reach 63,500 by 2020. The shoulder joint undergoes stresses and strains from normal everyday activity and disease that may trigger deformation and pain in the joint, resulting in the need to perform a total shoulder arthroplasty (TSA). A common obstacle with TSA is the risk of dislocation. The dislocations are thought to be due to the design of the components of the replacement joint, improper therapy procedures, incorrect prosthetic orientation and improper movements after surgery. The geometry of the total shoulder replacement needs to be re-evaluated in order to reduce the number of shoulder dislocations that occur after surgery, to improve the quality of life of the recipient.

8:40 AM - DESS09-0111

FEA of Proximal Humerus Locking Plate Using Bone and Implant Model

Alyssa George
Wright State University BIE Department, Igert Fellow
Dr. Tarun Goswami
Wright State University BIE Department, Orthopedic Surgery and Sports Medicine Department

Finite element analysis (FEA) of orthopaedic implants has become a common tool for evaluating the mechanical performance for various implant designs. Our goal in this work has been to create modeling of both the bone and the implant simultaneously with forces applied to the entire system. A recent study in our lab by Schumer et al of proximal humerus locking plates was done on cadaveric humeri. Our current study is now using finite element modeling to recreate these physical tests. Computed tomography (CT) images of the humeri and implants have been used to create models with Mimics® software (Materialise, Ann Arbor, MI, USA). The FEA of these models is being done in Abaqus FEA software (SIMULIA, Providence, RI, USA) to simulate the physical testing. Eventually, we hope to supplement the physical tests with these modeling tests for cases where physical tests are limited by resources.

9:00 AM - DESS09-0115

3D Modeling and Finite Element Analysis of Human Temporomandibular Joint

Shirish Ingawale
Wright State University
Tarun Goswami
Wright State University

Anatomically viable 3-D models of the temporomandibular joint (TMJ) aid better understanding of structure and function of the joint. The finite element analysis (FEA) of such anatomical models and the TMJ implants enable us to simulate the geometry, forces, stresses and mechanical behavior of the joint components and implants. We have developed 3-D models of healthy and diseased TMJs from medical images using Mimics® software (Materialise, Ann Arbor, MI). This paper presents results of FEA simulations of the TMJ models and implants performed under different jaw-loading conditions – such as normal opening and closing of mouth, unbalanced loading, bruxism and clenching – in an attempt to explore the mechanisms of temporomandibular disorders (TMDs) and improvement of the design and behavior of prosthetic devices.

9:20 AM - DESS09-0122

Biomechanical Evaluation of Acromioclavicular Joints Reconstructed with an AC Tightrope along with the Clavicle Plate

Gregory Gould
Wright State University
Kenny Edwards (MD) Joseph Rubino (MD), Tarun Goswami (DSc)
Wright State University

Many problems have been found with the common procedures used to fix the injuries of the clavicle and the Acromioclavicular joint. These procedures have been described as being too invasive or requiring a second surgery. Using the AC tightrope along with the clavicle plate, these problems will be alleviated. A biomechanical testing program has been initiated to test 20 cadaver (acromioclavicular joints), which have been fixated with a plate and AC tightrope. The biomechanical testing will evaluate the stiffness, stability and performance for 5000 cycles simulating the activities of daily life of this joint then perform load to failure testing. These tests will allow for the strength and the stiffness of the plate and the AC tightrope to be determined and appropriate recommendations in surgery.

SESSION 4: Autonomous Navigation	8:00 - 9:40 AM	Room 157A

Chair: Karleine Justice, Avetec

8:00 AM - DESS09-0106

Unmanned Aircraft Systems Challenges and Opportunities

David Stubbs
Booz Allen Hamilton
Sean Moulton, Margaret Sampson
Booz Allen Hamilton

Unmanned aircraft systems (UAS) have exploded into the operational support around the world. One UAS component of particular interest in the technology development community is the ground segment (or what was formerly the cockpit) as it is not limited by traditional cockpit constraints of size, weight, power and pilot physiological requirements. Removing these limitations changes dramatically 100+ years of traditional cockpit design and permits design and developmental ideas never thought possible. These new ground segments also have significant challenges in the areas of connectivity, interoperability, and software/hardware design. This presentation will discuss several current projects addressing the opportunities and challenges of designing new generation ground segments. The work directly supports key UAS government R&D facilities and multiple projects which are directly involved with combat operations.

8:20 AM - DESS09-0102

Autonomous Operation of Unmanned Aircraft Systems (UAS) in the Terminal Area

Bonnie Schwartz
Air Force Research Laboratory, Control Sciences Development and Applications Branch (AFRL/RBCC)

The terminal area is the complex operating zone around the airport including all ground surfaces and a crowded cylinder of airspace centered on the airfield. Terminal area operations necessitate a high degree of autonomy for the UAS to perform complex tasks such as taxi, takeoff and landing while dealing with a dynamic environment containing proximate aircraft and air traffic control. This requires many advances in autonomous control, navigation, and communication technologies. AFRL has conducted studies to identify and begin addressing the most challenging problems associated with autonomous operations of UAS in the terminal area.

8:40 AM - DESS09-0039

Flight Test Investigation of Waypoint Guidance for a Relay Unmanned Aerial Vehicle

Andrew Stryker

Air Force Institute of Technology

There are many operational scenarios that may arise where an unmanned surveillance aircraft (rover) is not able to maintain communications line of sight (LOS) to the controlling base station. Implementation of an automated airborne relay can mitigate LOS problems. Previous work has developed an optimal guidance solution for single rover applications, as well as suboptimal approaches for determining the relay path. The emphasis of current work is on extensions to the theoretical solution and suboptimal approximation for multi-rover scenarios. Practical limitations to various solutions will be investigated through flight tests of a heterogeneous unmanned air vehicle system developed at the Air Force Institute of Technology.

9:00 AM - DESS09-0062

Single Operator, Multiple Unmanned Aerial Vehicle (UAV) Discrete-Event Simulation

Chris Wellbaum

Air Force Institute of Technology

A single operator conducting a mission using multiple UAVs is not only responsible for controlling the UAVs` flight paths, but is tasked to watch surveillance video, report target status, monitor vehicle health, communicate with external resources, and ensure self safety. An enabling factor associated with mission success is the operator`s understanding of how to efficiently and effectively plan and execute the tasking. The unmanned aircraft systems (UAS) operations model can be used to develop tactics, techniques, and procedures for small UAS mission planning. To realize the utility of controlling multiple UAVs cooperatively, developing and understanding how to best operate and deploy multiple UAVs is critical to mission success. To meet this need, a multi-vehicle discrete-event simulation was developed to analyze a select set of scenarios to determine optimal mission parameters based on varying objectives. The simulation results will be compared with flight test data to assess model validity.

9:20 AM - DESS09-0108

Sensor Based Navigation Control with Potential Fields from On-Board Sensor Measurements of Robotic Vehicles

Kayode Ajayi-Majebi
University of Dayton
Raul Ordonez
Electrical & Computer Engineering Department, University of Dayton

In this presentation, a method is developed for realizing a potential field from the onboard distance sensor measurements of a robotic vehicle with the sensors distributed around the perimeter. The sensor based potential field so developed is then used for obstacle avoidance navigation in combination with other path following of path planning controllers steering the robot to a goal location in the presence of obstacles. The method proposed follows from the idea that for certain types of robotic vehicles, the distance sensor measurements alone are all that is necessary to generate the potential fields and the obstacle avoidance control with a minimum of external modulating parameters. The method, simulated with the Khepera II robotic vehicle is generalizable to robots with similar sensor arrangements.

SESSION 5: Fuels/Energy/Power 8:00 - 9:40 AM Room 157B

Chair: Terry Hankins, AFRL

8:00 AM - DESS09-0072

Chemical and Emissions Characteristics of Jet Fuels from Alternative Sources

Christopher Klingshirn
University of Dayton Research Institute
M.J. DeWitt, L. Shafer, S. Zabarnick, Z. West, R. Striebich
University of Dayton Research Institute
E. Corporan, J.T. Edwards
Air Force Research Laboratory, Fuels and Energy Branch AFRL/RZPF
J. Klein, Jim Klein LLC

Volatility in petroleum-rich countries has renewed interest in the research and development of fuels derived from alternative and domestic sources. The US Air Force has been very active in the evaluation, demonstration and certification of fuels derived from natural gas and coal via Fischer-Tropsch (FT) synthesis, specifically, Synthetic Paraffinic Kerosene (SPK). Certification of alternative fuels for use in aircraft, require extensive laboratory and large-scale evaluations. The present effort describes recent evaluations of several jet fuel candidates derived from coal, natural gas, and chicken renderings. Evaluations for specification tests per MIL-DTL-83133F, chemical composition and emissions characteristics using a T63 engine were completed. Comparisons between the performance of these alternative fuel candidates relative to specification JP-8 are presented. The potential of these fuels as drop-in replacements for conventional jet fuel and observed deficiencies will be discussed.

8:20 AM - DESS09-0103

Reviewing the Assured Aerospace Fuels Research Facility and the Production of Research Quantities of Jet Fuel

Adam Parks
Air Force Research Lab
Robert Morris, Jr.
Air Force Research Lab

To realize Department of Defense needs, the Air Force is leading the development of energy options in an effort to increase war fighting capabilities by enabling secure and reliable energy alternatives. The Fuels and Energy Branch of the Air Force Research Laboratory (AFRL/RZPF) was charged with creating a scientific platform that provides answers to fundamental questions regarding current and future jet fuels. This platform, the Assured Aerospace Fuels Research Facility (AAFRF), was designed, fabricated, and installed by a coalesced team of government employees and contractors, including Battelle and University of Dayton Research Institute (UDRI). The AAFRF, located at WPAFB, Ohio, is a multi-phased effort. Phase I involves the production of approximately 10-15 gallons of jet fuel per day with properties that approximate military specification. This presentation provides the details of AAFRF capabilities in producing research quantities of aviation fuel and the status of its operation.

8:40 AM - DESS09-0105

Development of Miniature Microbial Fuel Cells

Piyush Shah
Wright State University
Alex Watson, Hao Wang, Tim Gorey, Don Comfort, Andrew Sarangan, John Rowe, James Joo
University of Dayton
Olgierd Wojnar, Gregory Reich
Air Force Research Laboratory

Microbial fuel cells are capable converting commonly available carbon sources into electrical energy. It is an attractive energy harvesting solution for remotely operated vehicles and portable electronics. In this work, we are determining the scale-down effects on power production by developing a lab-scale and a MEMS-scale microbial fuel cell. The devices use Pseudomonas aeruginosa as the bacterial culture on the anode side, separated by a proton exchange membrane, and a platinum coated cathode. Commercially available cellulolytic enzyme mixtures are being evaluated for degradation of environmental carbon sources, such as grass, leaves, twigs, etc., which can then be used as growth medium and carbon source for P. aeruginosa within the fuel cell. In this presentation the fabrication techniques and measurement results from the fuel cells will be discussed.

9:00 AM - DESS09-0071

Unsteady Response of a Turbine Driven by a Pulse Detonation Engine

Kurt Rouser
Air Force Institute of Technology
Paul King,
Air Force Institute of Technology
Fred Schauer, Rolf Sondergaard
Air Force Research Laboratory
John Hoke
Innovative Scientific Solutions, Inc.

Experimental results are presented from an investigation of unsteady turbine performance powered by pulse detonation combustion. Integration of Pulse Detonation Engine (PDE) and Gas Turbine Engine (GTE) cycles takes advantage of pressure rise through constant volume combustion. Improvements over conventional GTEs are expected in thrust and fuel consumption. Previous experimental work by the Air Force Research Laboratory demonstrated a means to self-aspirate a PDE with a Garrett T3 automotive turbocharger. The current research effort examines the practicality of integrating a turbine and PDE. The development of an experimental method is presented for assessing unsteady efficiency of the T3 radial turbine, and a correlation is observed between turbine speed response and PDE operating parameters.

9:20 AM - DESS09-0040

Actuator Regenerative Energy Effects on Aircraft Engine/Gearbox Subsystems

Matthew Rutledge
Wright State University/Avetec
Dr. Tony Corvo
Avetec

To increase reliability and efficiency, standard aircraft components are being replaced with more electric subsystems aimed to reduce weight, conserve space, and improve energy management. One application of this process replaces standard hydraulic actuators used in flap or aileron movement with electromechanical actuators powered by an external generator. During different types of return movements, the electromechanical actuator will produce regenerative power that flows back through the generator and pulses into the engine-gearbox subsystem. Coupled with the driving force produced by the engine, the regenerative power, defined by characteristic amplitude, frequency and other pulse attributes, can dramatically impact the performance and life of the gearbox. Steady state and transient subsystem models will be developed to simulate gearbox behavior subject to incurred engine loads, regenerative power loads, and other dynamic phenomena such as backlash present in the gear interactions.

SESSION 6: Undergraduate Projects 8:00 - 9:20 AM Room 163A

Chair: Ann Heyward, OAI

8:00 AM - DESS09-0030

Sensor for oscillating pressures in combustors

Christine Englert
University of Cincinnati
Christopher Porter
University of Cincinnati

Commercially available pressure transducers cannot survive the high temperatures in the combustors and after burners of aircraft engines. Therefore sensors, based on the wave tube principal are employed. To obtain a relatively flat frequency response, the wave tube has to be very long. Such sensors are cumbersome to employ. This paper will present the concept of a pressure sensor in which the pressure transducer is mounted in a cavity filled with a porous material that attenuates the acoustic waves propagating in it. The pressure sense-tube is connected to the cavity. By adjusting the lengths of the cavity and the sense tube and the porosity of the porous material, we can obtain a sensor design of the required sensitivity and response characteristics over the frequency range of interest. The theory behind the design of the pressure sensor and its validation by experimental data will be presented.

8:20 AM - DESS09-0085

Multimodal Sensing for Anomalous Vehicle Detection

Kent Weaver
Wright State University
Julie A. Skipper, Douglas T. Petkie
Wright State University

Multimodal sensing strategies were employed to detect anomalously loaded vehicles. We first used accelerometers to experimentally validate the output of our kinematic model of a vehicle traversing a speed bump. Next, sensor suite components were evaluated for efficacy in discriminating anomalously-loaded vehicles as they travel over the bump, which serves as a system perturbation. Our prototype system includes electro-optical and short-wave infrared imagers, a millimeter-wave radar system and a novel acoustic array, along with algorithms to autonomously extract some key signatures from the raw sensor data. Finally, the multimodal signatures are input into a custom classifier to facilitate anomaly detection.

8:40 AM - DESS09-0110

Wiimote/PC/IR Interaction

Tim Hines
Wright State University
Shane Smith
Ohio University
Rhonda J Vickery
High Performance Technologies, Inc.

