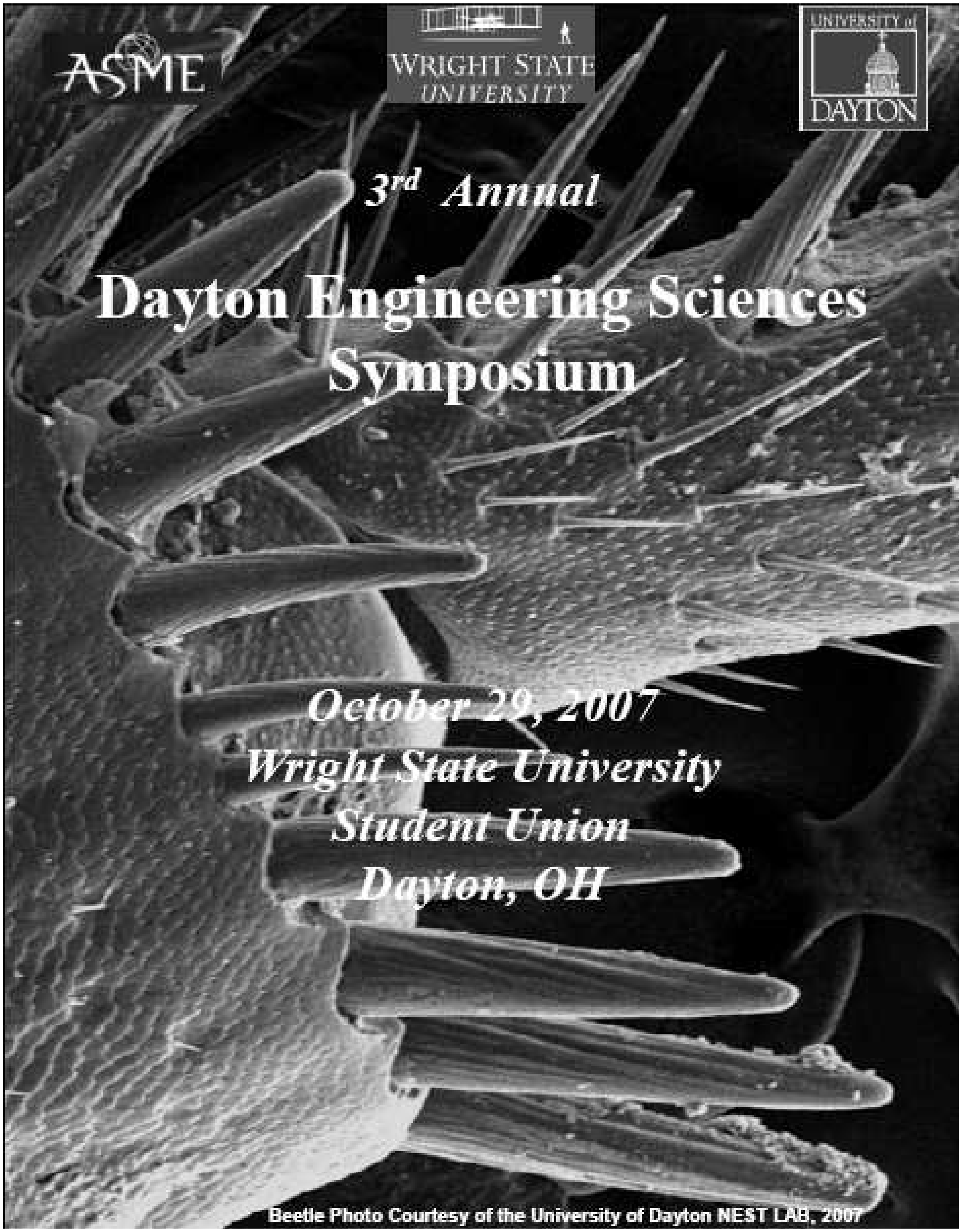

ASME

WRIGHT STATE UNIVERSITY

UNIVERSITY of DAYTON

3rd Annual

Dayton Engineering Sciences Symposium

October 29, 2007

Wright State University

Student Union

Dayton, OH

Beetle Photo Courtesy of the University of Dayton NEST LAB, 2007

WELCOME

On behalf of the Organizing Committee, we would like to welcome you to the 3rd Annual Dayton Engineering Sciences Symposium (DESS). Sponsored by the Dayton Section of ASME, the symposium is intended to facilitate communication between members of the regional technical com munity, and to provide a forum for sharpening technical presentation skills among students, engineers, and scientists.

This year's symposium features 106 presentations spanning a broad range of engineering sciences. In addition to scientific research, the symposium includes special sessions on both Undergraduate Projects and Engineering Education, as well as significant participation from local industry. This year's symposium will have a special emphasis on technical innovation. To this end, the Keynote Address will be delivered by Susan Bodary, Executive Director of EDvention, an organization affiliated with the University of Dayton and tasked with accelerating talent capable of enhancing innovation in the Dayton region. Her presentation will provide a vision for what we want to accomplish in growing talent capable of enhancing innovation in the Dayton region and the role that EDvention will play. Ms. Bodary is eager to get feedback from DESS attendees. Additionally, an industrial panel from companies in the Dayton-Cincinnati region recognized as innovators will discuss the role of innovation in their organization, and subsequent industrial speakers will talk about innovation best practices and support available to innovators in the Miami Valley.

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

Kevin Hallinan and Sivaram Gogineni
General Chair and Co-Chair

Organizing Committee

Tim Leger, Conference Website and Registration Coordinator
Kevin Hallinan, Session Chair Coordinator
Elizabeth Schmackers, Conference Program Coordinator
Nathan Klingbeil, Wright State Coordinator
Ginger Stuck, Affiliation and Name Tag Coordinator
Vincent Miller, Financial Coordinator
Alyson Turri, President ASME Executive Board
Stephen Balek, President, ASME Executive Board

SCHEDULE AT A GLANCE

Morning:
Registration and Continental Breakfast: 8:00 – 8:40 AM

Structures and Solid Mechanics I: 9:00-11:00, E156A
Fluid Mechanics/CFD I: 9:00-11:00, E156B
Energy: 8:40-11:00, E156C
Micro/Nano Systems: 8:40-11:00, E157A
Education: 9:00-11:00, E157B
Electronics/Sensors I: 8:40-11:00, E163A
Biomechanics I: 8:40-11:00, E163B

Break: 11:00-11:20

Keynote Address: 11:20-12:00, Apollo Room, Susan Bodary, *"Creativity, Innovation and Communication: Building STEM Talent for a Competitive Future"*

Lunch: 12:00-1:00, Apollo Room, STEM Education Discussion

Afternoon:
Innovation Panel: 1:00-2:00, Apollo Room
Design / Optimization: 1:00-3:20, E156A
Fluid Mechanics/CFD II: 1:00-3:20, E156B
Electronics/Sensors II: 1:00-3:20, E156C
Biomechanics II: 1:00-3:20 PM, E157A
Materials/Materials Processing I: 1:00 -2:40, E157B
Heat Transfer and Thermal Sciences I, 1:00-2:40 PM, E163A
Biomedical Engineering: 1:00-3:20 PM, E163B
Propulsion Rockets I: 2:40-3:20 PM, E163A

Break: 3:20-3:40

Materials/Materials Processing II: 3:20-4:40, E156B
Systems Engineering / Optimization: 3:40-5:20 PM, E156C
Biomechanics III: 3:40-4:40 PM, E157A
Materials/Materials Processing II: 3:40-4:20
Heat Transfer and Thermal Sciences II: 3:40-5:00 PM, E163A
Propulsion Rockets II: 3:40-4:40 PM, E163B

TECHNICAL PROGRAM

Structures and Solid Mechanics I: 9:00-11:00 AM Room E156A
Chair: Steve Pitrof, Delphi

9:00-9:20 Bino Varghese, “Usage of Von Mises Stresses in the Finite Element Analysis of Brittle Materials Represent Conservative Limits for Bone Failure”

9:20-9:40 Harry Hilton, “Aero-servo-viscoelasticity and structural control”

9:40-10:00 Oleg Shiryayev, “Structural Damage Identification Using Randomdec Signatures: Application to FEM Data”

10:00-10:20 Craig Baudendistel, “Effect of a Graded Layer on Plastic Dissipation During Mixed-Mode Fatigue Crack Growth in Layered Materials”

10:20-10:40 Tyler Robbins, “Detection of Changes in Structural Parameters from Vibration Data

10:40-11:00 Douglas Wickert, “Observations on the Minimum Polynomial Order for Mixed, Least-Squares Finite Element Formulations”

Fluid Mechanics/CFD I: 9:00-11:00 AM Room E156B
Chair: Shiva Prasad, Emerson Climate

9:00-9:20 Barbara Rodriguez, “Computational Fluid Dynamics Analyses for DEBI-BATL entry into Subsonic Aerodynamic Research Laboratory” (undergraduate)

9:20-9:40 Cody Rasmussen, “Fully-Coupled and Nonlinear Least-Squares Finite Element Formulation for Fluid-Structure Interaction”

9:40-10:00 Hong Yan, “Investigation of Thermal Perturbation Induced Flow Instability”

10:00-10:20 Michael Ol, “Vorticity Production in High-Frequency Airfoil Pitch/Plunge”

10:20-10:40 Michael Hanchak, “1-D numerical model of liquid jet break-up with drop tracking”

10:40-11:00 William Bennet, “Computational Investigation into the Effects of Energy and Momentum Sources on Subsonic and Hypersonic Flows” (undergraduate)

Energy: 8:40-11:00 AM Room E156C
Chair: Binod Kumar, University of Dayton Research Institute

8:40-9:00 Richard Strong, “StrongMobile Flying Car Project”

9:00-9:20 Joykumar Thokchom, “Direct Oxidation Solid Oxide Fuel Cells (SOFC) from YSZ-Al2O3 Composite Electrolyte”

9:20-9:40 Nutan Gupta, “Rechargeable Lithium-Air Power Sources: Potential and Possibilities”

9:40-10:00 Thomas Robbins, “Quasi-One Dimensional Materials for Thermoelectric Applications” (undergraduate)

10:00-10:20 Vince Romanin, “Zero Energy Building: Heating and Cooling A House by Pumping Water Through Structural Insulated Panels (SIPs)” (undergraduate)

10:20-10:40 Yuxing Li, “Effect of increase of ozone concentration on photochemistry efficiency of spring wheat”

10:40-11:00 Ian Fuller, “A Method of Storing and Generating Hydrogen for Power Applications”

Micro/Nano Systems: 8:40-11:00 AM Room E157A
Chair: Rebecca Hoffman, ABAQUS, Inc.