Though quite sophisticated, the Wii Remote (also known as the Wiimote) is very common as a controller for over 50 million Wii consoles in use worldwide. Because of its unique capabilities and Bluetooth connectivity, the Wiimote has also become a popular input device for the PC. We investigated several Wiimote projects described on the web by Johnny Chung Lee while a PhD student at Carnegie Mellon University. We started with the White-board project, which utilizes an IR pen in conjunction with a Wiimote to "write" on any screen – even projected. We also experimented with finger-tracking using the Wiimote with the Lee multipoint grid program, and extended the popular "Minority Report" style interface by designing and building our own IR gloves using low-cost materials from Radio Shack and The Home Depot. Future plans include integrating this multi-touch interface with the NASA World Wind software.

9:00 AM - DESS09-0137

LIDAR and DIAL with Femtosecond Pulses for Standoff Detection of Hazardous Materials

Michael Gord
Dayton Christian High School
Sukesh Roy
Spectral Energies, LLC
Paul S. Hsu, James R. Gord
Air Force Research Laboratory, Propulsion Directorate

The Global War on Terror requires new techniques for detecting hazardous materials. If the characteristics of light scattered from the interaction of a femtosecond laser pulse and a hazardous material target are measured, then the distance to the target and the identity of the hazardous material can be determined. An instrument was constructed based on LIDAR (light distance and ranging) and Rainbow DIAL (differential absorption LIDAR) to measure the roundtrip time-of-flight to the target and back and the spectral absorption of the target. Targets included a mirror, a cloud of water vapor, a cloud of saturated KCl solution in water, and a Rb vapor cell (cold and heated). Characteristic absorption features were observed for a heated Rb vapor cell at 780 nm and 840 nm. Applications include homeland security, industrial process monitoring, and atmospheric and environmental studies, including exploration of greenhouse gases and global warming.

SESSION 7: Sensors 1	8:00 - 9:40 AM	Room 163B

Chair: Ryan Schmit, AFRL

8:00 AM - DESS09-0063

Demonstration of Holographic Aperture Ladar Image Resolution Enhancement

Mallory Fischer
University of Dayton
Jason Stafford, Brad Duncan
University of Dayton

Holographic aperture ladar (HAL) is a variation of synthetic aperture ladar (SAL), which uses a translating receiver to synthesize a large effective aperture using appropriate phasing and correlation of the detected signals in post-processing which leads to an increase in the cross range scene resolution. Our previous laboratory work has concentrated on demonstrating the validity of the stripmap HAL transformation for a single phase segment due to an off-axis point target. For our work to be presented here we have focused on experimentally demonstrating the longitudinal resolution enhancements our theoretical work predicts. In particular, our latest work has focused on collecting, via off-axis holographic techniques, multiple sequential complex pupil plane field segments from a point target which have then been coherently stitched together to synthesize a large effective pupil plane field.

8:20 AM - DESS09-0021

Design, Development and Assessment of Flexible Framework for Object Detection in Imagery

Priya Ganapathy
BioMedical Imaging Laboratory, Wright State University
Julie A. Skipper, Ph.D.
Department of Biomedical, Industrial and Human Factors Engineering, Wright State University

In the field of target detection, there has been increasing interest in developing high performance systems that are both accurate and efficient. The task is quite challenging due to the requirements for application-oriented optimization of sensitivity and specificity, and quantification of associated risk and benefit. We have designed, developed and assessed a flexible framework to evaluate and combine algorithms/classifiers, with a general aim of improving target detection systems. Our approach can be customized to optimize a wide range of systems for automated target recognition, medical image analysis, remote sensing, intrusion detection, and biometrics. Here, we present the design, implementation and optimization of the framework to detect ground-based improvised explosive devices (IED) in images acquired with electro-optical and short-wave infrared cameras. Using the various modules of our framework (evaluation, classification, and cost function), we simultaneously achieved an overall improvement in detection accuracy of 38% with 83% savings in computation time.

8:40 AM - DESS09-0054

Development of Biopolymer Based Resonant Sensors

Erica Jones
University of Dayton
Mark Patterson, Guru Subramanyam
University of Dayton

Our group is currently investigating biopolymers for electronics, photonics and sensor applications. In this work, we have fabricated a resonant sensor using various biopolymers. The resonant sensor consists of an inductor in series with a variable capacitor composed of two electrodes separated by a chemically sensitive biopolymer. The resonant sensor is a multi-parameter device as one can measure the resonance frequency, amplitude and phase of the scattering parameters. Examples of chemical testing using the resonant sensor will be presented.

9:00 AM - DESS09-0023

Multi-sensor Integration Platform for System Evaluation and Fusion Algorithm Assessment

Hrishikesh Karvir
Wright State University
Julie A. Skipper
Wright State University, 207 Russ Engineering Center, 3640 Colonel Glenn Hwy, Dayton, OH, USA 45435

In multi-sensory systems, the choice of sensors and the hardware integration strategy are largely governed by the intended application. To meaningfully fuse and interpret the acquired data, an overall system evaluation is first needed. A fusion test-bed that allows rapid integration of multiple sensors and evaluation of different fusion architectures facilitates both of these requirements. To achieve this, we built a field-deployable, multi-sensor integration platform using cost-sensitive commercially available off-the-shelf components. This platform was tested in the development of a vehicle-mounted, ground-based surveillance unit that features an electro-optical (EO) camera and a shortwave infrared (SWIR) camera for object detection. Libraries of Matlab and LabVIEW functions were developed for synchronous data acquisition, preprocessing, image analysis and information fusion at the data-level, feature-level and decision-level. The ability to integrate new sensors, synchronize data acquisition and access different fusion schemes through developed software routines provides investigators with essential tools for fusion research.

9:20 AM - DESS09-0143

High-Bandwidth Plasma Sensor for Compressor Stall Warning

Sivaram Gogineni
Spectral Energies, LLC
Eric Matlis and Tom Corke
University of Notre Dame
Aspi Wadia
GE Aviation

A new type of sensor is being developed to measure unsteady pressures in the compressor sections of gas-turbines. This sensor is based on the use of a weakly ionized plasma contained between two metallic electrodes. The advantages of plasma-based sensors are that they are mechanically robust with no moving parts, can survive high temperatures over 2000F, have a native high frequency response which can be in excess of 1MHz, and are inherently capable of wireless transmission. The external features match commercial Kulite sensors to ensure that they are interchangeable. This sensor has been tested at the University of Notre Dame Transonic Compressor Facility to measure transient stall mechanisms and is being prepared for a test on a GE LEAP56 engine. Comparisons to Kulite data taken under similar conditions demonstrate that the plasma sensor is successful at measuring the unsteady pressure field associated with tip-gap flow in the compressor.

SESSION 8: Solid Mechanics 2	10:00 - 11:20 AM	Room 156A

Chair: Nathan Klingbeil, WSU

10:00 AM - DESS09-0011

The Effects of Aluminium Doping on the nonlinear optical and Photoluminescence Properties of ZnO Thin Films

Zouhair Sofiani
Ibn Tofail University
M. Addou, K. Bahedi
Ibn Tofail University, Kenitra Morocco
M. Eljouad, B. Sahraoui
Angers University, Angers, France

Good quality ZnO thin films are fabricated using SPRAY PYROLYSIS technique. In this paper we will examine Ce and Er species influence on the structural, morphological and luminescent properties in addition to the Third Harmonic Generation (THG) of sprayed ZnO films. The third order non linear susceptibilities were in the range of 10-12 [esu]. Our objective is the right monitoring of the formation process for this matrix material from which the doping effect can be safely investigated.

10:20 AM - DESS09-0025

Digital Image Correlation Error Associated With Various Experimental Effects

Thomas Spradlin
Wright State University
Robert Reuter, Kristina Langer
Wright-Patterson Air Force Base
Ramana Grandhi
Wright State University

Digital Image Correlation is a non-contact, full-field displacement measurement technique that has experienced a swell in popularity and use due to advances in computing technology. Though the algorithms and speckle patterns used for Digital Image Correlation have seen several extensive studies, other experimental effects, such as surface roughness, surface finish, and light intensity have yet to be thoroughly investigated. Permutations of surface roughness and finish are represented on six Aluminum 2024-T351 flat-edged tensile specimens. All six specimens have strain gages applied prior to surface finishing. The specimens are then photographed at ten light intensities both before and after loading. The images are used for Digital Image Correlation using the software package Aramis, and the error for each of the conditions is evaluated in comparison with strain gage strain values. The optimum light value for each of the surface conditions will be identified and more general experimental guidelines established.

10:40 AM - DESS09-0043

Uncertainty Quantification of Simulation-Based Model Using Bayesian Model Averaging

Inseok Park
Wright State University
Ramana V. Grandhi
Wright State University

Given experimental data measured from an engineering system, response prediction of a simulation model with a random input parameter set involves uncertainty due to both the randomness in input parameters and the prediction error of the model. Also, model form uncertainty exists when two or more simulation models are used to predict the responses of an engineering system because it is beyond our capability to identify the best model of a simulation model set. In this research, Bayesian Model Averaging (BMA) is utilized to quantify the model form uncertainty as well as parameter and predictive uncertainties in prediction of an output response. Model probability is evaluated by observing the deviations between predictions of a set of simulation models and experimental data. A laser peened component is used to demonstrate the application of BMA to an engineering problem.

11:00 AM - DESS09-0068

A Mixed Finite Element Method to Predict Strip Profile of Thin Gauge Steel

Jantzen Hinton
Wright State University
Dr. Ramana Grandhi
Wright State University
Dr. Arif Malik
St. Louis University

This work discusses a computational method developed by Drs. Arif Malik and Ramana Grandhi for finding the web thickness of a metallic strip being passed through a rolling mill using a combined method of Finite Element Analysis and solid mechanics. To avoid buckling, edge defects, and other major profile variations, a fast and accurate method was implemented in order to drastically reduce the computation time when approximating the profile of a thin steel strip. Coupling Winkler elastic foundations with Timoshenko beam elements employs the use of relatively small matrix manipulations to converge while standard FEA software must use thousands of 3-dimensional elements to accurately predict the strip profile. Continuation of this work will consist of using this mixed Finite Element Method when modeling the winding of a strip in order to create a dynamic analysis of stress build up due to variations in the strip profile.

SESSION 9: High Speed Fluid Dynamics	10:00 - 11:20 AM	Room 156B

Chair: Roger Kimmel, AFRL

10:00 AM - DESS09-0141

Review of High Alpha Configuration Development Efforts

Alyson Turri
Air Force Research Laboratory (AFRL/RBAA)
Daniel Tejtel
Air Force Research Laboratory (AFRL/RBAA)

The Air Force Research Laboratory's Air Vehicles Directorate has been investigating reusable launch vehicle re-entry at high angles of attack as a potential approach to mitigate thermal protection system requirements, thereby improving system operability. A program was undertaken to develop a series of configurations to study and better understand the aeroheating relief to be gained from high alpha trajectories. As a result of the study, a hypersonic wind tunnel tests was conducted and a significant experimental aerodynamic and aeroheating database was created. This experimental database has been used as the basis for a computational fluid dynamics (CFD) validation effort to ascertain code performance at these flight conditions.

10:20 AM - DESS09-0032

HIFiRE-5 Flight Test Update

Roger Kimmel
USAF
David Adamczak
AFRL/RBAA

The Hypersonic International Flight Research Experimentation (HIFiRE) program is a hypersonic flight test program executed by the Air Force Research Laboratories (AFRL) and Australian Defence Science and Technology Organization (DSTO). Flights one and five are devoted to aerothermal experiments. The objective of Flight 5 is to measure hypersonic boundary layer transition on a 3D body. Experimental and computational studies used to design the vehicle have also resulted in basic research advances. Leading edge, crossflow and second-mode transition are expected. Portions of the test vehicle are expected to transition at relatively high altitude. Transition from leading edge roughness is predicted well by swept cylinder correlations. The leading edge is more sensitive to 3D roughness than 2D roughness, and the leading edge is more sensitive than the minor axis. A multipiece clamshell construction is envisioned to avoid seams and fasteners in critical areas. Surface tolerance requirements are similar to those on HIFiRE-1.

10:40 AM - DESS09-0131

Dual Mode Scramjet: A Computational Investigation on Combustor Design and Operation

Ryan Milligan
Wright State University
Dean Eklund
Air Force Research Laboratories
James M. Wolff
Air Force Research Laboratories
John Tam
Taitech inc.

Numerical analysis was performed on a Dual-Mode Scramjet isolator-combustor. Preliminary analysis was performed to form a baseline geometry. Another study validated the results of a 2D model compared to a 3D model. Stable combustion was shown at two different flight conditions, M=3.0 and M=2.5. A marginal 5% decrease in stream thrust was shown by introducing a 50/50 mix of methane and ethylene. Based on the results of the preliminary analysis, detailed geometry analysis was performed on the 3D baseline geometry. Adding a new set of cavity feeding injectors increased the overall stream thrust and the equivalence ratio in the cavity. Using less fuel than the baseline configuration, revealed a 6.4% increase in stream thrust and an 11% increase in combustion efficiency by placing the second stage injector further upstream. Future analysis includes combining the cavity feeding with closer injector placement, which is expected to yield even better results.

11:00 AM - DESS09-0013

Particle-Based Plasma Simulation of the NEXT Ion Engine

Michael Jonell
Wright State University
James Menart
Wright State University
Sudhakar Mahalingam
Tech-X Corporation

A detailed ion engine discharge PIC-MCC (Particle-In-Cell Monte Carlo Collision) computer model was developed by Wright State University and in 2007 was used to numerically model aspects of the NSTAR (NASA Solar Technology and Application Readiness) ion engine. The model compared well with experimental results. The goal of this work is to use the model to perform a similar analysis on the more advanced NEXT (NASA Evolutionary Xenon Thruster). This model tracks neutrals, first ions, second ions, primary electrons, and secondary electrons. Each of these particle species is tracked in a detailed manner including the effects of many types of collisions and the effects of electric and magnetic fields on the charged particles. In this paper, verification of the Wright State computer model is made by comparing results to experimentally obtained NEXT performance data. Charged particle distributions and temperatures, along with thruster parameters, are presented along with other performance results.

SESSION 10: Prosthetics	10:00 - 11:20 AM	Room 156C

Chair: Kimberly Bigelow, UD

10:00 AM - DESS09-0035

Fluid Mechanics of Human Heart & Positive Displacement Pump - What can be Learnt from the Analogy?

Bellur Shiva Prasad
Wright State University

Human Heart is the first and most complex positive displacement pump ever invented. Despite its importance, very little attention has been paid to modeling/simulation of the heart using the analogy. Parameter/s better than “Ejection Fraction” or “Cardiac Output” are needed for assessing its efficiency/performance. The analogy assumes greater importance for designing mechanical pumps. Mimicking the dynamics of the heart would be essential. The human heart has evolved as a part of a complex dynamically coupled circulatory system with the pulmonary and systemic functions operating at two dominant and distinct frequencies. Hence in addition to the known problem of blood cell damage occurring with the use of axial pumps, the modification of the overall circulatory system dynamics and the adaptability of the brain could pose problems more serious than the known rejection issue with bio-incompatible materials. The presentation will focus on areas where such analogy and transplantation of technology are needed.

10:20 AM - DESS09-0034

Mathematical Prediction of Volume of Neurological Tissue Stimulated in Deep Brain Stimulation

Melissa Jones
Wright State University
Dr. Tarun Goswami
Wright State University

In this study, three multi-variant mathematical models are presented which were developed to predict the volume of tissue stimulated in terms of several independent parameters. The volume of tissue stimulated (VTS) was modeled as being dependent upon electrode diameter, aspect ratio, applied current, pulse duration, voltage and frequency. Several relationships were determined between the VTS and each parameter, and the most significant parameters were determined based upon the value of their coefficient. Because limited data was available in the literature, validation of the models with wide range of data was not possible. However, the equations provide both theoretical and experimental basis for predicting the volume of tissue stimulated in deep brain stimulation and will be very useful in future studies.

10:40 AM - DESS09-0022

Virtual Reality: From Training to Rehabilitation -Analysis of Amputee Gait Using Virtual Realty Rehabilitation Techniques-

Maurissa D'Angelo
Wright State University
D. Reynolds, S. Narayanan
Wright State University
S. Kotowski, S. Page
University of Cincinnati

Inefficient amputee gait has significant impact on the quality of life of individuals living with limb loss and often affects their ability to successfully complete activities of daily living. It is hypothesized that through appropriate visualization methods, amputees will be able to more effectively and efficiently ambulate with more symmetrical gait due to improved stride length, more equal weight distribution between limbs and a more narrow and improved base of support. Improved gait techniques will help to facilitate overall stability and assist in preventing potential hazards for individuals. The needs of amputees have been studied and currently a system to incorporate chronic and repetitive exercises and functional real world demands is being developed to test the effectiveness of a virtual reality rehabilitation system for amputees. Understanding the benefits of Virtual Reality to the rehabilitation field, specifically gait rehabilitation, will help to improve overall gait efficiency and prevent gait related injuries.

11:00 AM - DESS09-0125

Degenerative Hair Cell and Artificial Hearing Implants

Allison Van Horn
Wright Statue University Department of Biomedical, Industrial, and Human Factors Engineering
Dr. Robert Goldenberg
WSU Professor and Chief, Division of Otolaryngology Department of Surgery
Dr. Tarun Goswami
WSU Associate Professor, BIE/Orthopaedic Surgery

There are an estimated 33 million people solely in the Unites States deaf or hard of hearing. Hearing loss results from hair cells in the cochlea getting damaged and degenerating, leading to a lower quality of life. Hearing loss can be caused by many factors. Age, loud noises, and many medical conditions are just a few examples. There are multiple ways to improve hearing damage. Hearing aids are often used to help amplify the sound but they do not restore hearing. Cochlear implants also provide hearing sensations, but once again they do not restore hearing. A new innovative design to improve and restore hearing is needed. Repairing and creating hair cells in the cochlea can better improve hearing and possibly even restore hearing loss.

SESSION 11: Trajectories	10:00 - 11:20 AM	Room 157A

Chair: Vince Raska, AFRL

10:00 AM - DESS09-0017

Fuzzy Counter Ant Algorithm for Maze Problem

Mohit Ahuja
University of Cincinnati
Baisravan HomChaudhuri
Graduate Student, Department of Mechanical Engineering, University of Cincinnati, Student Member, ASME
Kelly Cohen
Associate Professor, Department of Aerospace Engineering, University of Cincinnati.
Manish Kumar
Assistant Professor, Department of Mechanical Engineering, University of Cincinnati, Member, ASME

Two dimensional maze problems have been considered as an interesting test bed in AI and there have been a growing number of publications concerning their usage to investigate the effectiveness of multi-agent algorithms. Solving the maze is essentially an exploration and exploitation problem where the solution is unknown apriori. Exploration in an uncertain environment with incomplete information about the operating environment is an important task for autonomous robots which can be used for various applications such as mine detection, ISR, border patrolling etc. In this effort, fuzzy logic is employed for unsupervised learning based decision support system for maze solving. Our fuzzy approach is inspired by a swarming ant colony optimization algorithm. In addition to simulations, we are working on experimental validation in our laboratory. Preliminary results using Matlab simulations indicate the expected trend that using multiple agents would reduce the convergence time as compared to a single agent

10:20 AM - DESS09-0004

(Control Science) Unmanned Air System (UAS) Autonomous Sense and Avoid (SAA)

Vince Raska
US Air Force Research Laboratory, Air Vehicles Laboratory, Control Applications and Development Branch (AFRL/RBCC)
Dr. Won-Zon Chen
Northrop Grumman Corporation, Aerospace Systems
Mr. Jacob Kay
Bihrle Applied Research, Inc.

To operate freely in commercial airspace, UAS require an on-board SAA system to provide an “equivalent level of safety.” An Air Force Research Laboratory team is developing an autonomous SAA system comprising three layers: sensors detecting cooperative/non-cooperative traffic, sensor integration, and autonomous collision threat evaluation and avoidance. This presentation focuses on autonomous avoidance, design objectives, algorithmic approaches, simulation, flight results, and lessons learned. Candidate avoidance trajectories with 30-second look-ahead are generated and stitched together by two 15-second segments to achieve a variety of avoidance maneuvers. The optimal avoidance trajectory is selected by evaluating candidates against prioritized criteria and updated every second to ensure best avoidance solution until the conflict is cleared. JOCA has been developed and refined through computer simulations, and inflight encounter scenarios.

10:40 AM - DESS09-0026

Constrained Near-Optimal Control Using a Numerical Kinetics Solver

Alan Jennings
University of Dayton
Raul Ordonez
University of Dayton

Optimal trajectory generation is difficult requiring calculus of variations. Solving the integral equations is often intractable for complex systems. A numerical kinetic solver is used to develop the equations of motion. The three steps to the problem are to draw the rigid body, identify states, and pose the optimal control problem in terms of the states. Optimality residuals are shown on a pendulum and contrasted to a linear quadratic regulator. This allows for optimal trajectory generation without intensive system analysis so that designs can be compared early in the design phase. In addition, autonomous agents can repose the optimal control problem or system configuration to solve optimal trajectories at run time.

11:00 AM - DESS09-0018

Trajectory Envelope For a Controlled Re-entry Vehicle Satisfying Waypoint Constraints

William Karasz
AFIT
Dr. Richard Cobb
Air Force Institute of Technology

The Air Force's Prompt Global Reach concept describes the desire to have a capability to reach any target within a 9000 nautical mile distance within two hours of launch. To meet this objective, much effort is being devoted to hypersonics and re-entry vehicles. Specifically this research focuses on path planning and waypoint selection by finding the trajectory envelope of a hypersonic vehicle. Given an initial starting condition, target, and set of waypoints, this research indirectly identifies waypoints that are feasible by finding the trajectory envelope or region of all feasible paths of the hypersonic vehicle. Waypoints inside the envelope are feasible and those outside are infeasible. Several methods for approximating the trajectory envelope are presented, including geometric, partial analytic, and dynamic optimization methods.

SESSION 12: Systems Engineering	10:00 - 11:00 AM	Room 157B

Chair: Lance Chenault, Aerospace Business Development Assoc.

10:00 AM - DESS09-0044

An Air Force S&T Directorate's View on Applying Systems Engineering Principles to its Programs

Robert McCarty
SynGenics Corporation
James Malas,Robert Rapson, Ronald Pendleton, Robert Enghauser, Bryan DeHoff, William Kesling, Gerald Hasen
Materials and Manufacturing Directorate, Air Force Research Laboratory
Carol Ventresca, Thomas Archer
SynGenics Corporation

This paper reports on an on-going activity within a Research and Development organization's Systems Engineering office which is working on tailored application of Systems Engineering to Science and Technology (S&T) programs. The broad range of S&T development programs will significantly benefit from the application of systems engineering principles during program assessments, planning, and execution. Systems engineering methods and tools provide the structured management for improving effectiveness and efficiency of program management and improving success of technology transitions and transfers. An Integrated Product and Process Development (IPPD) analysis of the suitability of various systems engineering methods for different types of materials and manufacturing S&T programs is presented.

10:20 AM - DESS09-0029

Facility Systems Integration and Optimization

Evan Nutt
University of Dayton, Waibel Energy Systems

Rising energy costs coupled with cramped operating budgets have caused building managers to turn to green projects that optimize building performance. Waibel Energy Systems has created a brand called BuildingLogiX, which is a system of robust, web-based applications that translate complex machine and system data into metrics that are meaningful and understandable at both the operations and management levels. The packaged knowledge is delivered via a standard web browser making it accessible to authorized users anywhere in the world. Whether one needs to organize customizable energy data into informative invoices for the building tenants, generate historic trends on a specific building component, or proactively manage a facility's energy consumption, the advanced web-based applications leverage the value of the building system investments. The building manager can now troubleshoot building irregularities down to the component level. This capability enables incremental changes that can increase savings and efficiency at a facility wide level.

10:40 AM - DESS09-0104

The Use of Systems Engineering in AFRL Capability-Based Technology Transition Projects

David Stubbs
Booz Allen Hamilton
Thomas Ray
Booz Allen Hamilton

The Air Force Research Laboratory, Air Vehicles Directorate (AFRL/RB) and Booz Allen Hamilton entered into a Cooperative Research and Development Agreement (CRADA) to research and document the early use of Systems Engineering in capability-based, technology maturation and transition projects. The goal was to identify best practices used on projects that that led to more successful technology maturation and transition. The project focused on documenting Systems Engineering and technology development best practices that AFRL program managers found to be valuable for typical AFRL R&D capability-based projects. This effort employed a fairly traditional research approach including a literature review and interviews with AFRL project leads about their projects. The interviews focused on approaches and strategies that balanced customer requirements with innovative technology solutions in technology maturation planning. The CRADA team analyzed the interview findings in the context of the ongoing research in this area and identified three key Systems Engineering-related practices.

SESSION 13: Undergraduate Projects & Education 10:00 - 11:20 AM Room 163A

Chair: Ann Heyward, OAI

10:00 AM - DESS09-0073

High Altitude Free Fall Capsule Experimentation

John Snyder
Wright State Undergraduate Mechanical Engineer
Dr. Joseph Slater, Dr. Oleg Shiryayev
Wright State University

The 2009 Wright State University High Altitude Balloon program (WSU HAB) is working toward the completion of systems that will facilitate near space free fall experimentation. Results from this research may provide cost effective and practical solutions for stability testing of reentry vehicles or high altitude unmanned aerial vehicles from nearly 100,000 feet. Fail-safe operation of capsule release and parachute deployment mechanisms is crucial for performing free fall experiments. Six months of design and testing has lead to implementation of Nickel Chromium (NiCr) heating elements for severing nylon cable systems that initiate capsule release and parachute deployment. Several laboratory and in-flight tests revealed that NiCr performs well under the low temperatures and pressures present at near-space altitudes. The WSU HAB program is anticipating a successful capsule release and parachute deployment in the fall of 2009 followed by future development of free fall vehicles.

10:20 AM - DESS09-0050

Release Mechanism (High Altitude Balloon)

Besmira Sharra
Mechanical Engineering High Altitude Balloon Team, Release Mechanism study
Dr. Joseph C. Slater, PE
Wright State University

Design of a balloon release mechanism used by the WSU High Altitude Balloon team is presented. Commanding balloon cutaway after burst is not always effective because the balloon has a tendency to get tangled in the parachute causing parachute collapse just seconds after burst. The presented release mechanism will help prevent the balloon from being tangled with the parachute and its cords. It does this by using the cord tension to keep a spring clamp shut. When zero tension exists, such as after balloon burst, the spring opens the clamp and releases the balloon. A system to prevent premature release is also presented.

 ABSTRACTS

10:40 AM - DESS09-0079

Preparing Engineers to Succeed

Ken Simone
University of Dayton Research Institute

I submit to present at the symposium my observations of Engineering Education challenges and innovative methods to meet those challenges to prepare engineers to succeed. I will prepare to discuss the changing demands on engineers over the past 30 years and the impact on our educational institutions. The importance of design projects will be discussed and examples of past successes and failures will be analyzed. Best practices for definition and management of projects will be presented.

11:00 AM - DESS09-0038

Applying the Concept of Integrated Project Design to a Commercial Net-Zero Energy Building in the Classroom

Russell Marcks
Sinclair Community College
Larraine Kapka, Charlie Setterfield, Eric Dunn, Jennifer Wise
Sinclair Community College

A 49-student team representing five different programs at Sinclair Community College participated in a capstone design project to develop a net-zero energy building. Using an integrated design approach, these students developed the architectural, mechanical, HVAC, civil, and environmental design. The project was facilitated by four assigned faculty members with input from three additional departmental faculty, the program advisory members and from the Sinclair facilities management team. The intent of the project is to 1) Introduce the integrated design concept, 2) expose the students to the Net-Zero energy concepts, 3) introduce students to application of renewable energy resources, 4) Promote teamwork. This presentation addresses the initial preparation for tackling such a large project, technical and pedagogical issues encountered over the course of the project, as well as lessons learned for application to the next project.

SESSION 14: Sensors 2 — 10:00 - 11:00 AM — Room 163B

Chair: David Allen, WSRI

10:00 AM - DESS09-0048

Surface Acoustic Wave Vapor Sensing Platform Using Biomolecular Coatings

Daniel Gallagher
Air Force Research Laboratory
Lawrence Brott, Mark Allard, Wendy Goodson, Rajesh Naik
Air Force Research Laboratory

A new vapor sensor platform is proposed, designed around surface acoustic wave (SAW) devices that are functionalized with highly selective coatings (polymers, biomolecules). Using the inverse piezoelectric effect, a pair of interdigitized electrodes creates a surface acoustic wave on lithium niobate. By placing a vapor-sensitive coating in the path of the wave, strong coupling between the coating and the acoustic wave is observed. When the biomolecules within the coatings bind to target molecules in the air, the acoustic velocity of the wave is altered, changing the frequency response. This platform can be customized by varying the sensing coating to support specific needs with a sensitive, low false-positive detector. Initial sensing results are presented showing device sensitivity to ethanol using a polymer film. Current work includes improving both the sensitivity and specificity of the sensors by incorporating a monolayer of biomolecules such as peptides as the coating layer.

10:20 AM - DESS09-0003

Pan-Tilt-Zoom Camera System for Dynamic In-Flight Tracking and Measurement

Chris Allen
Air Force Institute of Technology
Dr. Jonathan Black, Alan Jennings, Daniel Magree
Air Force Institute of Technology

Noncontact dynamic measurements of lightweight flexible aerospace structures in motion present several challenges. Texture based photogrammetry provides high resolution surface profiles at the cameras frame rate. For texture based analysis, the surface should be crisp and not out of focus. Both these would require actively tracking the camera on the object. By using a real-time videogrammetry system, a set of cameras is coordinated to track large scale motion and produce high speed, high quality images for surface reconstruction. From the surface deflections, vibration modes or joint dynamics can be recreated for FEA validation and determination of in-flight deformation. Sometimes the desired loading is a result of the motion interacting with structural dynamics as is the case with aeroelasticity. Vibration tests on a flexible beam will be used to verify system accuracy.