8:40-9:00 Leanne Petry, “Electrochemical and Surface Characterization of Ablated Platinum Nanoparticles

9:00-9:20 Matthew Boehle, “Exfoliated Graphite Composites in EMI Shielding Applications”

9:20-9:40 Weibin Chen, “Focusing surface plasmons with subwavelength structures”

9:40-10:00 Lirong Sun, “Profile Control of Silicon Etching by an Inductively Coupled Plasma Technique”

10:00-10:20 Maher Amer, “Interactions in Micro- and Nano-Structured Mesomatter;A Raman Spectroscopy Investigation”

10:20-10:40 Ian Barney, “Oxide Nano-Coatings to Enhance the Growth of Carbon Nanotubes on Microcellular Carbon Substrates”

10:40-11:00 Satish Kuchi, “The Effect of Finite Geometry on Solidification Microstructure in Beam-Based Fabrication of Thin Wall Structures”

Education: 9:00-10:20 AM Room E157B
Chair: Margaret Pinnell, University of Dayton

9:00-9:20 Lawrence Zavodney, “Culturally-Appropriate Engineering Design for Developing Countries”

9:20-9:40 David Myszka, “Exposing Students to the Features of a Computer Data Acquisition System By Generating the Vibration Response of a Structure,

9:40-10:00 Nathan Klingbeil, “Engineering Mathematics Education at Wright State University: A Model for Increasing Student Success in Engineering”

10:00-10:20 Robert Gilbert, “Using Student Activities to Initiate Sinclair Community College’s Energy Education Programs”

Electronics/Sensors I: 9:00-11:00 AM Room E163A
Chair: Jaime Betard, Aerospace Survivability and Safety Flight, WPAFB

9:00-9:20 Sanjay Boddhu, "CTRNN-EH Controllers: Evolving a Navigation System for Micromechanical Flying Insect"

9:20-9:40 Zhesheng Jiang, "Research on Robust Approach and Landing Trajectory Generation for Reusable Launch Vehicles"

9:40-10:00 Todd Benanzer, "System-Level Design and Optimization of a UUV Using Integrated Path Planning and Component Sizing"

10:00-10:20 Vishnu Kesaraju, "A Micro-Simulation Test of Two-Level Optimization-Based Ramp Metering Controls"

10:20-10:40 J. Markiel, "Separation of Static and Non-Static Features from Three Dimensional Datasets: Supporting Positional Location in GPS Challenged Environments"

10:40-11:00 Kumar Yelamarthi, "A Transistor Sizing Algorithm for Dynamic CMOS Circuits to improve Design for Manufacturability"

Biomechanics I: 8:40-11:00 AM Room E163B
Chair: Tarun Goswami, Wright State University

8:40-9:00 Vinit Patel, "Finite element analysis of the locking compression plate"

9:00-9:20 Leimin Au, "Biodegradable Polymer Scaffolds: Fabrication and Tissue Engineering"

9:20-9:40 Alison Gadd, "Biomimetic Characteristics of Pneumatic Muscle"

9:40-10:00 Brandi Carr, "Knee Implant Models and Biomechanics"

10:00-10:20 Danielle Miller, "A review of ultrahigh molecular weight polyethylene reinforced with carbon nanotubes and its potential use in orthopaedic applications"

10:20-10:40 Himanshu Bhatt, "Wear Rate Parameters in Total Hip Replacement"

10:40-11:00 Junitha Michael, "Design perspective: Total Ankle replacement and ankle braces"

Break: 11:00-11:20

Keynote Address: 11:20 AM - 12:00 PM, Apollo Room
Speaker: Susan Bodary, Executive Director of EDvention, " *Creativity, Innovation and Communication: Building STEM Talent for a Competitive Future"*

Speaker Bio: Susan Bodary serves as the Executive Director of EDvention, a regional *preschool to the workforce* consortium based at the University of Dayton. EDvention is dedicated to accelerating science, technology, engineering and math (STEM) talent development to grow the Dayton Region . Susan also serves as a Senior Policy

Associate with Achieve, Inc., a national education policy reform organization in Washington, D.C.From 2004-2007, Susan served as the Executive Assistant for Education & Workforce to Ohio Governor Bob Taft. In that capacity she led a policy team advising on early, primary, secondary and higher education as well as workforce development. Susan coordinated efforts to bridge the gaps between educational systems, worked to create a single educational technology agency for the state, and managed Ohio's commitment to the American Diploma Project Action Network, an effort to ensure that more high school students graduate fully prepared for success in college and in work. Susan spearheaded the development and enactment of the Ohio Core, a rigorous high school curriculum to better prepare students for work, college and life that was signed into law in January 2007. She also launched and guided the Partnership for Continued Learning. Established in statute and chaired by the governor, the Partnership for Continued Learning is the state's *preschool to the workforce* council.

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

Innovation Panel: **1:00-2:00 PM** **Apollo Room**
Phil Doepker, Innovation Center Director, University of Dayton
David Plescia, Research and Development Engineer, Ethicon Endosurgery, Cincinnati
Orville Cook and Thomas Howard, Dayton Coalition

Topic: Panelists will discuss innovation in the Dayton Cincinnati area, addressing the definition of innovation, how to develop it, and how to finance it.

Design/Optimization: 1:00-3:20 PM Room E156A
Chair: Harini Shankar, Delphi

1:00-1:20 Suman Niranjan, "A Simulation-Optimization Approach for Multi-Echelon Inventory Systems with Intermediary Product Demand"

1:20-1:40 Matthew Riley, "Quantification of Risk and Probability of Success for Undersea Vehicles"

1:40-2:00 Vishnu Kesaraju, "Integrated Simulation Framework with Process-driven and Event-driven Models

2:00-2:20 Jian Zhu, "Attribute Based Access Control for Collaboration Environments"

2:20-2:40 Agus Widjaja, "Micro inductor designs for fully integrated low voltage DC/DC converter applications"

2:40-3:00 Justin Teller, "Matching and Scheduling on a Heterogeneous Chip Multi-Processor Architecture"

3:00-3:20 Hai Jiang, "Phase Shifterless Beam Forming Using the Coupled Oscillator Array"

Fluid Mechanics/CFD II: 1:00-3:20 PM Room E156B
Chair: Kevin Klasing, GEAE

1:00-1:20 Veera Vytla, "Study on the effects of scrubber operation on mine face ventilation using Fluent"

1:20-1:40 Subhadeep Gan, "Large-Eddy Simulation (LES) of Turbulent Plane Couette Flow Using Standard Smagorinsky and Dynamic Sub-Grid Scale (SGS) Modeling"

1:40-2:00 Jordi Estevadeordal, "A PIV Investigation of Blade-Row Interactions in a Transonic Compressor"

2:00-2:20 Charles Webb, "Hydrodynamic Performance and Wake Structures of Flapping Foils Undergoing Different Pitch and Plunge Motions"

2:20-2:40 Ryan Schmit, "Estimation of Optical Path Difference using Particle Image Velocimetry Measurements over a Flat Aperture Turret"

2:40-3:00 Scott Stanfield," Spatially Resolved Temperatures of a Dielectric Barrier Discharge Using Emission Spectroscopy"

3:00 – 3:20 Michael Schneider, "Nanoparticle Synthesis by Plasma Vaporization: Effects of Swirl on the Flow Topology and Dye Injection Rates of the MiniTorch Cold Model" (undergraduate)

Electronics/Sensors II: 1:00-3:20 PM Room E156C
Chair: Thomas Baudendistl, PCKA Associates

1:00-1:20 Michael Myers, "A Novel Fast locking Phase lock Loop"

1:20-1:40 Benjamin Tran and Bryan Harris, "A Simple Robust Method for Creating a Non-Contact High Rate Optical Extensometer"

1:40-2:00 Michael Boyd, "Data Acquisition Systems for Hardware-in-the-Loop Research"

2:00-2:20 Nicholas Baine, "Autonomous Lawnmower Project" (undergraduate)

2:20-2:40 Kyle Jurick, "A continued research on the benefits of directional antennas"

2:40-3:00 William Bennet, "Design of UAV Capable of On-Board Power Generation and Surveilance"

3:00-3:20 Jaime Bestard, "Missile miss distance measurements"

Biomechanics II: 1:00-3:20 PM Room E157A
Chair: David Reynolds**,** Wright State University

1:00-1:20 Kara Muckley, "Intervertebral Disc Replacement Devices"

1:20-1:40 Richard Murdock, "Review of the Relationship of Bone Disease to Bone Characteristics"

1:40-2:00 Shawn Gargac, "Design of Novel Total Ankle Replacement Models"

2:00-2:20 Shirishkumar Ingawale, "Temporomandibular Joint Disorders: A review of Treatment Options and Implants"

2:20-2:40 Samantha Crossen, “Dislocation of Total Hip Replacement in Recipients”

2:40-3:00 Allison Van Horn, “Total Hallux Metatarsophalangeal Joint Replacement”

3:00-3:20 Jennifer Serres, “A Test Apparatus for the Characterization of a Festo Pneumatic Muscle Actuator”

<u>Materials/Materials Processing I</u>: 1:00-2:20 PM Room E157B
Chair: Tony Corvo, AVETeC

1:00-1:20 Deborah Sweeney, “Elevated Temperature Oxidation Resistance of Boron Modified Titanium Alloys”