10:40 AM - DESS09-0084

2D Tomographic Reconstruction of Temperature Fields in Reacting Flows at 50 kHz Using a TDM Sensor

Andrew Caswell
Spectral Energies, LLC
Lin Ma, Weiwei Cai
Clemson University, Department of Mechanical Engineering
Thilo Kraetschmer, Scott T. Sanders
University of Wisconsin-Madison, Department of Mechanical Engineering
Sukesh Roy
Spectral Energies, LLC
James R. Gord
Air Force Research Laboratory, Propulsion Directorate

Combustion instability represents a key issue that significantly affects the performance of practical combustors and afterburners. Such instability exhibits two modes: the low-frequency "rumble" and high-frequency "screech." Resolving these instability modes requires diagnostics that are capable of providing continuous measurements with sufficient spatial and temporal resolution. This work describes a tomography sensor based on hyperspectral absorption spectroscopy to address this critical diagnostic need. This sensor enables continuous tomographic imaging of temperature and chemical species with a bandwidth of 50 kHz. Based on the projection measurements, a tomographic reconstruction was conducted to retrieve the temperature and concentration of H2O in an atmospheric-pressure near-adiabatic H2–air flame. The application of this sensor for retrieving the 2D temperature field in an augmentor will be discussed as well.

SESSION 15: Structures & Damage Prediction 1:20 - 3:00 PM Room 156A

Chair: Jia Guo, WSU

1:20 PM - DESS09-0051

Determination of Probability Density Functions of the Cohesive Zone Model Parameters

Venkateswaran Shanmugam
Wright State University
Dr. Ravi Penmetsa
Wright State University

In the recent years Cohesive Zone Models (CZM) have gained increasing popularity for modeling the fracture process and also in other applications like composite de-lamination, solder failures in circuits, etc. This can be attributed to the ability of the CZM to adapt to the nonlinearities in the process it represents by adjusting the model parameters. These parameters that are selected to represent the material behavior in the vicinity of the crack or a damage zone are non-deterministic in nature resulting in random fracture strength estimates. Numerous researchers in the literature suggest values for the CZM parameters based on their experience from limited test data. Since data for fracture toughness is available, this research is aimed at determining the probability density functions for the cohesive zone parameters using simple bilinear cohesive zone model that would give the same scatter in fracture strength as that obtained from the Linear Elastic Fracture Mechanics.

1:40 PM - DESS09-0088

Design Considerations for Structures in Extreme Thermal Environments

Joshua Deaton
Wright State University

Aircraft structures subjected to elevated temperature induced by internal heat sources and aerodynamic effects can potentially sustain damaging thermal stresses. While the typical method for alleviating thermal stress is to accommodate thermal expansion in structural components, little work has been done to investigate situations where such expansion is not possible, such as in embedded engine integration and engine exhaust-washed structures. To best address this problem, the effects of the design parameters of the structure must be explored, in addition to each parameter's relative uncertainty. This presentation highlights the design issues associated with aircraft structural components that experience is inhibited thermal expansion as well as review previous work in the area.

2:00 PM - DESS09-0121

Application of Probabilistic Methods to Turbine Engine Disk Life Prediction and Risk Assessment

Paul Copp
Wright State University
Dr. Tarun Goswami
Wright State University

Dr. Paul Copp Deputy Director, Damage Tolerance and Probabilistic Lifing Methodologies Center Wright State University Dr. Tarun Goswami Director, Damage Tolerance and Probabilistic Lifing Methodologies Center Wright State University Abstract Turbine engine disk life prediction and understanding the associated risk remains a significant challenge for today's designer. Despite advances made in materials testing, characterization, and application of damage tolerance and linear elastic fracture mechanics modeling, there remains a void in properly assessing loading, geometry, and material design property variability. Application of probabilistic methods offers an effective and useful approach to modeling this variability while also providing a means to assess random variable sensitivity and overall risk assessment. Current research, as well as, applicable industry and government regulatory guidelines and publications were summarized and will be presented. An assessment of the most effective tools, modeling methods, and predictive risk of failure assessments together with recommendations for future work will be discussed.

2:20 PM - DESS09-0067

Challenges of Implementing Retirement for Cause Lifing Philosophy

Jace Carter
Wright State University
Dr. Paul Copp, Dr. Tarun Goswami
Wright State University

Historically, the US Air Force has used safe-life and damage tolerance to predetermine the life of gas turbine engine rotating components. These methods are inherently conservative since components are retired with remaining usable life. Replacing engine components is costly and contributes to the overall life cycle costs (LCC). Retirement for Cause (RFC) allows components to be used to their full fatigue life, retirement of components occur only when a quantifiable defect is found through non-destructive inspection (NDI). Inspection intervals are developed on the basis of fracture mechanics to determine if components return to service (RTS). Since the inspection process is costly, RFC must optimize inspection periods in order to minimize LCC while maintaining a high level of component reliability. Other issues for implanting RFC such as needed NDI infrastructure required to handle increased inspections and inspection procedures for components RTS are addressed.

2:40 PM - DESS09-0064

Comparison of Aero Engine Component Lifing Methods

Ashley Whitney-Rawls
Wright State University
Dr. Paul Copp, Dr. Tarun Goswami
Wright State University

Failure of critical engine components can cause the loss of the engine, aircraft, or even loss of life. To reduce the risk of failure, methodologies and tools have been developed to determine the safe operating life of these components. The two most used lifing methods, safe-life and damage tolerance, are inherently conservative, retiring all components when a predetermined operating limit is reached. Both methods retire components with theoretical useful life remaining. Additional lifing methods are needed to reduce this conservative and extend the life of these components. Retirement for cause is a lifing method that tries to balance the potential risk of failure with the economics of component replacement, retiring component only when a defect is found. Published journals, military and industry standards on lifing methodologies were reviewed. Deterministic and probabilistic approaches and current tools are discussed. A comparison of current methodologies used by the government and industry is provided.

SESSION 16: Thermal Sciences 1:20 - 3:00 PM Room 156B

Chair: Scott Stouffer, UDRI

1:20 PM - DESS09-0065

Dynamic Testing of Electromechanical Actuators

Nicholas Rolinski
University of Dayton
Dr. Quinn Leland
Air Force Research Laboratory
Dr. Thomas X. Wu, David Woodburn
University of Central Florida
Dr. Jamie Ervin
University of Dayton

An electromechanical actuator (EMA) is to be dynamically tested for transient thermal and electromechanical behavior for the purpose of software model validation. The EMA follows a position profile within a hydraulic press which provides an opposing force profile. The two profile time-stamps are synchronized simulating a complete flight profile. Careful selection of experimental techniques is required since many established procedures are appropriate only for steady-state testing. To capture transient electromagnetic behavior, high speed data acquisition architecture is explored and implemented. Because normal synchronization techniques are not achievable due to hydraulic press and actuator limitations, a “divergence reset” synchronization control routine is selected. To compensate for hydraulic limitations, a feed-forward loop is added to the basic PID controller created for the press. These techniques are used together in a National Instruments LabVIEW virtual instrument to address and observe the system’s inherent time-dependencies in question and facilitate authentic dynamic testing.

1:40 PM - DESS09-0076

Evaporative Spray Cooling Using a Pulsed Nozzle

Larry Byrd
Air Force Research Laboratory
Lanchao Lin, Roger Carr
University of Dayton Research Institute

Evaporative spray cooling is a proven technique utilizing the latent heat of vaporization to remove high heat flux thermal loads. Typically the cooled area operates in a flooded mode with excess liquid going to a sump. This research explores the use of a pulsed spray to minimize the liquid flow rate and determine the effect on the critical heat flux. An experimental apparatus was developed to cool a thick film resistance heater using FC72 as the working fluid. Steady state data was taken for different nozzle pressure drops, pulse characteristics, heat flux and spray chamber temperature. The wall to saturation temperature difference will be examined to determine the heat transfer coefficient and liquid carryover. Preliminary results indicate that in some cases the pulsed spray mode can provide equivalent cooling at roughly sixty percent of the continuous spray flow rate but the critical heat flux may be lower.

2:00 PM - DESS09-0046

Studies of Thermally Conductive Foams Infused with Paraffins for Thermal Storage Applications

Douglas Johnson
University of Dayton
Shar Na Clement, Quinn Leland
Air Force Research Laboratory
Jamie Ervin
University of Dayton Research Institute

Any thermal management system (TMS) designed for the peak thermal load of low duty cycle systems will likely be over-sized. A TMS that stores the peak thermal load and rejects the heat at an average rate will have a smaller and lighter heat rejection system. The current research considers the use of thermally conductive foams that are infused with waxes (either n-octadecane or n-docosane) for thermal energy storage applications. The foam samples (aluminum, POCOFoam, and POCO HTC) were subjected to various heating conditions while embedded thermocouples measured the resulting temperature distributions. A significant concern is adequate heat transport to maintain a minimum temperature rise, especially under conditions of a high heat flux. Thus, the absence of a detectable melt front is desirable. Preliminary results indicate that the time required for complete melting and the final temperature after complete melting of the wax are strongly dependent on the foam thermal conductivity.

2:20 PM - DESS09-0047

3D Finite Element Analysis of a Single Chip SiC Power Module

Bang-Hung Tsao
University of Dayton Reserach institute
Katie M. Sondergelt, Jacob W. Lawson
University of Dayton Reserach institute
James D. Scofield
Air Force Reserach Laboratory

A three dimensional thermal-fluid and stress model of a single chip SiC power sub-module was generated using ANSYS in order to determine the maximum temperature and deformation under various conditions. The effects of heat flux, working fluid temperature and differential pressure on temperature and thermal stress contours were of particular concern. Steady state analysis with water as the working fluid, a simulated heat flux between 11.12x104 to 10x105 W/m2, an interface coupling film coefficient of 200 W/m2-K between the cooling plate and fluid, and ambient film coefficients from 6 W/m2-K to 25 W/m2-K, predicts maximum device junction temperatures between 327 and 578 K, and corresponding deformations from .0305% to .0438%. Transient analysis also showed junction temperatures in the predicted range and determined the time to reach steady state to be between 150 and 2500 seconds depending on the boundary conditions. Experiments were conducted in order to validate ANSYS results.

2:40 PM - DESS09-0045

3D Finite Element Analysis of a Multiple Chip SiC Power Module

Katie Sondergelt
University of Dayton Research Institute
Bang-Hung Tsao, Jacob W. Lawson
University of Dayton Research Institute
James D. Scofield
Air Force Research Laboratory, WPAFB

A three dimensional thermal and stress model of a high temperature SiC power switch module was generated using ANSYS to determine the maximum temperature and deformation. The effects of heat flux placed on the MOSFETs, diodes, and the two together were of particular concern. Looking at both steady state and transient analysis, a simulated heat flux of 1.0x104 to 1.5x107 W/m2 was used and was placed on either the four MOSFETs or the four diodes, or placed on all eight chips. The bottom of the Metgraf Cu 4-280 was held to a constant temperature of 273 K. With the heat flux range mentioned above, the maximum device temperatures ranged between 273.1 and 550.7 K, and corresponding deformations from 1.09x10-4 m to 1.58x10-4 m. A transient case allowed the heat flux to remain on for half a second and then off for half a second until the model reached steady state.

SESSION 17: Biomedical Diagnostics 1:20 - 3:00 PM Room 156C

Chair: Tarun Goswami, WSU

1:20 PM - DESS09-0101

An evaluation of variance in nuchal translucency (NT) measurement with an ongoing quality assurance (QA) program.

Angus Acton
Department of Biomedical, Industrial and Human Factors Engineering, Wright State University
Cathy Downing, David McKenna, Jiri Sonek
Miami Valley Hospital, The Fetal Medicine Foundation/USA
Dr. Tarun Goswami
WSU

Nuchal translucency measurement is a powerful risk assessment tool for a multitude of fetal complications including chromosomal and structural anomalies. Currently, the Fetal Medicine Foundation offers and recommends accreditation to physicians and sonographers who routinely perform nuchal translucency screens. In addition, an ongoing quality assurance protocol has been developed to ensure continued measurement accuracy. In order to assess the measurement quality at an individual institution, namely Miami Valley Hospital of Dayton, Ohio, a temporal study of the squared error was conducted for 14 sonographers who had a minimum of 30 measurements in the 2005-2006 and 2007-2008 bienniums. Results indicate a significant reduction in the squared error (± SD) in the NT measurements between the two successive study periods (0.43 ± 4.02 for 2005-6 vs. 0.19 ± 1.69 for 2007-8, $p<0.0001$) thus suggesting an ongoing QA program results in a tighter distribution of measurements and improved first trimester screening accuracy.

1:40 PM - DESS09-0024

Target recognition: fusing LWIR and EO imagery for detection of humans in a scene.

Renee Woodyard
WSU
Julie A. Skipper
Wright State University
Daniel Repperger
WPAFB/AFRL

We aim to identify humans in multimodal imagery by predicting the human long-wave infrared (LWIR) signature in a variety of environmental scenarios. By adapting Tanabes thermocomfort model, we simulated human body heat flow both between tissue layers (core, muscle, fat and skin) and between body segments (head, chest, upper arm, etc.), to yield temporal skin surface temperature data. Our model was found to be in close agreement with experimentally collected data, with a maximum deviation from literature values of approximately 0.80%. Next, we characterized our LWIR imager in order to develop a mathematical blur correction for the LWIR imagery. Incorporating the predicted human thermal signatures, we plan to perform feature fusion on the deblurred LWIR images and high-resolution electro-optical images in order to differentiate humans from their surroundings and identify non-human thermal clutter.

2:00 PM - DESS09-0007

Evaluation of quantitative computed tomography-based measures in predicting bone strength

Bino Varghese
BioMedical Imaging Laboratory
Thomas Hangartner
BioMedical Imaging Laboratory, Wright State University
Marvin Miller
Dayton Childrens Hospital, Wright State University

Background: Finite element (FE) models constructed from computed tomography (CT) data are invaluable tools in area of bone mechanics. However, their clinical application has been limited due to the lack of efficient automation and reliable estimation of accuracy. Methodology: A combined numerical–experimental study was performed comparing FE predicted surface strains with strain gauge measurements, for a variety of FE models constructed from 3-D CT images of long bones. The bones were tested under three-point bending and torsion. Findings: A preliminary study showed that the FE models constructed from the CT data emulate true bone response with an error of less than 20% across all bone models. Conclusion: The choices of a Poisson's ratio of 0.35, a Young's modulus of 20 GPa for the cortical bone and the derivation of trabecular-bone Young's modulus from CT images using a power-based density-modulus relationship are reasonable, for FE analysis of long bones.

2:20 PM - DESS09-0107

Utilizing center of pressure measurements from force-measuring platforms in the prevention of falls

Kimberly Bigelow
University of Dayton

Falls are the leading cause of unintentional death in older adults. This study focuses on postural instability as a contributor to falls. Center of pressure measurements were collected using a force-measuring platform to determine whether older fallers exhibited significantly different postural sway characteristics than non-fallers. Data was analyzed using both traditional time-domain measures and also Detrended Fluctuation Analysis, which looks at underlying fractal properties. It was found that older adults who fell two or more times can be differentiated from those who do not, but individuals who fall once or more cannot be differentiated from non-fallers. Results suggest that a single fall may correlate more to risk taking behavior, whereas multiple falls are the result of balance impairment. Future work aims to translate findings to impact clinical practice.

2:40 PM - DESS09-0042

Modulation of NF-êB Pathway by Gold Nanoparticles in B cells.

Monita Sharma
BMS PhD program, WSU / WPAFB AFRL/RHPB
Laura K Braydich-Stolle, Saber Hussain
Air Force Research Laboratory 711 HPW/RHPB
Courtney Sulentic
BMS PhD Program, Wright State University

This study aims at providing a better understanding of how gold nanoparticles affect the NF-êB signaling pathway and modulating the pathway using silicon coated gold nanoparticles functionalized with DNA, using a murine B- cell line as the model system. Silicon coated gold nanoparticles still retain the unique optical properties of the gold, but lose their inherent chemical reactivity towards –thiol groups. These biocompatible nanoparticles can then be functionalized with DNA to specifically alter the NF-êB pathway. Preliminary data suggested that gold nanoparticles downregulate the activity of NF-êB in B cells and increased the mitochondrial function in the B cell line being tested. These results suggest that the function of B cells could potentially be compromised by gold nanoparticles. With the ever expanding list of biomedical applications it is especially important to assess the impact of gold nanoparticles on the cellular functions before they can be safely used for nanomedicine.

SESSION 18: Renewable Energy 1:20 - 3:00 PM Room 157A

Chair: Kevin Hallinan, UD

1:20 PM - DESS09-0139

A Methodology to Estimate the Annual Average Daily On-Road Mobile Source Pollutant Emissions

Wilbert Meade
Institute of Environmental Sciences, Miami University
Ramanitharan Kandiah
International Center for Water Resources Management, Central State University

A considerable fraction of air pollution in the forms of hydrocarbons, carbon monoxide and air toxics comes from on-road mobile sources. This study describes a methodology to estimate the annual average daily emissions of on-road mobile toxins and the temporal trends in a region from the Annual Average Daily Traffic (AADT) data available for the region. Hourly Traffic Percentage by vehicle type is used to calculate AADT by vehicle type (AADTV). Computed AADTVs are used in MOBILE6 program to estimate the annual average daily air toxin emissions at each monitoring location. The annual average daily emission for each on-road mobile source pollutant in the region is computed as the weighted average of the emissions at all locations, using Thiessen polygon methods in ArcGIS. Data from three counties in Miami Valley, Ohio is used for the case study.

1:40 PM - DESS09-0112

Photovoltaic Module Assembly as Appropriate Technology in Pakistan

Faizan Ahmad
University of Dayton

This presentation outlines the development of photovoltaic module assembly as appropriate technology in Pakistan. An overview is provided of a three-week workshop in July 2009, in which a group of twenty unemployed people in Karachi, Pakistan were successfully trained in photovoltaic module assembly. Module components and assembly techniques are summarized and compared to conventional manufacturing methods. Also, plans are described for local investors to develop a business to manufacture and install the modules, which have production costs of less than $2 per watt-peak, in Pakistan.

2:00 PM - DESS09-0031

Reducing Energy Use in the City of Yellow Springs

Kevin Hallinan
University of Dayton
Robert Brecha, Kelly Kissock
University of Dayton
Austin Mitchell
Carnegie-Melon University

The electrical energy use for the city of Yellow Springs, Ohio was analyzed. Energy use data from 2003-2008 for over 1200 single residences was considered. Analysis shows a slight decline in Yellow Springs electrical energy use from 2003-2008. This collective change was evident despite an increase in baseline electrical energy use (non-weather dependent energy). Thus, the realized energy savings are due to reduced air conditioning use. Still, the typical Yellow Springs household energy use is about 20% above the Midwest U.S. average (0.45 kW/sq.ft/month versus 0.37 kW/sq.ft./month) and roughly four times above an Energy Star rating. Individual residential energy use was also analyzed for each home. Energy models for each home were developed, calibrated against actual energy use, and modified to interrogate energy savings from improvements to the residences. Ultimately proritized energy saving recommendations have been developed for each residence.

2:20 PM - DESS09-0077

Simulation and Optimization of a Hybrid Geothermal Heat Pump District Heating System in Yukon, Canada

Andrew Chiasson
University of Dayton

Hybrid geothermal heat pump systems couple earth heat exchangers to supplemental heating and/or cooling systems to improve overall system economics and performance. Recent and on-going research involves developing system simulation tools to design and optimize the performance of these dynamic systems. Presented here is an application of such tools to examine design options for a district hybrid geothermal heat pump system for a newly planned, sustainable subdivision in a subarctic climate in Yukon, Canada. The study examined the technical and economic feasibility of constructing the district heating system with a vertical borehole heat exchanger array, integrated with solar thermal collector arrays, a sewer heat recovery system, and a peaking boiler system. A life-cycle economic optimization analysis was used to identify the most feasible design options.

2:40 PM - DESS09-0140

Sinclair Community College Students use Regression Utility Analysis in Energy Audits

Robert Gilbert

Sinclair Community College Professor, University of Dayton Ph.D. Candidate

Sinclair students conduct energy audits for non-profit organizations within the community. Before the field data collection, they analyze at least one full year of utility data for the residence or commercial building. A linear regression analysis is conducted and the temperature dependent utility use is separated from the temperature dependent utility use. They are able to determine the overall UA of the building. For residential buildings this overall UA includes natural air infiltration. For commercial buildings this overall UA includes primarily positive outside air. From the utility analysis they determine heating, cooling, domestic hot water, lighting and plug load utility use. Field data is collected with respect to the building's envelope, mechanical systems, building tightness with a blower door test where applicable, and operational procedures. The utility analysis and field data is used to calibrate energy use simulation software.

SESSION 19: Computer Science	1:20 - 3:00 PM	Room 157B

Chair: Jonathan Poggie, AFRL

1:20 PM - DESS09-0138

Cyber Net Event Correlation to Human Networks (CyNCH) Program: Attributing Cyber Events Beyond the Keyboard

Philip Maynard
711HPW/RHXS
Dr Michael Haxton
Booz-Allen-Hamilton
Mr Michael Moore
Booz-Allen-Hamilton
Dr William Mesaros
Booz-Allen-Hamilton

The scope of the CyNCH research effort is to research, develop, and implement solutions that transcend focusing on preventing unauthorized access to information assets and perimeter defense of networks. This effort will concentrate on proving Computer Network Defense (CND) operators with a capability to recognize information system compromise and content exfiltration while subsequently attributing the cyber attack to a social network, sponsored/unsponsored group or individual responsible for carrying out the attack. The CyNCH research effort will build a forensic analysis capability and analytic methodology to enable accurate cyber attack attribution and subsequent characterization of the attack's impact upon organizational and mission readiness. This presentation will lay out the vision for this capability along with the research program that the 711th Human Performance Wing is embarking upon.

1:40 PM - DESS09-0134

An Attempt to Incorporate Trust and Privacy in Attribute Based Access Control for Cross-Organizational Collaboration

Jian Zhu
Department of Electrical and Computer Engineering, University of Dayton
John S. Loomis
Department of Electrical and Computer Engineering, University of Dayton

Many researchers in the area of computer security have been drawn to attribute-based access control (ABAC). Compared to other up-to-date models, ABAC provides more granularity and flexibility, which make it a valuable candidate for securing collaboration between organizations, especially over an open network such as the Internet. On the other hand, this model lacks provisions for trust and privacy issues, both of which are becoming increasingly critical, particularly in collaboration environments. Trust has been used as an independent and a joint decision-making factor in access control. Privacy preservation is also becoming one of the main goals. However no effort has been made to address them together. As an attempt to show how trust and privacy can be incorporated in ABAC model, this paper describes our understanding of trust and privacy preservation. The paper also proposes how to represent the two issue quantitatively, and how they impact the access control decision.

2:00 PM - DESS09-0132

Accelerating Image Registration on the SRC-7 MAP Processor

William Turri
University of Dayton Research Institute
David Pointer
SRC Computers, LLC

Compensating for airframe motion in Unmanned Aerial Vehicle (UAV) imagery is crucial to mission success. Image stabilization is a necessary enabler to functions such as target tracking, feature extraction, temporal image compression and others. Our goal is to stabilize 11-megapixel grayscale video at a sustained rate of three frames-per-second (fps). Meeting this computational demand along with airframe size, weight and power (SWaP) requirements is challenging. Previously published results utilizing the SRC MAP Processor for numerous airborne radar and image processing applications indicate the SRC-7 MAP Processor provides the performance required by typical airborne image processing applications, while requiring 165 cubic inches of space, weighing less than 6 pounds and consuming less than 100 watts of power. Preliminary results show a computational speedup of 70x compared to the same algorithm implemented on an Intel i7 CPU—further improvements should yield improvements over 90x.

2:20 PM - DESS09-0133

Optimal Truncation in JPEG 2000 Image Compression

William Turri
University of Dayton Research Institute
Eric Balster
University of Dayton
Benjamin Fortener
University of Dayton

JPEG2000 is the latest standard in image compression from the Joint Photographic Experts Group (JPEG) committee. The JPEG2000 compression system improves upon the original JPEG compression standard through the use of a wavelet transform and an Embedded Block Coding with Optimal Truncation (EBCOT) technique that allows for a compression advantage over JPEG of about 30 percent on average. EBCOT depends on an arithmetic entropy coder called the MQ Coder that processes data and outputs the final image bit-stream that is stored in a JPEG2000 file. After the MQ Coder, the bit-stream can be truncated at points defined during the encoding process, and this truncation may be done optimally to minimize the amount of distortion introduced to the decoded image. This presentation gives a background on the derivation of weighting values used for optimal trunction, and where they are applied in the optimal truncation process.

2:40 PM - DESS09-0041

Tell us a story: Supporting the workforce with knowledge preservation

David Kancler
University of Dayton Research Institute
Paul Pieochta
University of Dayton Research Institute

In today's world, information moves at the speed of light. However, while the digital age has made rapid information exchange the norm, a consistent effort to care for this information, or older, non-digital information, has not been made. Yesterday's tribal knowledge movement worked: the chance to sit with the expert, ask questions, and co-author solutions. Knowledge is much more than pieces of data, or even the assembly of data into information. Knowledge is, as it always has been, gained by understanding content, context, and application. Knowledge Preservation (KP) is more than capturing a paper, article, process or training program. KP targets the "stories" connecting the papers, training and documentation. Within organizations, senior personnel have these experiences, along with their context. But 30% of the United States' population is approaching retirement. What will we do when they leave the workforce, WITH their knowledge, gained from personal experiences.

SESSION 20: Energetic Materials	1:20 - 3:00 PM	Room 163A

Chair: Tony Corvo, AVT

1:20 PM - DESS09-0119

Quantum Dots Based Large Area Flexible Polymeric Films for Photovoltaic Applications

Raj Makote
UDRI, University of Dayton Research Institute
Sravanthi Durganala
University of Dayton

The worldwide photovoltaic market is growing rapidly to meet new demands for renewable energy. Organic solar-cells have advantages of low cost and easy to scale up techniques. We are developing synthetic chemical processes to manufacture quantum dots like CdSe, PbS and PbSe in large quantities via colloidal chemistry. Solution processed route produce visible or infrared range quantum dots as highly tunable bandgap materials. Various approaches via self assembling, dip coating or spray coating process have been investigated to incorporate infrared quantum dots into large area polymer films. These techniques will enable to fabricate flexible, rolling and lightweight solar panels.

1:40 PM - DESS09-0098

Solar Photovoltaic Charging of Single-Cell Lithium-Air Batteries

Peter Kolis
University of Dayton
Dr. Binod Kumar
University of Dayton Research Institute

Solid-state lithium-air secondary batteries currently in development boast the highest theoretical energy density of current battery chemistries. The effective combination of solar photovoltaic cells and solid-state lithium-air secondary batteries would allow the renewable, self-charging, and energy-dense storage of electrical power, with applications in portable consumer electronics, the electric auto industry, and residential/commercial solar photovoltaic systems. A solid-state lithium-ion secondary battery developed by the University of Dayton Research Institute was monitored as it was charged and discharged to determine its response to direct solar-photovoltaic charging, and the resulting data was analyzed to determine the suitability of this battery chemistry to direct solar-photovoltaic charging.

2:00 PM - DESS09-0066

New Anode Materials for Lithium Ion Batteries

Gerard Simon
Wright State University
Dr. Tarun Goswami
Wright State University

Graphite is currently the material of choice in commercial lithium-ion batteries anodes. It intercalates lithium well, with a theoretical specific capacity of 372 mAh/g, is inexpensive, and widely available. This limit on the specific capacity is partially imposed by the thermodynamic equilibrium saturation composition of LiC6. In practice, one can expect to attain a reversible capacity in the vicinity of 350 mAh/g. However, to increase the performance of Li-ion batteries and decrease the cost for future applications such as electric vehicles, electronics, and biomedical devices, the anode material must be improved. Nanotechnology, in the form of carbon nanotubes and metal nanoparticles, is at the center of much of the anode materials research. This effort focuses on the development of materials that capitalize on the higher capacities of nanomaterials, while controlling the amount of irreversible capacity in order to develop a battery with a targeted reversible capacity of 1,500 mAh/g.

2:20 PM - DESS09-0052

Sulfur-tolerant Catalysts in the Solid Oxide Fuel Cell

Joe Bozeman III
Renewable and Clean Energy Program
Dr. Hong Huang, Dr. Ruby P. Mawasha
Wright State University

Sulfur-tolerant catalysts in the Solid Oxide Fuel Cell (SOFC) are desirable for the progression of fuel cell marketability and application. There are many aspects of the SOFC that requires optimization in this regard such as: doping agents, synthesis methods and analytical procedure among others. Elucidation of the above issues and results are encompassed in this presentation.

2:40 PM - DESS09-0093

Optical Characterization of Energy Release from Combusting Nanoenergetic Materials

Hans Stauffer
Air Force Research Laboratory, Propulsion Directorate
Sukesh Roy
Spectral Energies, LLC
James R. Gord, Christopher E. Bunker
Air Force Research Laboratory, Propulsion Directorate

Materials containing nanometer-scale particles of aluminum have recently shown considerable promise in allowing improved control of energy density and energy-release rates associated with the next generation of explosives and propellants. Several variables are known to contribute to the energetic properties of these materials, including nanoparticle size and size distribution, proximity to and chemical composition of surrounding oxidant, nanoparticle density within composites containing oxidizing species, and nature of the nanoparticle passivating layer. However, the direct measurement of the time-dependent energy release rates during ignition of these materials has until recently proven challenging. Results will be presented in which time-dependent energy-release rates are characterized for several energetic materials containing nano-aluminum using time-resolved optical probe techniques.