1:20-1:40 Joy Davis, “Pushout Testing to Determine Fiber-Matrix Interface Properties of Fiber Reinforced Ceramics”

1:40-2:00 Balakrishna Cherukuri, “Ageing response of Boron modified Beta Titanium alloys”

2:00-2:20 Anil Kumar Karumuri, “Coatings to Improve Oxidation Resistance of the Uneven Graphitic Structures”

<u>Heat Transfer and Thermal Sciences I:</u> 1:00-2:40 PM Room E163A
Chair: Alex Heltzel, PCKA Associates (for both sessions)

1:00-1:20 Caleb Barnes, “Water-Cooled Load Bank for Aircraft Power Systems Analysis”

1:20-1:40 Mohammad Almajali, “A Novel Way to Tailor Thermal conductivity of Carbon foams”

1:40-2:00 Sabyasachi Ganguli, “Anisotropic thermal conductivity in adhesive joints”

2:00-2:20 Shadab Shaikh, “Effect of carbon materials on thermal wear of sliding surfaces”

2:20-2:40 Dan DeBrosse, “Thermal behavior of a new carbon suspension in polyoelefin oil” (undergraduate)

<u>Propulsion Rockets I</u>: 2:40-3:20 PM Room E163A

2:40-3:00 Christopher Corbin, “Design and Analysis of a Mach 3 Dual Mode Scramjet Engine”

3:00-3:20 Garth Justinger, “A Comparison of Gaseous and Particulate Emissions for JP8 and Fischer-Tropsch Fuels in a Well-Stirred Reactor”

<u>Biomedical Engineering</u>: 1:00-3:20 PM Room E163B
Chair: Thomas Hangartner, Wright-State University

1:00-1:20 Jerry Czarnecki, “A Novel Approach to Control the Growth, Orientation and Shape of Human Osteoblasts”

1:20-1:40 John Lannon, “Time-series evolutionary experiments using Junk DNA”

1:40-2:00 Mary Kundrat, “Utilization of Cellular Automata to Predict Osteoblast Growth on a 2D Carbon Veil”

2:00-2:20 Krishna Desai, “Implantable Biosensors for Glucose Measurement”

2:20-2:40 Carissa Brunsman-Johnson, “Glucose Monitoring Devices”

2:40-3:00 Shawn Haynes, “Alu elements in Cancer ontology research.”

3:00-3:20 Carla Thompson, “Bone Morphogenetic Proteins”

<u>Break</u>: 3:20-3:40 PM

<u>Materials/Materials Processing II</u>: 3:40-4:40 PM Room E156B
Chair:

3:40-4:00 Gulshan Singh, “Effective Laser Shock Peening Process Design”

4:00-4:20 Hemanth Amarchinta, “Simulating Laser Shock Peening Process”

4:20-4:40 Carl Druffner, “Drilling of Cooling Holes through Thermal Barrier Coated Hastelloy using a Picosecond Laser System”

<u>Systems Engineering / Optimization</u>: 3:40-5:20 PM Room E156C
Chair: Sivaram Gogineni, Innovative Scientific Solutions

3:40-4:00 Brian Heath, “The Emergence of Agent-Based Modeling”

4:00-4:20 Heather Dwire, “Risk-Based Design Plots for Aircraft Damage Tolerant Design”

4:20-4:40 Priya Ganapathy, “Combining object detection algorithms to improve the performance of an automated target detection system”

4:40-5:00 Ronald Roberts, “Enriched Multipoint Cubic Approximations for Large Scale Optimization”

5:00-5:20 Meenakshi Prajapati, “A Model for Multi-Product Demand Forecasting and Production Planning under Uncertain Environment”

<u>Biomechanics III</u>: 3:40-5:00 PM Room E157A
Chair: Kara Muckley, Wright State University

3:40-4:00 Maria Gerschutz, "Application of an Adaptive Simulated Control System for Industrial Pneumatic Muscle Actuators"

4:00-4:20 Christin Grabinski, "Carbon Nanoparticle Flow Behavior Near Respiratory Mucus"

4:20-4:40 Elizabeth Maurer, "Bone Tissue Growth on Microcellular Carbon Foam"

4:40-5:00 Rikki Chokshi, "Biolung"

<u>Heat Transfer and Thermal Sciences II:</u> 3:40-5:00 PM Room E163A
Chair: James Menart, Wright State University

3:40-4:00 Shadab Shaikh, "Carbon Nano-additives to Enhance Latent Energy Storage of Phase Change Materials"

4:00-4:20 Chris Allen, "Global Optimization of an Aircraft Thermal Management System"

4:20-4:40 Randy Tobe, "Design of an Acoustically Loaded Thermal Protection System for SHM"

4:40-5:00 Mohammd Almajali, "Interfacial and Capillary Pressure Effects on the Performance of Wax/Foam Composites"

<u>Propulsion and Rockets II</u>: 3:40-4:40 PM Room E163B
Chair: Scott Stouffer, *University of Dayton Research Institute*

3:40-4:00 James Van Kuren, "An Alternative Fuels Testing Laboratory"

4:00-4:20 Karleine Justice, "Parametric Cycle Analysis of the Meyer Nutating Engine"

4:20-4:40 Faure Joel Malo-Molina, "Numerical Study of Two Innovative Scramjet Inlets Design Coupled to a Generic Combustor with a TVC and Using Hydrocarbon and Air Mixture"

ABSTRACTS

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

Usage of Von Mises Stresses in the Finite Element Analysis of Brittle Materials Represent Conservative Limits for Bone Failure

Bino Varghese and Thomas N. Hangartner,
BioMedical Imaging Laboratory,Wright State University
Marvin E. Miller
BioMedical Imaging Laboratory,Wright State University and Childrens Medical Center of Dayton

Three dimensional finite element (FE) modeling has been employed to predict bone strength. The FE calculated bone strength is a better estimate compared to image-based strength assessment using moment of inertia. Based on mechanical testing of bone specimens, it is observed that cortical bone shows brittle characteristics and trabecular bone shows ductile characteristics. However, the Von Mises stress failure criterion, which is established for predicting failure in ductile materials, has been used as the failure criterion in most FE bone models, irrespective of the tissue type under consideration. In this study, we construct 3-D FE models of the radial bone from anteroposterior radiographs assuming that all bone cross-sections are elliptical in shape. FE cantilever and torsion analysis results record Von Mises, maximum principal and shear stresses. We find that Von Mises stresses represent conservative limits for bone failure, but maximum principal stresses may more accurately reflect the real world situation

Aero-servo-viscoelasticity and structural control

Harry Hilton and Craig G. Merrett
University of Illinois at Urbana-Champaign (UIUC)

The areas of aeroelasticity, aero-viscoelasticity, controls and viscoelasticity are relatively mature subjects, although far from complete or closed research entities. Viscoelastic control has been exercised through piezoelectric devices, smart materials, magneto-rheological (MR) viscoelasticity, and making use of the natural viscoelastic damping properties. The current paper reports on pilot studies of aero-servo-viscoelasticity, which is the confluence of aerodynamics, closed loop controls, dynamics and viscoelasticity. The biggest solution hurdles rest with efficient evaluations of viscoelastic time integrals and the capture of proper fluid-solid interactions. Servo-controls utility rest with their ability based on closed loop feedback of current operating conditions to provide stabilization of creep divergence, control reversal, flutter and/or material failures of viscoelastic lifting surfaces; aerodynamic noise attenuation; delay column and panel creep buckling; increase panel flutter velocities; postpone composite delaminations and crack propagations; and to produce prescribed morphing of UAV and MAV lifting surface shapes to produce desired flight effects.

Structural Damage Identification Using Randomdec Signatures: Application to FEM Data

Oleg Shiryayev and Joseph C. Slater
Wright State University

A new damage detection method is presented that utilizes statistical properties of random decrement signatures. The technique is model-free and does not require measurements of external excitations. The technique is applied to simulated acceleration measurements obtained from a finite element model of a frame-like structure. In this work, damage is represented by a cracked structural member that is described by a nonlinear stiffness characteristic due to opening and closing crack. Results indicate that the technique is able to detect damage depending on amount of noise present in the data. Although the technique did not allow to pinpoint the exact location of the damaged member, it allowed to locate a damaged spar.

Thomas Baudendistel, “Effect of a Graded Layer on Plastic Dissipation During Mixed-Mode Fatigue Crack Growth in Layered Materials”

Effect of a Graded Layer on Plastic Dissipation During Mixed-Mode Fatigue Crack Growth in Layered Materials

Craig Baudendistel and Nathan Klingbeil
Wright State University

Recent work has proposed a dissipated energy theory of fatigue crack growth in layered materials under mixed-mode loading. An inherent assumption of this prior work is that a perfect crack exists along the interface joining the top and bottom layers. The current work extends the approach to incorporate a grading of plastic properties between layers through parametric finite element modeling with ABAQUS. This allows for a more realistic representation of the plastic dissipation accumulated during a steady-state cracking configuration. As a result, more accurate fatigue crack growth rates in layered material systems can be predicted. In conjunction with the finite element results, experimental data is needed to verify the validity of the dissipated energy theory for mixed-mode loading. Successful validation will allow prediction of fatigue crack growth rates based on a substantially reduced test matrix of monotonic properties, resulting in shorter material development cycle times.

Detection of Changes in Structural Parameters from Vibration Data

Tyler Robbins and Kumar V. Singh
Wright State University

It is critical to monitor the structural health to avoid catastrophic failure, by pin-pointing damaged areas before they become severe. The dynamics of the structure are characterized by its spectrum: natural frequencies and mode shapes. The vibration spectral data set is a function of material and physical parameters (mass, stiffness, area, etc.) of the structures. Once the structural physical and/or material parameter changes, then it will also change the associated spectrum, which is the basis of existing nondestructive structural health monitoring techniques. In this research we have shown that collocated frequency response functions (containing spectral data) can be used to detect the changes in structural parameters. Such changes can be pinpointed by analyzing the spectral data obtained by an array of sensors and actuators. Applications of this approach are demonstrated for the case of weld identification as well as damage parameter identification of transversely vibrating beam.