SESSION 21: Electronics 1:20 - 3:00 PM Room 163B

Chair: Waruna Kulatilaka, Spectral Energies, LLC

1:20 PM - DESS09-0069

Characterization of longitudinal field by studying the orbital rotation of a trapped metal micro-detector

Yiqiong Zhao
University of Dayton

It is well known that longitudinal field appears when light is strongly focused, which is usually used for tip-enhanced Raman spectroscopy and other spectroscopic techniques. In addition, the light will transfer the optical angular momentum to the matter during the interactions, and then drive the rotation motion of the matter. In this paper we studied and characterized the longitudinal field by using a metal micro-detector that is trapped off the beam axis. The micron particle absorbed the orbital angular momentum transferred from longitudinal field and rotated around the beam axis. The rotational properties of the trapped particle were quantitatively measured for different laser power and different numerical aperture of focal lens, which is found to be in excellent agreement with the theoretical predictions.

1:40 PM - DESS09-0059

Recent Advances in Agile Antennas

Mark Patterson
University of Dayton Research Institute
Hai Jiang, Guru Subramanyam
University of Dayton

An analysis of the performance of microstrip patch antennas with tapered or matched transmission lines connected to a coplanar waveguide varactor. In addition, phase delay lines connected to the antennas are analyzed and a passive wireless bio/chemical sensor platform is introduced.

2:00 PM - DESS09-0053

Optimal design of Interdigitated Capacitors (IDC) on Barium Strontium Titanate (BST) thin films

Sree Vemulapalli
University of Dayton
Guru Subramanyam, Mark Patterson, Chenhao Zhang
University of Dayton

In this work, we tried to develop voltage tunable Interdigitated Capacitors (IDC) using Barium Strontium Titanate (BST) thin films with better electrical properties such as high Q(quality factor) and low leakage currents. The work also involves the study of change in IDC's electrical parameters (capacitance, resistance, inductance) with change in structural parameters like the finger dimensions and gap widths.

2:20 PM - DESS09-0128

A Parallel Time-Domain Finite-Element Method to Solve Maxwell's Equations

Joonshik Kim
Ohio State University

Many problems in electrical engineering—including EMC/EMI, radar scattering, antenna analysis and design—require the numerical solution of Maxwell's equations. We investigate and develop a parallel and explicit time-domain finite-element (FETD) algorithm for the solution of Maxwell's equations in irregular grids using mixed basis functions. The proposed mixed FETD is stable, energy-conserving, and uses a topological sparse approximation of the inverse Hodge (mass) matrix to bypass the need for iterative solvers. The convergence of the approximate inverse to the true inverse is investigated numerically. Three-dimensional time-domain simulations are performed to validate the algorithm and verify its accuracy. The performance of the algorithm on a parallel cluster is also investigated, showing a quasi-linear speed up of the required CPU resources.

2:40 PM - DESS09-0016

High speed encoder for flash ADC using Pseudo-dynamic CMOS logic

Vinayashree Hiremath
Wright State University, Dayton, Ohio
Dr. Saiyu Ren
Wright State University

In the design of an ultra high speed Flash ADC, a major challenge lies in designing high speed encoder. The usual implementation of encoder has been either a ROM or PLA or a Fat tree encoder which are moderately slow. Here, new encoder logic is presented which is much faster and has fewer transistors compared to Fat tree encoder. This encoder is designed using pseudo-dynamic CMOS logic. This is implemented in a 4 bit Flash ADC, using CMOS 90nm technology. The number of transistors in fat tree encoder is 138 whereas this encoder is implemented using only 50 transistors. The maximum sampling frequency in fat tree encoder is 2.38GHz and this can go upto 5GHz. The average power dissipation of fat tree encoder is 155µW while this encoder consumes only 83µW. This encoder is implemented in a 4 bit Flash ADC and results clearly show that it outperforms standard encoders.

SESSION 22: Uncertainty/Solid Mechanics 3:20 - 5:20 PM Room 156A

Chair: Paul Copp, WSU

3:20 PM - DESS09-0058

Current State of Metamaterials

Mark Patterson
University of Dayton Research Institute

In this presentation, the current state of metamaterials is discussed with reference to fields of interest, applications, advantages, limitations, and research efforts. While the range of frequencies at which metamaterials work extends past the visible light range, the scope of this presentation will be the electromagnetic spectrum from GHz to THz.

3:40 PM - DESS09-0012

Creation of a Mode Shape Based Damage Metric for Structural Health Monitoring

Randy Tobe
Wright State University
Dr. Ramana Grandhi
Wright State University

Detecting damage in critical structures (such as a thermal protection system (TPS) on hypersonic flight vehicles) is vital for reducing the amount of time and man-hours required for downtime and maintenance between flights. This research investigates detecting fastener failure in a TPS prototype based on changes in the mode shape. This damage simulation is completed using an experimentally validated finite element model. The investigation began using the following existing damage metrics: modal assurance criteria, partial modal assurance criteria, and coordinate modal assurance criteria. While these metrics did show some success in detecting and localizing the fastener failure (especially in cases with significant damage), they were not as successful in detecting and localizing smaller damage levels. Therefore, new damage metrics based on differences between the healthy and damaged mode shapes were created. Larger values are predicted to be close to the damaged area of the structure based on the problem formulation.

4:00 PM - DESS09-0091

Stochastic Response Of A Curved Beam: A Comparison Of Fokker-Planck Equation Approach With Monte Carlo Simulations Of Reduced Order Models

Holly Soper
Miami University
Amit Shukla
Department of Mechanical and Manufacturing Engineering, Miami University
S. Michael Spottswood
AFRL/RBSM, Wright Patterson Air Force Base

The large deformation, nonlinear response of curved structures under transverse stochastic excitation is of interest to aerospace industry for predicting the failure modes and limit states of the structural system on future hypersonic flight vehicles. These structures are mostly complex in geometry and have curvature. A simple curved beam system is used in this study for investigating the dynamic stability using the methods of stochastic differential equations. Using the Fokker-Planck Equation, first the probability of snap-through and snap-buckling is presented for a nominal curved beam system. Secondly, the effect of geometric (including radius of curvature) and material properties on the probability of snap-through and snap-buckling is presented. Future work includes the study of the effect of changing boundary stiffness on the probability of snap-through and snap-buckling is presented. Finally, these results are compared with numerical simulation results obtained using reduced order models as well as some experimental observations.

4:20 PM - DESS09-0010

Uncertainty Quantification of Simulated Residual Stress Induced by a High Strain Rate Process

Hemanth Amarchinta
Wright State University
Thaddeus Tarpey
Department of Mathematics and Statistics, Wright State University
Ramana Grandhi
Department of Mechanical and Materials Engineering, Wright State University

Several processes are being used on aircraft to increase fatigue life of metallic components. Laser Peening (LP) is one process currently used to increase fatigue life by inducing compressive residual stresses on the surface regions of a material. LP has an advantage of more depth penetration and covers a wider range of geometries compared to other techniques. Simulating the LP process is essential due to the cost involved in performing experiments. Variations in the estimation of residual stresses can cause significant uncertainty in fatigue life calculations because fatigue life estimations are known to be sensitive to residual stresses. This work develops a framework to quantify uncertainty in residual stresses induced by the LP process. This framework development includes nonlinear regression analysis to obtain the model constants that act as input uncertainty. A statistical technique known as bootstrapping for regression is used to evaluate the normality assumption of input uncertainty.

4:40 PM - DESS09-0001

Uncertainty Quantification in Vehicle Design Incorporating Aeroelastic Flutter Analysis

Jason King
Wright State University
Dr. Ramana Grandhi
Wright State University

Due to the rising cost of launching payloads into outer space with the current vehicles, engineers are designing new vehicles that will reduce turnaround time and cost per launch. This leads to a large amount research being conducted on reusable launch vehicles (RLV). Vehicle design is an inherently non-linear multi-physical problem with the presence of continuous, mixed, and integer variables. Due to the wide presence of uncertainty in these variables including both epistemic and aleatory uncertainties, accounting for uncertainty in the problem becomes a necessary measure to quantify the probability of success of the system. The research shown assists the RLV research by incorporating risk-minimization of the design of a vehicle. This has been completed by incorporating epistemic uncertainty quantification related to aeroelastic and structural integrality of the vehicle focusing on the flutter phenomenon.

5:00 PM - DESS09-0019

Quantification of Modeling Uncertainty in Aeroelastic Design

Matthew Riley
Wright State University
Ramana V. Grandhi
Wright State University
Raymond Kolonay
Wright Patterson Airforce Base

Uncertainty in design problems can originate from three sources: parametric uncertainty, predictive uncertainty, and model uncertainty. While parametric uncertainty is a well-explored phenomenon, model and predictive uncertainty are less understood. In this work, to quantify this uncertainty between models, probabilities are assigned to the models of interest, based on expert opinions. These model predictions are then combined using an adjustment factors approach to develop a prediction of the parameter of merit that considers the uncertainty in the models. Next, the model uncertainty introduced by assigning model probabilities to each of the models will be quantified and the results will be used to guide further efforts. Finally, if necessitated by the results of the model uncertainty quantification, the predictive uncertainty in the model will be quantified by utilizing test data to quantify the inherent uncertainty in the models compared to experimental data.

SESSION 23: Fluid Dynamics	3:20 - 5:20 PM	Room 156B

Chair: Yanhua Wu, WSU

3:20 PM - DESS09-0070

Translation Mapping of the SARL Wind Tunnel Facility

Ryan Schmit

Air Force Research Laboratory

To develop a production-like capability using the Particle Image Velocimetry (PIV) technique in the Subsonic Aerodynamic Research Laboratory (SARL) wind tunnel; proper particle seeding is the biggest issue for this open loop seven by ten foot wind tunnel. Because the flow field traverses from the rectangular inlet to the octagonal test section, the translation mapping is not an easy process. Therefore, a translation mapping test to determine the flow field's motion was conducted and the result showed significant influences i.e. cross winds and jet blooming, from outside sources.

3:40 PM - DESS09-0113

Flow Visualization Study of Passive Flow Control Features on a Film-Cooled Turbine Blade Leading Edge

Daniel Carroll

Air Force Institute of Technology

Flow visualization was performed on a model of a film-cooled turbine blade leading edge in a closed loop water channel. The model consisted of a half-cylinder with flat afterbody, with a single coolant hole located 15 degrees off the stagnation line and slanted 20 degrees off the surface. Passive flow control features included small, medium, and large cylindrical and spherical dimples upstream and downstream of the coolant hole, as well as two different transverse trenches milled directly over the coolant hole. A single row of small dimples directly upstream of the coolant hole steadied the coolant jet at low blowing ratios. Medium and large spherical dimples immediately downstream of the coolant hole had a calming effect on the coolant jet. A square-edged transverse trench spread the coolant in the transverse direction but the coolant lifted out of the trench at higher blowing ratios. A second, tapered-depth trench prevented the liftoff.

4:00 PM - DESS09-0002

Wavelet Analysis of a Highly Irregular Roughness Topography

Huiying Ren
Wright State University
Yanhua Wu
Mechanical and Materials Engineering Department, Wright State University

Engineering wall-bounded turbulent flows are significantly affected by the surface roughness conditions. Although rough-wall turbulent boundary layers have been studied for several decades, the majority of these investigations only used laboratory simulated roughness such as sandgrain, wire meshes, grooves and ordered array of regular elements. However, the realistic rough surfaces are significantly different from the simulated ones in that the roughness elements are highly irregular and may occupy a broad range of length scales, orientations and aspect ratios. The present effort is to use wavelet to analyze a realistic surface roughened by deposition of foreign materials to facilitate future turbulence studies on such surface conditions.

4:20 PM - DESS09-0036

Thermal Analysis of a Human in Action using CFD

Jessica Rinderle
Wright State University
Dr. Brian Tsou
Tec Edge
Eric Pitt
Miami University/ATIC
Dr. George Huang, Bo Evans
Wright State University
Josh Anderson
Dayton Early College Academy

In this work simulations of a human in action were computed using the SC/Tetra computational fluid dynamic software and Poser, an animation software. The objective was to create a heat signature for a human performing different actions, from walking to running. This could be used to identify a fleeing criminal trying to blend into a crowd or the movements of troops. For the simulations the human geometry was obtained from Poser and then put into SC/Tetra. A thermoregulation model in SC/Tetra computed the temperature of the body, and the metabolic rate was changed for the various actions being simulated. Two sets of cases were computed. One set simulated a man running at the same speed in various climates. The second set created a database of the average head temperature of a human with the varying wind speeds, metabolic rates, and external temperatures.

4:40 PM - DESS09-0033

Acoustic resonance in a tube with specified acoustic impedance at the two ends

Christopher Porter
University of Cincinnati Undergraduate Student
Christine Englert
Undergradute Student, University of Cincinnati

In the main combustors and afterburners of aircraft engines, acoustic resonance modes couple with unsteady combustion to generate very high amplitude pressure oscillations, known as combustion screech and howl. In some component tests, a rectangular sector of the main combustor is used to evaluate the combustion process. In such tests the acoustic resonance modes are generally based on one-dimensional wave propagation. The relative amplitudes and frequencies of the resonant modes depend on the acoustic impedance characteristics at the upstream and the downstream ends of the combustor. We shall present data from experiments in a tube of square cross section with different impedance characteristics at the two ends and a velocity source, representing the flame, in the middle. These data will be compared with theoretical predictions using one-dimensional wave propagation. We shall also present the measured radiation impedance for the flanged and the un-flanged open ends of the rectangular tube.

5:00 PM - DESS09-0082

Non Photolithographic Technique for Micro fluidic Channels using Wet Etching in Pyrex Glass Wafer using Paraffin Wax Mask

Piyush Shah
Wright State University
Andrew Sarangan, Elena Guliants
University of Dayton
Chris Bunker
Air Force Research Laboratory
Dr.LaVern Starman
Air Force Institute of Technology

Glass substrates are an attractive choice of substrate for many micro fluidic and optical applications due to its chemical stability, bio compatibility, and excellent optical transparency characteristics. It is also the choice of material for many MEMS packaging applications due to its good bond ability to silicon. When using glass substrates in MEMS application, the common methods for micro patterning glass is wet etching and dry etching. Various strategies of anisotropic dry etching glass wafers have been reported in literature using SF6 plasma and inductively couple plasma systems, however the etch rates reported are significantly lower than wet etching counterparts. Isotropic HF wet etching of glass wafers continuous to remain one the most sought techniques for low cost, high etch depth and high etch rate requirements. However mask survivability is the limiting factor in deep wet etching using 25% or 49% concentrated HF acid. Glass substrates are an attractive choice of substrate for many micro fluidic and optical applications due to its chemical stability, bio compatibility, and excellent optical transparency characteristics. It is also the choice of material for many MEMS packaging applications due to its good bond ability to silicon. When using glass substrates in MEMS application, the common methods for micro patterning glass is wet etching and dry etching. Various strategies of anisotropic dry etching glass wafers have been reported in literature using SF6 plasma and inductively couple plasma systems, however the etch rates reported are significantly lower than wet etching counterparts. Isotropic HF wet etching of glass wafers continuous to remain one the most sought techniques for low cost, high etch depth and high etch rate requirements. However mask survivability is the limiting factor in deep wet etching using 25% or 49% concentrated HF acid. In this paper we demonstrate the use of paraffin wax as the mask material. A method to spin coat, micro pattern paraffin wax without conventional photolithographic technique is demonstrated.