Observations on the Minimum Polynomial Order for Mixed, Least-Squares Finite Element Formulations

Douglas Wickert and Robert A. Canfield
Air Force Institute of Technology

A mixed, first-order finite element formulation for plane elasticity problems is convenient for many applications, particularly those involving both stress and displacement boundary conditions. Unfortunately, the most straight-forward system decomposition into first-order form destroys the inherent ellipticity of elastic boundary value problems and results in slow convergence for many types of problems. A family of fully-coercive planar elements using an increased degree of freedom basis for each state variable has recently been introduced. We use a slightly less efficient but more naturally-implemented planar element based on a p-type extension and achieve theoretically optimal convergence rates at a predictable polynomial order using least-squares finite elements. The theoretical predictions are explained and convergence results are presented for an example problem involving an axially-loaded plate with a circular hole.

<u>Fluid Mechanics/CFD I</u>: **9:00-11:00 AM** **Room E156B**

Computational Fluid Dynamics Analyses for DEBI-BATL entry into Subsonic Aerodynamic Research Laboratory

Barbara Rodriguez
University of Dayton / AFRL-VA

CFD was used to analyze the aerodynamic flow pattern around a 24-inch cylinder/turret design. CFD simulations were performed, using the in-house Air Vehicles Unstructured Solver (AVUS), to acquire analytical results regarding the air flow around the turret. The turret was modeled in the Subsonic Aerodynamic Research Laboratory (SARL) wind tunnel and then run, time-accurately, for flow conditions between Mach 0.3 - 0.5. The optical viewing path of interest in this experiment is interrupted by the vortices generated by the turret. As the speed increases, those vortices impinge on the tunnel walls closer to the turret. The model's horseshoe vortex also begins in the inlet of the tunnel. It seems to begin far enough from the turret that it propagates into the bell mouth of the wind tunnel. The CFD results are used in a predictive approach in order to decide on proper placement of the turret within the wind tunnel.

Fully-Coupled and Nonlinear Least-Squares Finite Element Formulation for Fluid-Structure Interaction

Cody Rasmussen and Robert Canfield
Air Force Institute of Technology

Fluid-structure interaction problems prove difficult due to the coupling between fluid and solid behavior. Typically, different theoretical formulations and numerical methods are used to solve fluid and structural problems separately. The least-squares finite element method is capable of accurately solving both fluid and structural problems. The implementation of this technique in both fluids and structures was used. Since least-squares finite element methods are applicable to both structures and fluids, a simultaneous solution method was then applied to fluid-structure interaction problems. This method will be applied to a two-dimensional gust problem that is traceable to the complex joined-wing sensor-craft.

Investigation of Thermal Perturbation Induced Flow Instability

Hong Yan and Joseph Shang
Wright State University
Datta Gaitonde
Air Force Research Laboratories

A numerical study is performed to explore thermal perturbation as a local flow control technique. A pulsed heating strip is placed on the surface in a Mach 1.5 flat plate laminar boundary layer. The pulsing frequency is 100 kHz and duty cycle is 0.5. The grid is refined in the vicinity of the leading edge to capture a weak shock induced by boundary layer displacement in the leading edge, and in the heating element to resolve the energy dissipation. A high-resolution upwind-based method and fourth-order accurate Runge-Kutta scheme is used. Results show that the heating induced flow instability results in the cross-flow perturbation, leading to the formation of the streamwise vortices. The spectrum analysis shows that the primary frequency mode dominates in the near field of the heating element. The generalized inflection points are observed during the heating process, indicating the strong effect of the spanwise disturbance.

Vorticity Production in High-Frequency Airfoil Pitch/Plunge

Michael Ol
Air Force Research Laboratories

Unsteady aerodynamics of airfoils and wings is seeing a resurgence of interest beyond its classical foundations, especially at low Reynolds numbers, for applications to miniature unmanned aircraft and to understanding animal flight. One approach towards better engineering models of unsteady lift and thrust production, of management of transients for aggressive maneuvering and for attenuation of

gust response, and of optimization of configuration geometry and motion kinematics, is radical abstraction – for example, to that of two-dimensional airfoils executing pitch/plunge maneuvers. The present work gives examples of such abstractions and their limitations: experiments at dimensionless frequencies and Reynolds numbers appropriate to flapping-wing flight in nature. Quantitative visualization (particle image velocimetry) in a water tunnel shows strong spanwise flow in the starting-vortex for a nominally 2D airfoil. Large kinematic angles of attack are associated with ejection of leading edge vortices – to which large transients in lift and pitch are often ascribed.

1-D numerical model of liquid jet break-up with drop tracking

Michael Hanchak
Eastman Kodak Co.

It is the goal of the present research to create a numerical model of the jet break-up process and track the resulting drops as they travel downstream. The model uses a one-dimensional reduction of the axisymmetric Navier-Stokes equations to allow for fast code implementation without masking the fine details of the break-up process (Eggers and Dupont, 1994). As a result of arbitrary, aperiodic perturbations of the jet, drops may break up several times and even merge downstream. It is important to study how the drop merging affects inkjet printing systems that use aperiodic perturbations. Also studied will be how the drop formation process is affected by sharp transitions between periodic and aperiodic perturbation patterns.

Computational Investigation into the Effects of Energy and Momentum Sources on Subsonic and Hypersonic Flows

William Bennet, James Menart, and Scott Stanfield
Wright State University

The goal of this study is to better understand the effects to a flow field when subjected to a plasma arc. Previous experimental work has shown that significant changes to the surface pressure over a flat plate are possible when in the presence of a plasma arc, both with and without the addition of a magnetic field. There are four primary mechanisms that contribute to this pressure change. They are: direct heating, indirect heating, direct Lorentz forces and indirect Lorentz forces. In past studies separating the affects of the direct and indirect Lorentz forces has been difficult. This work attempts to do this computationally through the addition of energy and momentum sources to the bulk flow. Low speed wind tunnel testing is currently being conducted. The heating effects of the plasma at low speed are minimal and therefore the effects of the Lorentz forces can better be understood.

Energy: **8:40-11:00 AM** **Room E156C**

StrongMobile Flying Car Project

Richard Strong
Safety Analysis Systems Co.

The work is developing an aircar system that can carry people safely and easily from door-to-door on frequent medium-range trips, such as routine regional business travel. The goal is development and use of an aircar system, called the StrongMobile AirCar Transport System. The current StrongMobile design is called the “Magic Dragon”. The Magic Dragon design is of a single-unit vehicle that can be operated either as an automobile or as an airplane, with automatic ‘push-button’ transformation, just like magic. Long-range planning is to achieve high production rates for lower unit costs, as compared to airplanes. This may lead to thousands of operators avoiding millions of hours of wasted ‘windshield time’ on the highways or changing modes. This time could be used for more profitable activities, such as expanding the business region. You may expect to see a billion-dollar industry within a decade from start-up.

Direct Oxidation Solid Oxide Fuel Cells (SOFC) from YSZ-Al2O3 Composite Electrolyte
Joykumar Thokchom and Binod Kumar
University of Dayton Research Institute
H. Xiao
Aerospace Power and Propulsion, UES Corp.
M. Rottmayer and T.L. Reitz
Air Force Research Laboratories

Bilayers comprised of dense and porous YSZ-Al2O3 (20 wt%) composite were tape cast, processed, and then fabricated into working solid oxide fuel cells (SOFCs). The porous part of the bilayer was converted into anode for direct oxidation of fuels by infiltrating CeO2 and Cu. The cathode side of the bilayer was coated with an interlayer [YSZ-Al2O3 (20 wt%)] : LSM (1:1) and LSM as cathode. Several button cells were evaluated under hydrogen/air and propane/air atmospheres in intermediate temperature range and their performance data were analyzed. For the first time the feasibility of using YSZ-Al2O3 material for fabricating working SOFCs with high open circuit voltage (OCV) and power density is demonstrated. AC impedance spectroscopy and microstructure techniques were used to characterize the cell.

Rechargeable Lithium-Air Power Sources: Potential and Possibilities
Nutan Gupta, Joykumar S. Thokchom, and Binod Kumar
University of Dayton Research Institute

The rechargeable lithium-air power sources represent a land-mark development in the history of energy storage technology because they possess the highest achievable specific energy and the ability to mitigate impact of global warming resulting from the use of fossil fuels. However, their developments have been marred by the chemical reactivity of lithium metal and lack of suitable materials which can contain the metal and carry out electrochemical processes for power generation. This paper will present potential attributes of lithium-air batteries. Recent developments on ionic conducting materials compatible with lithium metal and at the same time stable in the normal environment will be discussed. The stability of interfaces inherent of rechargeable batteries will also be covered. Keywords: Lithium-air; Rechargeable; Specific energy; Ionic conductivity. * Corresponding author: Tel.: 937-229-3452; fax: 937-229-3433. E-mail: kumarb@udri.udayton.edu (B. Kumar).

Quasi-One Dimensional Materials for Thermoelectric Applications
Thomas Robbins
University of Dayton
Doug Dudis
Air Force Research Labs, ML

Research into possible improvement of thermoelectric materials through reduced thermal conduction and increased electrical reductions achievable in bulk materials using Quasi-one-dimensional organic molecules. This work is based on a theoretical basis which shows these materials to have a huge potentional for improvement over existing materials. Study of materials includes examination of newly created materials which show potential of being quasi-one-dimensional and classification of relevant material properties.

Zero Energy Building: Heating and Cooling A House by Pumping Water Through Structural Insulated Panels (SIPs)
Vince Romanin, Eric Urban, and Kevin Hallinan
University of Dayton

In order to save energy, a house can be conditioned by running water inside the walls of the building instead of using ducted air. Water can be warmed in the winter through a solar heat collector on the roof, and cooled in the summer using a geothermal heat sink. This method of heating and cooling is

expected to yield high energy savings in comparison with current methods. For this project, a scale model of a house was built with a network of tubes running along the walls. A constant temperature was sustained in the house by pumping water through the tubes. The data collected for this experiment and a thermodynamic analysis will be used to predict the practicality of building Structural Insulated Panels (SIPS) with built in water paths. These SIPS could be manufactured economically, used to build energy efficient houses, and reused at end of life.

Effect of increase of ozone concentration on photochemistry efficiency of spring wheat

Yuxing Li
University of Dayton

After 16 days and 22 days' ozone exposure, 1st-top leaves and 2nd-top leaves were selected to determinate the chlorophyll fluorescent parameters of the leaves with a portable fluorometer (FMS-2, Hansatech Co., England). The results showed that: 1. results suggested that elevated ozone could significantly affect the efficiency of photochemical reactions of leaves, which decreased significantly with the increase of ozone concentrations. 2. The decrease in efficiency of photochemical reactions induced by ozone was affected by both leaves age and exposure time. Response of 2nd-top leaves to ozone was much earlier than the 1st-top ones and the latter period of ozone exposure was much aggravated than the earlier period ones. 3. The decrease rate of leaves' efficiency of photochemical reactions caused by ozone exposure was far beyond that by aging.

A Method of Storing and Generating Hydrogen for Power Applications

Ian Fuller
Wright State University

A new method of storing and generating hydrogen for fuel cell applications has been developed. This innovative approach uses solid fuel sources (chemical or metal hydrides) to store hydrogen and employs a cheap, solid reaction-controlling agent, such as an acid or metal salt, to control the rate and final yield of hydrogen production. This agent takes the place of precious metal catalysts usually associated with hydride use. Both the hydride and controlling agent may be kept in the solid state thereby creating the most energy dense scenario as well as easing use and distribution of the fuel. By eliminating high pressure or cryogenic tanks it increases safety. By allowing use of the current infrastructure for transportation and distribution it abolishes the need for gas pipelines. Finally, by providing a cheap, efficient, clean, and abundant power source for transportation and micro-electronic devices this novel invention allows the hydrogen economy to flourish.

Micro/Nano Systems: **8:40-11:00 AM** **Room E157A**

Electrochemical and Surface Characterization of Ablated Platinum Nanoparticles

Leanne Petry. D. Hanson, and P.T. Murray
University of Dayton, Graduate Materials Engineering
E. Shin
University of Dayton Research Institute
V. Nalladega
University of Dayton, Graduate Mechanical Engineering
R. G. Keil
University of Dayton, Department of Chemistry

Platinum (Pt) metal nanoparticles are prepared by the recently-developed method of Through Thin Film Ablation (TTFA). The method consists of ablating a thin film of platinum from an optically transparent target to produce a collimated plume of ejected nanoparticles that are deposited onto a silicon substrate. Preliminary microscopic analyses indicate the Pt nanoparticles are well distributed and not agglomerated. Optical emission spectroscopy measurements suggest the adiabatically expanded nanoparticles are liquid at a temperature of 2940 K and have less than a 500 microsecond time of flight. This molten liquid has sufficient energy to induce a platinum silicide reaction, as identified by X-ray analyses and high resolution imaging of electrical conductivity properties, upon impact with the substrate surface. The beauty of the TTFA method is that the mean spacing between nanoparticles can be varied. The role that particle size and spacing has on Pt electrode kinetics is being explored and will be reported.

Exfoliated Graphite Composites in EMI Shielding Applications

Matthew Boehle and Khalid Lafdi
University of Dayton

The increasing density of electronic devices in industrial and military applications has lead to a need for enhanced electromagnetic shielding properties. Plastics have also become a major component in most electronic devices. Polymer composite shielding materials utilizing carbon nanotechnology merge these requirements into a device with reduced cost, higher performance and lower weight.In this study, the relationship between EMI shielding effectiveness and resistivity of epoxy composites was examined. Test specimens were prepared with varying concentrations and sizes of exfoliated graphite used as an additive. After testing the composite panels, a strong correlation between electrical properties and EMI shielding was found. The end goal of this work is to characterize the EMI shielding performance of carbon nanocomposites in order to design a material which can be optimized for a given application.

Focusing surface plasmons with subwavelength structures

Weibin Chen and Qiwen Zhan
University of Dayton, Electro-Optics

Super-resolution, which is defined as resolution beyond the diffraction limit of imaging optics, has considerably important applications in chemistry, biology and material characterization, as well as in semiconductor industry. Plasmonic structures have attracted increasing research interests due to their near field super-resolution properties and enormous field enhancement with appropriate illumination. Surface plasmon wave is an electromagnetic excitation at the dielectric/metal interface due to the interaction of metals with the incident light. We report the generation and focusing of surface plasmon waves by illuminating axially symmetric dielectric/metal subwavelength structures with radially polarized light. As examples, plasmonic lens with conical shape and annular rings under radial polarization illumination are studied. The focusing properties and field enhancement effect of these plasmonic lenses are numerically studied with a finite-element-method model. The field distribution with a full-width-half-maximum as small as 10 nm and intensity enhancement of five orders of magnitude can be achieved.

Profile Control of Silicon Etching by an Inductively Coupled Plasma Technique

Lirong Sun and Andrew Sarangan
University of Dayton, Electro-Optics

Reactive ion etching technique is capable of anisotropic etch profiles and high etch rates, but it can cause damage on the substrate due to the high ion energy. In order to achieve high etch rates, high anisotropy, low damage and high uniformity over a large area of micro-scale and nano-scale structures, the inductively coupled plasma (ICP) technique can be used. Two RF power supplies of the ICP system are used to independently control the ion density and the ion energy. By adjusting the ICP power, bias voltage, chamber pressure, temperature and gas chemistry, a continuous balance between the polymer

deposition rate and etch rate was obtained. A specific sidewall angle was achieved by a fixed ratio of the vertical etch rate and the lateral etch rate. The sidewall profiles were characterized by scanning electronic microscopy (SEM).

Interactions in Micro- and Nano-Structured Mesomatter;A Raman Spectroscopy Investigation

Maher Amer

A major goal of materials science is to produce mesomatter that are ordered on all length scales, from the molecular (1-100 Å) via the nano (10 – 100 nm) to the meso (1-100 microns). This high degree of order leads to unique physical and mechanical properties that are superior to those of the same material in a disordered form. Micro-Raman spectroscopy is a powerful technique that explores the vibrational modes of matter and, hence, enables monitoring of crystal structures, crystal orientation, and stresses with a spatial resolution of 1 m. In this talk, the application of micro-Raman spectroscopy in monitoring local interactions in nano- and micro-structured meso-material systems will be discussed. Specific examples such as measuring inter-granular mesoscopic stress fields in polycrystalline systems, measuring grain orientation and its correlation with mesoscopic stress fields in thin superconducting films, and monitoring phase transitions in nano-systems under high pressure will be given.

Oxide Nano-Coatings to Enhance the Growth of Carbon Nanotubes on Microcellular Carbon Substrates

Ian Barney, A.G. Jackson, and S.M. Mukhopadhyay
Wright State University

This project focuses on the growth of carbon nanotubes over larger engineering structures to create multi-scale materials with increased surface area, where additional functionalities may be added. Nanotubes have been fabricated on various carbon substrates (microcellular foams, fibers, and flat graphite) using chemical vapor deposition (CVD). Influence of surface functional groups on the growth of nanotubes was investigated by comparing pre-coated and uncoated samples. Analyses of chemical states have been preformed using x-ray photoelectron spectroscopy (XPS) and of structure using scanning and transmission electron microscopy (SEM and TEM). Results indicate that silica-like nano-coatings enhance the growth of carbon nanotubes, showing higher growth rate and improved homogeneity. Influence of substrate surface chemistry and deposition conditions on concentration, size, distribution, and chemical states of catalyst particles has been studied. Possible growth mechanisms and the potential for improved surface engineering of the nanotube overlayer for thermal, catalytic, and electrical applications will be discussed.

The Effect of Finite Geometry on Solidification Microstructure in Beam-Based Fabrication of Thin Wall Structures

Satish Kuchi and Nathan Klingbeil

Additive manufacturing processes use the energy from a laser or electron beam to build up structures layer by layer directly from powdered metals. It has been determined from previous work that solidification cooling rates and thermal gradients are the important factors for controlling the microstructure (grain size and morphology) and resulting mechanical properties of the deposit. This previous work was concerned with semi-infinite thin wall and bulky 3-D geometries where the thermal solution near the laser or electron beam is independent of the boundaries. The goal of the current study is to investigate the effects of finite geometry and associated non-steady state changes in process variables (beam power and velocity) on the thermal conditions controlling microstructure through parametric finite element modeling with ABAQUS. The results of this project will guide process designers in the additive manufacture of a variety of common thin wall and bulky 3-D geometries.

<u>Education</u>: **9:00-10:20 AM** **Room E157B**

Culturally-Appropriate Engineering Design for Developing Countries

Lawrence Zavodney and Thomas Thompson
Cedarville University

Academic institutions are encouraged to instill "the impact of engineering solutions in a global and societal context." Cedarville University now provides seniors with a capstone project option that directly solves an engineering problem in a developing country. Underclass students can participate on other projects. Two faculty took a survey trip to Liberia in 2006. Considering what would benefit the infrastructure of ELWA (i.e., their radio station, hospital, or school) or the rural people, we selected projects according to academic merit, field need, and student interest. Our pilot program took students and faculty to Liberia in May 2007. With help from the Liberians, the team installed a cooling system for the diesel powered generators and a medical waste incinerator, assessed the water distribution network for 2007-08 capstone modeling and improvements, surveyed the 134-acre facility for CAD mapping, and designed, built and distributed 10 solar-powered reading lamps.

Exposing Students to the Features of a Computer Data Acquisition System By Generating the Vibration Response of a Structure

David Myszka
University of Dayton
Todd Drehs
Honda of America, Mnf.