SESSION 24: Human Factors 3:20 - 5:00 PM Room 156C

Chair: Tommy Baudendistel, PC Krause & Assoc.

3:20 PM - DESS09-0136

Comprehensive Assessment of the Affect of Stress on Cognitive Performance

Kristie Nemeth
University of Datyon Research Institute
Laurie Quill
University of Datyon Research Institute

A 30 hr sleep deprivation study is being conducted with Air Force volunteers. At 2 hr intervals, they are given a battery of fatigue-related performance tests, cognitive and mood tests. Vigilance testing is conducted using the Psychomotor Vigilance Task (PVT), a portable simple reaction time test which requires sustained attention and discrete motor responses. The CANTABeclipse (spatial scanning, spatial working memory, planning and problem solving, and risk-taking tasks), Rapid Decision Task, and VAS and POMS (measuring sleepiness, alertness, concentration, and other dimensions) are also used. Changes in performance and subjective experience are evident as the sleep deprivation period increases. The extent of these changes fluctuates by participant. Our goal is to assist with definition of shift work and work pattern recommendations that predict maximum performance output from individuals in a broad range of work environments.

3:40 PM - DESS09-0014

Crisis Forecasting

Marc Ferguson
Air Force Research Lab, 711th Human Performance Wing, Counterproliferation Branch (AFRL/711HPW/RHPC)
James Ballas, 2nd Lt, USAF
Air Force Research Laboratory 711th, Human Performance Wing, Counterproliferation Branch (AFRL/711HPW/RHPC)

How can one quantify and correlate SA of Incidents to the appropriate level of response? Past research by SA experts suggest that the amount of SA correlates to the effectiveness and types of actions taken. In this author’s view, SA is about using the best available information, properly analyzing that information, then applying appropriate action to achieve objectives. For this effort, SA will focus on cues, triggers, thresholds, and decision points. The reason why an investigation into enhancing events’ SA is warranted is because the consequences of poor decisions are often unforgiving. With improved SA, decision-makers can think clearer through the “fog” of the incident. During events, leaders often fail to apply SA that supports optimal decision making. Proper application of heightened SA can pay tremendous dividends for decision-makers and those affected. Greater SA empowers decision-makers with firmer justification for their actions, with clearer end-states in mind.

4:00 PM - DESS09-0060

Human Computer Interaction Analysis of Multiple Small Unmanned Aircraft Systems

Jill Ward
Air Force Institute of Technology
Dr John Colombi
Air Force Institute of Technology

For this presentation, a practical application of a human computer interaction tool was examined for the quantitative analysis of various menu layouts. A numerical index was applied to measure the average time required for a human operator to complete the tasks necessary to control a small remotely piloted vehicle (RPV) through a computer interface. Our application included the construction of the interface model, an analysis of human operator tasks and the relationships among such tasks, and the calculation of the estimated control time required for an operator to interact through the interface. Lastly, a genetic algorithm was used to search for a better design layout. This numerical application provided insight for future increased model fidelity that better promotes the intrinsic capabilities and constraints of a human operator within this operational context. With the myriad of defense applications of small RPVs for surveillance, early evaluation of usability is essential.

4:20 PM - DESS09-0028

Leveraging collaboration technique tradeoffs in complex, multidimensional work environments.

Nicole Arbuckle
University of Dayton Research Institute
Brian Taylor, David Kancler
University of Dayton Research Institute

The increasing pervasiveness of available hardware and software systems has resulted in an increased number of technologies implemented in complex, multidimensional work environments. While these tools purport to streamline workflow and enhance collaboration, implementation decisions are made without full understanding of the potential benefits and drawbacks each technology offers. Even still suites of collaborative technologies have been acquired and integrated in many environments. Reports from the operational community are mixed with regard to the usability and effectiveness of these technologies. While such technologies can facilitate workplace efficiency, care must be taken to avoid unintended consequences such as information overload, attentional capture, and change blindness. We investigated effective use of collaborative technologies through fundamental human factors constructs such as situation awareness, workload and user preference. We present conclusions regarding various tradeoffs with respect to communication modality.

4:40 PM - DESS09-0135

Development of a DICOM toolkit in IDL for medical data processing and analysis

Rohit Bhat
Wright State University BIE
Dr. Martin Satter
Kettering Medical Center

Medical Images are stored in a universally accepted format known as DICOM. General data processing in a hospital includes creating DICOMDIRs for images, organizing them, anonymizing medical information from the images, visualizing a series of studies in 3D format with the display of axial, coronal and sagittal slices and transfer of images across servers by use of Query / Retrieve functionality. A fully fledged DICOM toolkit with the above functionalities is being modeled and developed in IDL so that it can be used effectively by all the technicians in the department, thereby helping the department on cost and time management by the use of a home made software with minimum budget and multiple functions.

SESSION 25: Manufacturing	3:20 - 5:20 PM	Room 157A

Chair: Rebecca Hoffman, SIMULA

3:20 PM - DESS09-0075

The Effect on Melt Pool Geometry and Solidification Microstructure In Beam-Based Fabrication of Thin-Wall Structures Due to Free-Edges

Joy Davis
Wright State
Dr. Nathan Klingbeil
Wright State University

Laser and electron beam-based fabrication processes are under consideration for aerospace applications. Additive manufacturing and repair applications require the ability to control melt pool geometry while still maintaining a consistent and desirable microstructure. To this end, previous work by the authors has employed point-heat source solutions to investigate the effects of process variables (beam power and velocity) on melt pool geometry and solidification microstructure (grain size and morphology) in beam-based fabrication of thin-wall structures. However, these results were limited to steady-state conditions away from free-edges. The current work extends the approach to investigate transient behavior in the vicinity of a free-edge.

3:40 PM - DESS09-0074

Virtual Design to Part Production, Quickly and Affordably

Derek Johnson
University of Dayton Research Institute
Brian Rice, Stephen C. Michell
University of Dayton Research Institute

The application of 3D printers typically includes the making of polymeric parts for marketing purposes and sometimes functional prototypes. The drive toward agile manufacturing has created interest in rapid low cost tooling for limited rate production. UDRI has developed a process to utilize 3D printed plastic pre-forms to cast a part cavity in a nano-enhanced tooling material. This process allows the part designer to transition from concept, to prototype, to production in a few days. The potential exists to create low production volumes, and possibly even high volumes in the future, with little expense compared to traditional production methods. This presentation describes the process of modeling, printing, casting, and finally molding polymeric or composite parts. Each step, as well as the entire process, has its own difficulties and considerations, but, with further development, this process could eliminate prohibitive costing that keeps new composite products from being introduced to the market.

4:00 PM - DESS09-0127

Rotating Contact Fatigue Study of Lubricated Steel Balls on a Steel Rod and Steel Races Under Three Point Ball Loading

Dr. Abayomi Ajayi-Majebi (PE)
Central State University
Kayode Ajayi-Majebi
University of Dayton

A four (4) station-head rotating contact fatigue testing machine has been used to study the rotating contact fatigue life of lubricated steel balls incident on a steel rod and two steel races. The balls are held in place using a bronze retaining head. diameter steel balls set in the bronze retaining head and contacting a 3" long, 3/8" diameter steel rod nestled in steel races are tested using a 75 HP, 120 volt single phase electric motor at a speed of 3600 rev/min under constant lubrication conditions until failure of the rods or balls occur evidenced by relatively pronounced wear and accelerated chatter of the testing head assembly. A Weibull analysis of the test result is used to determine the characteristic life of the bearing system in terms of cycles to failure, leading to point estimates of the predicted cycles to failure for different population failure thresholds.

4:20 PM - DESS09-0142

Development of a novel femtosecond laser machining/drilling technology based on temporal pulse shaping and in-situ inspection methods

Sivaram Gogineni
Spectral Energies, LLC
Sukesh Roy
Spectral Energies, LLC
Marcos Dantus
Michigan State University
James R. Gord
Air Force Research Laboratory

The objective of the research is to develop a novel femtosecond laser micromachining technology based on temporally-shaped pulses for drilling holes through a Hastelloy plate covered by thermal barrier coating. Spectroscopy based diagnostic measurements are performed for in-situ inspection and feedback. The laser beam is directed through a beam splitter and then through focusing lenses to focus the beam at the sample. The beam splitter allowes collection of the backscatter Laser Induced Breakdown spectrum(LIBS)of the sample while filtering out the beam used for drilling. LIBS signal is collected with a spectrometer. The sample is attached to an x-y motorized stage which allowes the movement of the sample with 1 micrometer precision. Using the above set up, holes are drilled through 3mm samples with varying intensities with and without the pulse shaper. Details of the experimental set up, challenges involved, and analysis on the results will be presented at the conference.

4:40 PM - DESS09-0078

Laser Micro-Fabrication of Micro Air Vehicle(MAV) Components

Christopher Taylor
Mound Laser & Photonics Center Inc.

In the fight against global terrorism, the American military faces many challenges that will require sensing and relaying information in urban warfare environment. A possible solution to this problem is the use of micro air vehicles (MAV). MAVs are small, potentially insect-sized, remotely controlled aircraft that would allow stealthy entry into enemy locations that are dangerous or otherwise inaccessible for the purpose of surveillance. Fabrication of MAVs faces many manufacturing challenges that and the size becomes smaller. New materials may need to be developed for structure and power, and machining and joining must be done at the micron scale. MLPC is developing fabrication techniques to meet these challenges using precision laser micromachining and laser joining techniques. Applications of this technology to MAV fabrication will be presented.

5:00 PM - DESS09-0126

Design, Fabrication Testing and Performance Evaluation of a Solarized Extended Six Passenger Textron EZ-Go Cart Vehicle at Central State University.

Dr. Abayomi Ajayi-Majebi (PE)
Central State University
Clark Fuller (Rtd.), Prof. Gerald T. Noel, Dr. Victor Aimiuwu
Central State University
Kayode Ajayi-Majebi
University of Dayton

A project involving the solarization and optimization study of an extended six (6) passenger EZ-Go golf car(t) (net weight 710 lb. and gross weight 1700 lbs) using solar panels has been successfully executed at CSU. The study involved integrating five (5) 85-watts solar panel arrays to charge eight (8) 6-volt deep cycle batteries that power the EZ Go Golf car(t). The project required the mechanical design, fabrication, assembly, testing and electrical interfacing of the various subsystem components of the EZ-Go Golf Cart that rest on the canopy support structure and is an outgrowth of solar energy research studies at CSU. The following factors were evaluated: solarization state, i. e. solar panel effect (on/off), terrain condition (paved or grassy) tire pressure (15 psi and 20 psi) and payload. The results of the full factorial design of experiments (DOE) analysis for voltage drop and ampere-hour draw down are presented under various scenarios.

SESSION 26: Design & Optimization	3:20 - 5:20 PM	Room 157B

Chair: B.G. Shiva Prasad, WSU

3:20 PM - DESS09-0020

Aerodynamic Shape Optimization of High Speed Train using Surrogate Models

Veera Venkata Vytla
Wright State University
George P. Huang, Ravi. C. Penmetsa
Wright State University

With the increase in speed of railway trains it became a necessity to consider the aerodynamics effects of airfow over train including the study of induced drag, aerodynamic noise, and wind-related vibrations. The current high speed train can achieve a speed of 300 km/hr and this speed can have a significant impact on the aerodynamic drag it generates. The goal of this study is to identify the nose shape of the train that induces the least drag. Any optimization problem involving CFD simulations can be very expensive and therefore one needs to impose restrictions on the number of functional evaluations that can be performed. Response surface based optimization helps in reducing the number of CFD simulations necessary to achieve this goal. In this work we propose and present an adaptive surrogate model to identify the 2-D optimum shape of the train nose.

3:40 PM - DESS09-0006

Risk-Based Energy Minimization for Airfoil Design

Kenneth Gannon
Wright State University, Computational Design and Optimization Center

Traditional design optimization of aircraft structures focuses on optimizing a component(s) of the aircraft based on particular performance metrics specific to the component(s), such as minimizing the weight of a wing to maximize the payload capacity of a vehicle. Performance parameters specific to that component, such as efficiency and aeroelastic concerns of a proposed wing design, are normally then treated as constraints, where an arbitrarily chosen performance metric is required for a feasible design. However, a non-traditional design formulation is investigated to explore component optimization, specifically airfoil optimization, by considering an objective directly related to the overall vehicle performance; an energy based function.

4:00 PM - DESS09-0055

Improved Conceptual Design Tool

Steve Mitchell
University of Dayton Research Institute

The attractive tailorability of composites can also be viewed as a liability. The virtually unlimited possibilities and combinations of fiber, resin, material form and ply orientation can seriously extend the early conceptual design phases of composite design. In fact these possibilities coupled with the component design requirements can lead to project delays and affordability issues in the manufacturing phase. This presentation describes a relatively new and unique composite design and optimization computer tool that instantly conveys issues and potential solutions. The tool uses the Ternary Diagram as the core display. Using this tool provides the user with an intuitive feel for the potential regions for solutions. In additional, a key feature is the ability of overlaying contours of many different material and engineering requirements. The clear and intuitive display also allows the tool to serve as a great teaching aid.

4:20 PM - DESS09-0130

Designing Energy-Waste Out of Industrial Equipment using Innovation, Precision, and Controls

Josh Boatwright
Kadant Black Clawson Inc.
Don Greier
Kadant Black Clawson Inc.

A 1,400 pound, 42 inch diameter disk rotates at 430 rpm while 1,100 gallons per minute of paper pulp flows through a 5 mil gap—consuming 1000 horsepower. Every 1/2 mil in misalignment is wasted energy and a loss of pulp quality and process control. Design innovation is required to maximize performance while keeping costs commercially viable for this complex industry. Identifying sources of imprecision, maintaining an error budget, decoupling pressure loads from critical process control surfaces, using symmetric design principles, detailed computational analysis and incorporating 3-axis feedback control are used to revolutionize disk refining of paper stock allowing for maximum recycling rates, reduced raw material consumption, and lower energy costs for the global paper industry.

4:40 PM - DESS09-0080

Optimization of Designs for low Size Weight and Power (SWaP)

Ken Simone

University of Dayton Research Institute

I submit to present at the symposium my observations related to the optimization of system designs to accommodate deployment in vehicles. The size weight and power of such systems is critical to the overall system success. I will prepare to discuss obstacles to design optimization and tools and methods to assist in overcoming these obstacles. Also, a discussion of new issues and inefficiencies created by the use of tools will occur. The end goal of this presentation will be to enable engineers to identify challenges and implement appropriate tools and methods to the challenges with predictable outcomes.