This presentation outlines an automated structural vibration response test that is completely prepared and conducted by engineering technology students. An imbalanced weight, is placed on the shaft of a DC motor, and mounted onto a semi-rigid structure. The students create a data acquisition program that sends a set voltage to the motor, operating it at a certain speed. The program gathers motor speed and vibration data, then changes the motor voltage and repeats the sequence. Thus, the frequency response of a mechanical structure is automatically generated. This test allows students to create a comprehensive, and in-depth mechanical test procedure using only common equipment, and low cost sensors. Additionally, the power of data acquisition software is incorporated, and clearly recognized. The experience is designed to be completed in one 2-1/2 hour period. This presentation provides the details of the test along with instuctor and student reactions.

Engineering Mathematics Education at Wright State University: A Model for Increasing Student Success in Engineering

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

The inability of incoming students to advance past the traditional freshman calculus sequence is a primary cause of attrition in engineering programs across the country. This presentation describes an NSF funded initiative at WSU to redefine the way engineering mathematics is taught, with the goal of increasing student retention, motivation and success in engineering. The approach involves the introduction of a novel freshman engineering mathematics course (EGR 101), which replaces traditional math prerequisites for core sophomore engineering courses, so that students can advance in their chosen degree programs without first completing the traditional freshman calculus sequence. The result has shifted the traditional emphasis on math prerequisite requirements to an emphasis on engineering motivation for math, with a just-in-time structuring of the remaining math sequence. This presentation provides an overview of the WSU model, followed by an updated assessment of student performance, perception and retention through its initial implementation.

Using Student Activities to Initiate Sinclair Community College's Energy Education Programs

Robert Gilbert

Sinclair Community College

Sinclair Community College instituted a broad based energy initiative in October 2006 at the request of its president Dr Steven Johnson. To facilitate the immediate implementation of the initiative, student activities were employed. A service learning weatherization program was accomplished by collaborating with the Community Action Partnership of the Greater Dayton Area. The students participated in energy audits and subsequent repairs for qualified households. The HVAC and Architectural capstone projects involved the energy assessment/audit on a high energy use building on the Sinclair campus. As a result of these successful capstone projects, the programs are now being expanded to commercial and public facilities within the Dayton area community. An internship class was formed. The students researched equipment and activities which were appropriate for the Center for Energy Education Laboratory. Another internship class constructed the laboratory.

Electronics/Sensors I: 8:40-11:00 AM Room E163A

CTRNN-EH Controllers: Evolving a Navigation System for Micromechanical Flying Insect Sanjay Boddhu and John C. Gallagher

Computational Autonomy Research Lab(CARL), Wright State University

The perceived future goal of the Micromechanical Flying Insect (MFI) project at Biomimetic Millisystem Lab, UC Berkeley is to develop a 25 mm micro-robot capable of sustained autonomous flapping flight. An apt suite of actuators, sensors and controllers to build this MFI should primarily satisfy small area and low power consumption criteria. The recent technology developed at CARL,WSU based on the Continuous Time Recurrent Neural Networks-Evolvable Hardware approach, opened an innovative research to study and propose a suite of controllers that are appropriate for the micro-robots like MFIs in terms of area, power and stability. This presentation discusses the same rationale to employ CTRNN-EH approach, in designing adaptive flapping pattern generators crucial for actuation of the wing trajectory at different phases in its flight. A brief description of the preliminary success achieved by deploying CTRNN-EH controllers on the simulated MFI model is provided with inferences for the future work.

Research on Robust Approach and Landing Trajectory Generation for Reusable Launch Vehicles

Zhesheng Jiang and Raul Ordonez

Department of Electrical and Computer Engineering, University of Dayton

In this presentation, research progress on robust approach and landing trajectory generation for reusable launch vehicle (RLVs) is reviewed. A motion primitive scheme is used to generate a trajectory database for each initial condition. From the trajectory database, a path-finding algorithm is employed to find an off-line optimal trajectory. When there are some disturbances for system parameters (a failure), that trajectory is reshaped into a neighboring feasible trajectory on-line by using neighboring optimal control (NOC). If the perturbations are small enough, a neighboring feasible trajectory existence theorem (NFTET) is investigated. When the perturbations become large, however, NFTET is no longer applicable. A new theorem named trajectory robustness theorem (TRT) is then proposed. According to TRT, a robustifier is introduced to compensate for the effects of the linear approximation in NFTET and hence eliminate the uncertainty of input deviation. The simulation results verify the excellent robust performance of this method.

System-Level Design and Optimization of a UUV Using Integrated Path Planning and Component Sizing

Todd Benanzer and Ramana Grandhi
Wright State University
William Krol
Naval Undersea Warfare Center - Newport RI
Unmanned undersea vehicles are currently being designed by the US Navy for use throughout the fleet. These UUVs are being designed to perform many different missions, such as reconnaissance, ocean topography mapping, and mine-finding. These missions place multidisciplinary constraints on the performance of the system. These constraints include maximum acoustic limits, minimum range, and top speed. Each component within the UUV has an effect on its performance; therefore, the entire system must be taken into account during the preliminary design phases. This research explores the advantages of performing an optimization on a system level rather than attempting to optimize each component individually. In addition, the constraints are not taken to be individual performance metrics such as top speed or turn radius, but rather the system will be evaluated on how well the desired missions can be performed given the system configuration.

A Micro-Simulation Test of Two-Level Optimization-Based Ramp Metering Controls

Vishnu Kesaraju and Frank W. Ciarallo
Wright State University
A two-layered hierarchical ramp meter control problem is studied and improved to provide tactical and real-time decisions to the microscopic freeway model. The freeway model is based on the I-10 freeway corridor in Phoenix, with seven on and off ramps. The upper layer or area-wide of the hierarchical system provides nominal ramp metering rates for all the individual on-ramps in the freeway corridor. This tactical layer aims at maximizing the freeway throughput and balancing the queue growth rates. While the lower layer or local control is an optimization formulation, which provides real-time ramp metering rate to a particular ramp, based upon the nominal rates it receives from the tactical layer. The research investigates the performance of the freeway with an enhanced feedback control based on the ALINEA algorithm, which is elegant and efficient in clearing the queues quickly on the on ramps with no breakdowns, and higher flows and speeds.

Separation of Static and Non-Static Features from Three Dimensional Datasets: Supporting Positional Location in GPS Challenged Environments

J. Markiel, Dorota Grejner-Brzezinska
The Ohio State University, SPIN Lab, Department of Civil and Environmental Engineering and Geodetic Science
Charles Toth
The Ohio State University, Center for Mapping
Environments where Global Positioning Satellite (GPS) signals are intermittent or non-existent exist in a number of situations. Flash LADAR technology provides the ability to acquire near continuous three dimensional datasets coupled with positional information by existing technologies such as GPS or Inertial Navigation Units (INU). By comparing features in an image with known coordinates with the same features in images acquired from unknown positions, we can obtain an ongoing positional reference to establish location. A critical component of this methodology is the identification of features exhibiting a static nature and the exclusion of non-static features from the locating process. In this paper we present our research in the utilization of three dimensional feature matching to separate static and non-static features from a time series of Flash LADAR images. We exhibit our findings in the use of polynomial signatures to match features between subsequent images.

A Transistor Sizing Algorithm for Dynamic CMOS Circuits to improve Design for Manufacturability

Kumar Yelamarthi and Chien-In Henry Chen
Wright State University

The advancement in CMOS technology has created an avenue for design and implementation of new high performance circuits than ever before. However, this advancement is limited by two challenges: time-to-market a design, and design for manufacturability, which are a result of increased complexity in transistor sizing in dynamic CMOS circuits, and increased magnitude of process variations. This research presents an efficient transistor sizing algorithm for complex dynamic CMOS circuits while addressing the above challenges. Efficiency of the proposed algorithm is validated through on implementation on several complex dynamic CMOS circuits whose delay was reduced up to 50%, and delay uncertainty up to 60%.

Biomechanics I: 8:40-11:00 AM Room E163B

Finite element analysis of the locking compression plate

Vinit Patel[1] and Tarun Goswami[1,2]
[1]*Department of Biomedical, Industrial and Human Factor Engineering*
[2]*Department of orthopaedic surgery and sports medicine*

Conventional locking compression plates have been used for many years with good success. However, for better results and long term stability, biomechanical study of the plates is being done. Finite element analysis of the Locking Compression Plates (LCP) can be performed with two methods, one with the help of SOLIDWORKS and other based on a Computed Tomography (CT) scan of medium synthetic femur. For CT scan method, MATLAB is used to find the co-ordinates of the CT image and 3D model of the femur is created in ANSYS using calculated co-ordinates. The 3D model is further used for the fatigue test and the results are obtained which would be compared with biomechanical study. Finite element analysis is be used successfully to evaluate and compare the results with the conventional biomechanical study.

Biodegradable Polymer Scaffolds: Fabrication and Tissue Engineering

Leimin Au[1] and Tarun Goswami[1,2]
[1]*Department of Biomedical, Industrial and Human Factor Engineering*
[2]*Department of orthopaedic surgery and sports medicine*

Over the years, tissue engineering has gain increasing interest as an alternative to replace organs and tissues. For this approach, a three-dimensional biodegradable polymer scaffold is fabricated to serve as a substrate for the implanted cells. This paper reviews all the requirements for a successful biodegradable polymer scaffold to ensure its functionality. The requirements include porosity size, degradation rate, mechanical properties, and mass transport properties. The many different types of biodegradable polymers are closely reviewed to understand usefulness for specific applications. Each method to fabricate a 3-D polymer scaffold has its advantages and disadvantages. This presentation will introduce some of the methods that have been observed and performed. Therefore, the success of a polymer scaffold could be determined by studying its microstructure, pH, dimensions, molecular weight, and mechanical behavior.