5:00 PM - DESS09-0129

Design of a Full-Scale Aerial Target

Trenton White

Air Vehicles / Air Force Research Lab

In consideration of the findings of the Defense Science Board's Task Force on Aerial Targets, the Air Vehicles Directorate of the Air Force Research Lab (AFRL/RB) designed an unmanned target aircraft that will be representative of fifth generation fighter characteristics. Using design techniques, best practices and information from Very Light Jet manufacturers and in-house programs such as the Composites Affordability Initiative, AFRL/RB has produced a conceptual full-scale target design that features performance improvements over the QF-16 in several areas and could potentially be cost-competitive with the QF-16.

SESSION 27: Materials 3:20 - 5:20 PM Room 163A

Chair: Joseph D'Angelo, Tiburon Associates

3:20 PM - DESS09-0095

Yttria Stabilized Zirconia–Based Composites with Adaptive Thermal Conductivity

Jamie Gengler
Spectral Energies, LLC
James R. Gord
Air Force Research Laboratory, Propulsion Directorate
Sukesh Roy
Spectral Energies, LLC
Chris Muratore, John G. Jones, Ajit K. Roy, Andrey A. Voevodin
Air Force Research Laboratory, Materials and Manufacturing Directorate

Nanocomposite coatings provide improved tribological characteristics over many homogenous material counterparts. Smart “chameleon” coatings allow changes in microstructure in response to environmental stimuli. Ag embedded within YSZ is a thermal-lubrication example where high temperature induces Ag migration to the surface, creating a thermally conductive coating on an insulating film. We present a study of thermal conductivity of YSZ thin films as a function of initial Ag content. Films were grown on a substrate and then heated to stimulate Ag flow to the surface. The Ag was removed leaving porous YSZ. Thermal conductivity was measured with time-domain thermoreflectance (TDTR), a femtosecond pump/probe technique. Decay rates were modeled using approaches by Cahill and Crank-Nicolson. A control sample comprising 25-nm grains of pure YSZ (7% Y2O3) yielded results comparable to published values. For YSZ samples of various initial Ag content, both models yielded changes in thermal conductivity up to a factor of four.

3:40 PM - DESS09-0061

Laser Precision-Based Graphene Growth Processes

Sarah Bertke
Mound Laser & Photonics Center, Inc.
David H. Tomich, John E. Hoelscher
Air Force Reseach Laboratory
Ronald L. Jacobsen
Mound Laser & Photonics Center, Inc.

We report studies of laser methods for fabricating large-area, high-quality graphene. Common methods for graphene growth (Pulsed Laser Deposition, Molecular Beam Epitaxy, thermal decomposition of SiC) apply energy evenly across an entire substrate, leading to simultaneous nucleation of graphene crystals in many locations and a thus poor continuity over large areas. An alternative is to use a defocused laser to apply energy at a single nucleation site, and then propagate graphene growth by scanning the laser along the substrate. The substrate structure then acts as a template for rearranging the surface carbon into graphene as the heating laser is swept across the surface. Defocussed laser rastering has also been applied to anneal poor quality MBE-grown graphene. Raman spectroscopy characterizes the graphene grown or annealed by these methods.

4:00 PM - DESS09-0120

Molecular Imprinting Techniques in Sol-gel Polymers for Enhanced Selectivity of Sensor and Membrane Materials

Sravanthi Durganala
University of Dayton
Raj Makote
University of Dayton Research Institute(UDRI)

Moleculary imprinted polymers (MIP) are also known as plastic antibodies. MIPs are prepared via polymerization of functional monomers in the presence of a template molecule. Removal of the template species leaves behind nano sized cavities, having the ability to selectively rebind the template again. Molecular imprinting is increasingly used for separation processes, lab-on-chip, immunoassays, artificial enzymes, biosensor materials. In this research we present sol-gel process to prepare molecularly imprinted thin films for sensor applications. Alkoxysilanes have been used as functional monomers and various phenols or nitroaromatics as template molecules. The selectivity of MIP sensor coating towards rebinding of specific analyte was improved greatly. The technique to prepare MIP membranes from organic-inorganic hybrid materials (ORMOSILS) is also discussed. The problems, challenges and factors affecting sol-gel MIPs are discussed to enhance interest in this promising field.

4:20 PM - DESS09-0123

Deposition of Ordered Arrays of Metal Sulfide Nanoparticles in Nano-Structures Using Supercritical CO2

Joanna Wang
Air Force Research Lab
Alexander B. Smetana,
Air Force Research Lab, University of Idaho
John J. Boeckl, Gail Brown
Air Force Research Lab
Chien M. Wai
University of Idaho

Metal sulfide quantum dot nanoparticles are incorporated in sensing applications, including chemical and warfare agent detection and environmental monitoring, and used as a photosensitizer or light detectors for photographic purposes. Nanoparticles have electric/optical properties that sensitively depend on the size. Ag_2S and CdS nanoparticles are synthesized by chemical reactions of metal cations with sulfide solutions using water-in-oil microemulsions. Dodecanethiol is then added to the microemulsion solution to stabilize the metal sulfide nanoparticles. After being separated from the reaction medium, the alkanethiol-coated nanoparticles can be dispersed in a non-polar solvent. The protected nanoparticles dispersed in an organic solution can be precipitated onto carbon-coated copper grids and silicon wafers to generate self-assembled 2-D arrays in supercritical fluid CO_2(Sc-CO_2). A unique feature of the Sc-CO_2 evaporation technique is the metal sulfide nanoparticles can be deposited uniformly into the nano-scale trenches on Si wafers which cannot be achieved by traditional solvent deposition methods.

4:40 PM - DESS09-0008

Development of "Smart Clamp" Sensors to Improve Electrical Wiring Reliability

Robert Kauffman
University of Dayton Research Institute
Douglas Wolf
University of Dayton Research Institute

Electrical wiring systems experience stresses such as vibration, abrasion, hydrolysis and chemical reactions which combine with clamp failure to accelerate the degradation of wiring insulation and associated connectors. This paper presents the results of a FAA funded research program performed to improve wire support reliability through improved health monitoring procedures. Simple “smart clamp” sensors are being developed for ensuring proper clamp installation and for detecting wiring bundles with loose/broken clamps prior to insulation damage. In addition to miniaturization, research is focusing on the incorporation of RFID tags and other techniques to power/supplement the data outputs of the smart sensors. To avoid saturating future monitoring systems with “normal” signals from thousands of properly functioning clamps, the sensors are being designed to only output data upon improper clamp installation/support failure.

5:00 PM - DESS09-0009

Development of Self-Healing Techniques to Improve Electrical Wiring Reliability

Robert Kauffman
University of Dayton Research Institute

The control problems and potential safety hazards resulting from damaged insulation require that prompt maintenance actions be taken to ensure reliable wiring performance. Therefore, a FAA funded research program is being performed to develop self-healing procedures to improve the reliability of existing and future wiring designs. The self-healing techniques incorporate a non-toxic, water based solution that can be sprayed into inaccessible compartments or brushed onto accessible wire bundles. When the solution comes into contact with a powered wire with damaged insulation, the solution reacts with the exposed metal conductor to produce an adherent, insulating film to repair the damaged insulation. The self-healing solutions are being developed to perform independent of the conductor or insulation composition, insulation damage mechanism or power characteristics. Hand-held devices to locate wiring with damaged insulation as well as future wiring designs with an inner self-healing insulation layer are also being developed.

SESSION 28: Laser Diagnostics 3:20 - 5:20 PM Room 163B

Chair: James Gord, AFRL

3:20 PM - DESS09-0087

Single-Beam CARS Spectroscopy of N2 and CO2 using an Ultrashort Laser Pulse

James Gord
Air Force Research Laboratory, Propulsion Directorate
Paul Wrzesinski, Dmitry Pestov, Tissa Gunaratne, Marcos Dantus
Michigan State University, Department of Chemistry
Sukesh Roy
Spectral Energies, LLC

Femtosecond (fs) coherent anti-Stokes Raman spectroscopy (CARS) of N2 and CO2 molecules using a single ~7 fs laser beam has been demonstrated. The transform-limited bandwidth of ~3000 cm-1 was sufficient to excite the rovibrational transitions of N2 in the band centered at ~2330 cm-1 and the Fermi dyads of CO2 at 1388 cm-1 and 1285 cm-1. The objective of this work was to investigate the feasibility of performing gas-phase CARS spectroscopy of diatomic molecules using a single laser beam. Specifically, the focus was to address the signal-to-noise ratio of the CARS signal as well as to investigate the detection limit of single-beam CARS spectroscopy for gas-phase thermometry and species-concentration measurements. We have also demonstrated the feasibility of selective excitation of N2 and CO2 by judiciously choosing the spectral phase of the laser beam. This effort will impact species-selective detection of molecules important in soot production (e.g., C2H2, C6H6).

3:40 PM - DESS09-0081

Single-Shot Thermometry in Reacting Flows at 1 kHz using Femtosecond CARS Spectroscopy

Sukesh Roy
Spectral Energies, LLC
Waruna D. Kulatilaka, Spectral Energies, LLC
Daniel R. Richardson, Robert P. Lucht
Purdue University, Department of Mechanical Engineering
James R. Gord
Air Force Research Laboratory, Propulsion Directorate

Single-laser-shot temperature measurements at a data rate of 1 kHz employing femtosecond coherent anti-Stokes Raman scattering (fs-CARS) spectroscopy of N2 are demonstrated. The measurements are performed using a chirped probe pulse to map the time-dependent frequency-spread dephasing of the Raman coherence, which is created by ~80-fs pump and Stokes beams, into the spectrum of the CARS signal pulse. Temperature is determined from the spectral shape of the fs-CARS signal for probe delays of ~2 ps with respect to the pump–Stokes excitation. The accuracy and precision of the measurements for the 300-2400 K range are found to be ~1–6% and ~1.5–3%, respectively.

4:00 PM - DESS09-0086

Fiber-Based CARS Spectroscopy for Gas-Phase Thermometry in Reacting Flows

Paul Hsu
Air Force Research Laboratory, Propulsion Directorate
Waruna D. Kulatiaka, Spectral Energies, LLC
Anil K. Patnaik, Wright State University, Department of Physics
Sukesh Roy, Spectral Energies, LLC
James R. Gord, Air Force Research Laboratory, Propulsion Directorate

The objective of this work was to investigate the feasibility of delivering intense laser pulses through optical fibers for nonlinear spectroscopy in reacting flows. In particular, damage thresholds of fibers, nonlinear effects, and spatial beam profiles at the output of the fibers were studied for propagation of nanosecond (ns) and picosecond (ps) laser beams. It was observed that ps pulses are better suited for fiber-based nonlinear optical diagnostic techniques, which generally depend on laser intensity rather than fluence. A ps, fiber-coupled coherent anti-Stokes Raman scattering (CARS) system using multimode step-index fibers has been developed. Temperature measurements using the fiber-coupled ps CARS system have been demonstrated in an atmospheric-pressure, near-adiabatic laboratory flame. The proof-of-concept measurements show significant promise for fiber-based CARS spectroscopy in harsh chemical environments. Furthermore, ps-CARS spectroscopy would allow the suppression of nonresonant background for improving the sensitivity and accuracy of CARS thermometry in high-pressure, hydrocarbon-fueled combustors.

4:20 PM - DESS09-0092

Investigation of Molecular Interference Effects from Broad-Bandwidth Excitation in Fs-CARS

Waruna Kulatilaka
Spectral Energies, LLC
Sukesh Roy, Spectral Energies, LLC
Robert P. Lucht, Purdue University, Department of Mechanical Engineering
James R. Gord, Air Force Research Laboratory, Propulsion Directorate

Femtosecond coherent anti-Stokes Raman scattering (fs-CARS) spectroscopy has emerged as a promising technique for high-speed, collision-free measurements of temperature and species concentration in reacting flows. In fs-CARS, the broad-bandwidth fs pulses will also resonantly excite other molecules that are in resonance with various pump-Stokes photon pairs. The polarization beating between these closely spaced Raman transitions can affect the coherence dephasing rate and hence, the extracted temperature. In this study, we investigated the effects of the intermolecular polarization beatings of N_2/CO and O_2/CO_2 in fs-CARS of N_2 and O_2, respectively. In the N_2 fs-CARS, we observed that the presence of CO had no effect on the initial overall coherence dephasing rates. However, in the case of the O_2/CO_2 system, where the two molecules contributing to the CARS signal have significantly different molecular structures, we observed that the presence of CO_2 can significantly change the time evolution of the Raman coherence.

4:40 PM - DESS09-0089

Comparison of Line-Peak and Line-Scanning Excitation in Two-Color Laser-Induced-Fluorescence Thermometry of OH

Stanislav Kostka, *Spectral Energies, LLC*
Sukesh Roy, Terrence R. Meyer, Spectral Energies, LLC
Michael W. Renfro, University of Connecticut, Department of Mechanical Engineering
James R. Gord, Air Force Research Laboratory, Propulsion Directorate
Patrick J. Lakusta, Richard D. Branam
Air Force Institute of Technology, Department of Aeronautics and Astronautics

Two-line laser-induced-fluorescence (LIF) thermometry is commonly employed to generate instantaneous planar maps of temperature in unsteady flames. The use of line scanning to extract the ratio of integrated intensities is less common because it precludes instantaneous measurements. Recent advances in the energy output of high-speed, ultraviolet, optical parameter oscillators have made possible the rapid scanning of molecular rovibrational transitions and, hence, the potential to extract information on gas-phase temperatures. In the current study, two-line OH LIF thermometry is performed in a well-calibrated reacting flow for the purpose of comparing the relative accuracy of various line-pair selections from the literature and quantifying the differences between peak-intensity and spectrally integrated line ratios. Data from excitation scans are compared with theoretical line shapes, and experimentally derived temperatures are compared with numerical predictions that were previously validated using coherent anti-Stokes Raman scattering.

5:00 PM - DESS09-0090

Controlled Two-Channel Slow Light in a Single Delay Device

Anil K. Patnaik,
Wright State University, Department of Physics
Paul S. Hsu, Air Force Research Laboratory, Propulsion Directorate
Sukesh Roy, Spectral Energies, LLC
James R. Gord, Air Force Research Laboratory, Propulsion Directorate

Simultaneous two-channel control of light speed using a homogeneous magnetic field with a single resonant laser as a dual-control knob is investigated. In a paradigm shift from conventional probe-control lasers used in electromagnetically induced transparency–based slow light, two coupling lasers in a single delay element are utilized as dual-signal channels where both the lasers nonlinearly influence the optical delay of each other. The magnetic field in conjunction with these laser fields acts as an additional parameter for controlling the differential delay between them. In a proof-of-principle experiment, two circular polarization components of a linearly polarized input laser are coupled to two channels of interest; namely, two orthogonal transitions of a V-type atom with Zeeman sublevels of 87Rb atoms. By tuning the magnetic field, the group velocity of light in two channels can be controlled simultaneously and altered by more than on order of magnitude.