Biomimetic Characteristics of Pneumatic Muscle

Alison Gadd, D.B. Reynolds and C.A. Phillips
Department of Biomedical, Industrial and Human Factors Engineering, Wright State University
D.W. Repperger
AFRL/HECP, Wright-Patterson Air Force Base

Biomimcry is an area of science that has looked at 'perfect' designs in nature and tried to recreate the benefits of those designs using current technology. A custom-made pneumatic muscle (PM) was tested by hanging a load on the muscle, applying a step increase in pressure and finally estimating the initial velocity of the PM. The resulting load-velocity relationship that corresponded to that pressure and load combination was recorded. Equations by A.V. Hill were used to model the force-velocity and the power-velocity relationship of the pneumatic muscle. These relationships were compared with similar relationships for human skeletal muscle in order to show that the pneumatic muscle behaved in a similar fashion to human skeletal slow-twitch muscle. As the pneumatic muscle was shown to be similar to human skeletal muscle, further designs that would help or mimic a human limb would be easy to create.

Knee Implant Models and Biomechanics

Brandi Carr[1] and Tarun Goswami[1,2]
[1]Department of Biomedical, Industrial and Human Factor Engineering
[2]Department of orthopaedic surgery and sports medicine

Since the 1950s, knee implants have been designed to replace damaged cartilage and bone of the knee. Researchers have evaluated the biomechanics of knee implant components to assess the performance of some of the knee implant models. Many authors have investigated biomechanical factors such as contact stresses, kinematics and fatigue to validate knee implant quality under specific loading conditions. Materials used for knee implants are selected to balance strength requirements with biocompatibility needs. While use of materials such as titanium alloys, cobalt chrome and ultra-high molecular weight polyethylene have led to improved implant designs, wear, loosening and other factors continue to limit the performance of knee implants. Two- and three-dimensional finite element models have been developed which include the artificial knee and portions of the surrounding biological materials to investigate this interaction. Finite element analysis has been used to predict implant biomechanical behavior under various static and dynamic loading conditions.

A review of ultrahigh molecular weight polyethylene reinforced with carbon nanotubes and its potential use in orthopaedic applications

Danielle Miller[1] and Tarun Goswami[1,2]
[1]Department of Biomedical, Industrial and Human Factor Engineering
[2]Department of orthopaedic surgery and sports medicine

Ultra high molecular weight polyethylene is currently the primary material for articulating surfaces in total joint replacements. Studies have revealed that the addition of carbon nanotubes to ultra high molecular weight polyethylene has resulted in improved tensile strength, elastic modulus and tribological properties. It is hypothesized that reinforcing ultra high molecular weight polyethylene with carbon nanotubes has the potential to reduce implant wear. A reduction in wear would result in a decreased immune response thus leading to a decreased chance for osteolysis and implant loosening and ultimately reducing the number of revision surgeries. While the carbon nanotube-polymer composites have shown a reduction in wear it is important that these wear particles are not causing adverse effects to the biological tissues. This review addresses the topic of carbon nanotube-ultra high molecular weight polyethylene composites as well as functionalization and its importance in producing biocompatible, non-toxic composites for applications in orthopaedics.

Wear Rate Parameters in Total Hip Replacement

Himanshu Bhatt[1] and Tarun Goswami[1,2]
[1]Department of Biomedical, Industrial and Human Factor Engineering
[2]Department of orthopaedic surgery and sports medicine

In 1960s, Sir John Charnley established modern aspects for the procedures of total hip replacement (THR). Since then, wear rate and wear affecting parameters have been a predominant problem influencing long-term performance of a hip prosthesis. The articulating motions between the femoral and the acetabular components produce wear debris in implant material. Surface roughness, clearance, friction coefficient, and sliding distance are contributing parameters which affect wear rates. Wear produced in a hip implant leads to the loosening of a hip prosthesis and thus, failure of a hip implant. Since 1962, ultra-high-molecular-weight-polyethylene (UHMWPE) has been successfully used as an acetabular weight bearing component in THR applications because of its high wear resistance and biocompatibility during the clinical use. The cross-linked UHMWPE is found to be efficient in improving the lifespan of an artificial hip. In further advancement, gradient cross-linked UHMWPE showed nearly undetectable wear rates during in vitro studies.

Design perspective: Total Ankle replacement and ankle braces

Junitha Michael[1] and Tarun Goswami[1,2]
[1]*Department of Biomedical, Industrial and Human Factor Engineering*
[2]*Department of orthopaedic surgery and sports medicine*

Ankle joint is the most vulnerable joint. Talus is the critical bone of the joint due to its intricate anatomy. Though there are other treatments available for ankle arthritis, total ankle replacement (TAR) is considered to be most reliable. For a better TAR model, talar dimensions are important. A study was carried out with radiographs of 23 normal and 6 deformed ankles. The average radius of normal and deformed ankles was found to be 21.795 ± 3.2744 mm (p-value 0.05) and 23.1687 ± 3.7598 mm (p-value 0.05) respectively. The discussion also deals with various clinical fixation methods associated with ankle deformities and comparitive study of clinical outcomes of various TAR models. Ankle braces are developed by the authors, to relieve pain associated with post-op TAR, ankle sprain and ankle fractures, in conjunction with the research in TAR.The braces are aimed to provide enhanced support while being economical.

<u>Design/Optimization</u>: **1:00-3:20 PM** **Room E156A**

A Simulation-Optimization Approach for Multi-Echelon Inventory Systems with Intermediary Product Demand

Suman Niranjan and Frank W. Ciarallo
Biomedical Industrial and Human Factors Engineering, Wright State University

The system considered here is a multi-echelon assembly system with an intermediate product demand (i.e. external demand) in one or more upper echelons. The components are procured from the external suppliers, are assembled into intermediate products and a final product. Uncertainty is involved in both demand and supply of components, intermediate products and the final product. A mathematical model for a capacitated multi-echelon system with demand for the intermediate products and the final product is developed. A simulation based inventory optimization approach is employed to determine the optimal base-stock levels at each stage. We also develop infinitesimal perturbation analysis (IPA) estimators of derivatives with respect to base stock levels for these systems. The gradient estimation technique of perturbation analysis is used to derive sample path estimators. The optimal base-stock level that satisfies the required service level is found by a modified Zoutendijk’s feasible direction method.

Quantification of Risk and Probability of Success for Undersea Vehicles

Matthew Riley and Ramana Grandhi

Wright State University
William Krol
Naval Undersea Warfare Center – Newport

In undersea vehicle design, the quantification of risk and probability of success is crucial to the design process. By obtaining accurate data from the design and simulation process, there is less need to perform expensive experimental testing to each newly designed component in order to obtain data regarding its probability of success. Thus, in order to best quantify this information, accurate models must be developed of system components to obtain results representative of the actual conditions experienced by the component during operation. These models need to be adaptable in nature to account for the variety of conditions expected to be experienced by a component in different vehicles. By modeling, designing, and simulating the response of a component to exterior conditions, an accurate representation of the probability of success of the component can be determined without the need for experimental testing.

Integrated Simulation Framework with Process-driven and Event-driven Models

Vishnu Kesaraju and Frank W. Ciarallo
Biomedical Industrial and Human Factors Engineering, Wright State University

A simulation framework that integrates process-driven and event-driven approaches offers a powerful combination of tools to the modeler. An important feature of standard event graphs is parameterization of the event vertices, allowing similar model sub-graphs to be combined together as a generic sub-graph distinguished by parameter values. A framework based on an integrated entity/event approach has been further enhanced to explicitly represent entities at the event-driven level. The integrated simulation framework works towards attenuation of the abstraction involved in parameter passing. The solution lies in explicitly passing the entities through the event-driven model. Event parameters are replaced by entity attributes. The usage of entities in the event-driven layer serves two purpose, a) reduce the abstraction by manipulating entity objects instead of working with parameters, and b) gives the intuitive feel of process-driven models to modelers at the event level, which enhances the appeal of the event-driven models.

Attribute Based Access Control for Collaboration Environments

Jian Zhu and Waleed Smari
Department of Electrical and Computer Engineering, University of Dayton

Access control is an area in computer security and information assurance that has been of interest for a while and will continue to be. Building community computing and other similar collaboration environments is a very hot subject as well. The incorporation of access control policies and solutions in collaboration systems has been gaining a lot of attention recently. Many models and policies have been proposed to meet the increasing complexity and flexibility requirements of these systems. One of these is attribute based access control (ABAC). It represents an emerging trend where access decision is made based on attributes rather than identities which are used in traditional models. These attributes are characteristics of subjects, objects, and situation under which a request is submitted and evaluated. This presentation will introduce the model and discuss how it will be extended to address some of the new needs of today's collaboration environments.

Micro inductor designs for fully integrated low voltage DC/DC converter applications

Agus Widjaja and Mark Patterson
University of Dayton

The integration of external inductors into a single chip for DC/DC converter applications has been a big challenge for solid state power converter industries. Size is the primary limitation since micro inductors fabricated using metals commonly used for CMOS processes do not generate enough inductance for the converter. In this research, planar spiral micro inductors are fabricated by sputtering using a combination of Al, Cu and Ni. To find the optimum composition ratio of Al, Cu and Ni, augmented simplex lattice mixture design degree 3 with 3 components is used. Keywords: DC converter, planar spiral, micro inductors, mixture design, CMOS.

Matching and Scheduling on a Heterogeneous Chip Multi-Processor Architecture

Justin Teller and Fusun Ozguner
Ohio State University
Robert Ewing
Air Force Research Labs, WPAFB

The organization of Heterogeneous Chip Multi-Processors (H-CMPs) differs significantly from "traditional" parallel machines; communication to the memory system carries roughly the same cost as inter-processor communication, processing cores share significantly more resources, and reconfigurable resources can be present. In light of these differences, we present novel scheduling models and heuristics to more efficiently map parallel applications onto H-CMPs. Contention Aware HEFT (CA-HEFT) uses our new contention model to generate higher quality task schedules. HEFT with Mutually Exclusive Groups (HEFT-MEG) goes further by evaluating reconfiguration decisions while scheduling, effectively choosing different configurations for each application phase and enabling reconfiguration at runtime. Implementing CA-HEFT on IBMs Cell processor shows impressive performance increases on RobustDataAlignment (a computer vision application). Finally, we show that CA-HEFT enables reconfiguration at runtime on UT at Austins TRIPS processor, developed under DARPAs Polymorphous Computing Architectures (PCA) program.

Phase Shifterless Beam Forming Using the Coupled Oscillator Array

Hai Jiang and Krishna M. Pasala
University of Dayton

For traditionally antenna array, the phase shifters and power dividers are used to control the amplitude and phase distribution along the array. However in practice, it is difficult to integrate the bulky phase-shifter circuitry with other circuitries while developing monolithic T/R modules. Thus a new phase-shifterless beam-scanning technique using arrays of coupled oscillators was proposed. The concept is when the free-running frequencies of the oscillators are within a collective locking range, the oscillators will automatically synchronize to a single frequency with a phase relationship that is controlled by the original distribution of free-running frequencies. In other words, the phased array system can be realized without using any phase shifter. In this paper, the fundamental theory of the coupled oscillator array is developed. A nine-element oscillator array under weak coupling is also demonstrated and different amplitude distributions are used for sidelobe reduction.

<u>Fluid Mechanics/CFD II</u>: **1:00-3:20 PM** **Room E156B**

Study on the effects of scrubber operation on mine face ventilation using Fluent

Veera Vytla, George P. Huang
Wright State University
Andrew M. Wala
University of Kentucky

One of the concerns during the coal extraction, using room-and pillar mining method, is that large volumes of methane are released. There are different ventilation techniques that supply fresh air to carry-out and dilute the methane in the face area. There is a need for a tool to analyze these techniques and design effective face ventilation systems. In our previous studies CFD tool Fluent was used to predict the flow and methane distribution in different ventilation scenarios with empty face area. Those results were validated against the experimental data provided by the NIOSH Pittsburg Research Center. In this presentation an effort will being made to predict the flow and methane distribution in the mine face area

with the machine mounted scrubber located in the face area. The study is carried out to understand how the use of scrubber affects the airflow and the methane concentration.

Large-Eddy Simulation (LES) of Turbulent Plane Couette Flow Using Standard Smagorinsky and Dynamic Sub-Grid Scale (SGS) Modeling

Subhadeep Gan and Urmila Ghia
Department of Mechanical, Industrial, and Nuclear Engineering, University of Cincinnati
Karman Ghia
Department of Aerospace Engineering and Engineering Mechanics

In this work, the turbulent plane Couette flow is studied using a high-order compact-difference scheme and LES. This is a canonical test problem for wall-bounded anisotropic turbulence. Some of the important flow features are the monotonic velocity profile, the constant shear stress distribution, and the finite rate of production of turbulent kinetic energy at all positions across the channel. The simulations are conducted for the parameter used in the experiments of Bech et. al. (1995) and Aydin and Leuthheusser (1987). The simulations are conducted using LES with a constant Smagorinsky model and the dynamic SGS model of Germano et al. (1991). Mean velocity profile, mean velocity profile using wall co-ordinates, resolved streamwise turbulent intensities, and resolved Reynolds shear stress distribution will be presented. These results will establish the accuracy and efficiency of this solver for unsteady turbulent flow simulations, and the merits of the different SGS models.

A PIV Investigation of Blade-Row Interactions in a Transonic Compressor

Jordi Estevadeordal
ISSI, Dayton, OH
Steve Gorrell
Brigham Young University
Steve Puterbaugh
Air Force Research Labs, WPAFB

Details of the unsteady flow field between an upstream stator and a downstream rotor in a transonic compressor are obtained using Particle Image Velocimetry (PIV). PIV data facilitate analysis of vortex shedding, wake motion, rotor incidence, and bow-shock interaction phenomena in the blade row. Such analysis not only aids the understanding of the effect of blade-row interactions on compressor performance but also allows verification of time-accurate CFD codes that are used to characterize transonic compressors. Rotor-bow-shock strength varies with the axial distance between the stator and rotor and the operating condition. Wake topological features and details of the bow-shock interactions are captured for various conditions. Results show how vortices are shed as counter-rotating pairs in the stator wake synchronized with the rotor blade positions and how the bow-shock turns to normal on the stator pressure surface, validating a prior significant observation made with time-accurate CFD.

Hydrodynamic Performance and Wake Structures of Flapping Foils Undergoing Different Pitch and Plunge Motions

Charles Webb and Haibo Dong
Wright State University

There is currently an ongoing effort to develop bio-inspired flight for micro air vehicles (MAVs) that can match the hovering and maneuvering performance of winged insects, which are nature’s best answer to the perfect small-scale flying machine. Flapping foils are being considered for lift generation and/or propulsion in MAVs. As a part of this effort, computational fluid dynamics (CFD) is being used to examine the fundamental fluid physics and explore the design space of such wings. In the current study, we describe a sequence of numerical simulations that explore the effect of pitch-plunge frequency on the vortex structures and hydrodynamic performance of airfoil SD7003 in both steady and unsteady flows (gusts). The development and stability of the leading-edge vortex are examined for different pitch-plunge flapping frequency ratio, and different pitch pivots. Dye-injection results conducted in the Horizontal Free Surface Water Tunnel (HFWT) at VAAA/AFRL are used for the validations.

Estimation of Optical Path Difference using Particle Image Velocimetry Measurements over a Flat Aperture Turret

Ryan Schmit
Air Force Research Laboratories, WPAFB

Particle Image Velocimetry (PIV) images were taken over a flat aperture turret in the Subsonic Aerodynamic Research Laboratory (SARL), Wright-Patterson Air Force Base. 3D PIV images of the flow field over the turret were captured at Mach 0.2 along the centerline of the turret in the streamwise plane. The turret is 12 inch in diameter with a 5 inch diameter flat aperture at an elevation angle of 90 deg and azimuth of 90 deg. The PIV results show that the shear layer over the aperture was on average 0.5 inch thick. A methodology was developed to convert the instantaneous velocity measurements from the PIV images into instantaneous index of refraction measurements. After ray tracing a beam through the shear layer, an estimation of the Optical Path Difference Root Mean Square (OPDrms) was determined. The result produced was in good agreement with optically measured OPDrms results from Gordeyev et al.

Spatially Resolved Temperatures of a Dielectric Barrier Discharge Using Emission Spectroscopy

Scott Stanfield and James Menart
Wright State University
Charles DeJoseph, Roger Kimmel, and Jim Hayes
Air Force Research Laboratories, WPAFB

Dielectric barrier discharges (DBD) can be used as flow control devices that through momentum coupling are capable of altering the gas flow around them. In this work emission spectroscopy which is a non-intrusive technique is used to spatially resolve the rotational and vibrational temperatures of the discharge region of the DBD. The results show that the rotational temperature obtained for N2 is different than that obtained for N2+ even though the distributions of the rotational energy levels of both species are Boltzmann. One possible explanation which is dependent on the chemical kinetics and the spatial and temporal structure of the discharge is explained. The results also show the rotational temperature of both species fluctuating in a periodic manor within the gap of the discharge and slowly damping out in the flow direction. The cause of these fluctuations along with the implications to the induced flow is given.

Nanoparticle Synthesis by Plasma Vaporization: Effects of Swirl on the Flow Topology and Dye Injection Rates of the MiniTorch Cold Model

Michael Schneider
Stagier at the von Karman Institute for Fluid Dynamics/University of Dayton

Nanoparticle synthesis via inductively coupled plasma vaporization of micron scale particles and subsequent homogenous nucleation, through a quenching process, is theoretically possible. The MiniTorch facility at the Von Karmen Institute is a test bed for this process. The effects of swirl on the flow topology were studied using flow visualizations via dye injection in a water model. Using the WT-1 Water Tunnel and a scale model, a Reynolds number comparison simulation was performed. Axial rotation was induced by a perforated cap swirl generator to determine the effect on the stability of the recirculation zones. Investigations into the minimum central injection dye mass flow rate required to penetrate these recirculation zones, for certain injector lengths and Reynolds numbers, were also undertaken. CFD simulations were also performed to compare to MiniTorch CFD models. The swirl had negligible effect on the central injection and the minimum mass flow rates share an exponential relationship.

<u>Electronics/Sensors II</u>: **1:00-3:20 PM** **Room E156C**

A Novel Fast locking Phase lock Loop

Michael Myers and Raymond E. Siferd
Wright State University

Phase Lock Loops (PLL) are the essential blocks for digital communication receivers and clock generators in system-on-chip designs. In this paper a novel PLL implementation demonstrating fast acquisition and low jitter characteristics is shown. This is accomplished through the use of a nonlinear gain unit designed and implemented based on an intelligent control algorithm. The controller is a nonlinear proportional controller, allowing a large gain to reduce the locking time and a small gain for noise reduction. The proposed design obtains jitters of 200 fsec and lock times of 200 nsec.

A Simple Robust Method for Creating a Non-Contact High Rate Optical Extensometer

Bryan Harris and Jian Gao
University of Dayton
Benjamin Tran
Wright State University

An extensometer is a device that accurately measures the relative motion of two points on a stretching object or material specimen. This presentation discusses a method of position measurement similar to an optical encoder. A pattern of light and dark lines of known width are attached to or painted on the object to be measured. The lines are then illuminated by a He-Ne laser with a spot size equal to or smaller than the line width and/or spacing of the pattern. As the pattern of lines shift, the laser beam is then reflected and its optical power is measured by a photodetector. The intensity of the reflected light with a period equal to the spacing of the lines may be multiplied by the line spacing to obtain a displacement. Post-processing may be able to increase the resolution beyond the line spacing by measuring the relative changes in light intensity.

Data Acquisition Systems for Hardware-in-the-Loop Research

Michael Boyd
PCKA

One of the most central parts to a research laboratory is its data acquisition (DAQ) system. Choosing a DAQ system to suit both a budget and the needed capabilities for the area of research could prove a daunting task. This presentation will describe certain systems produced by two leading manufacturers in data acquisition, National Instruments and dSPACE. A description of the capabilities of the two systems and the area in aerospace research they are used in will also be given. Since both systems are real-time simulation and data acquisition systems with similar abilities, a comparison will be made to differentiate the two systems. Some of the comparisons include cost, data acquisition capability, real-time operating system (RTOS) architecture, and software integration with hardware. Since each system has its own strengths, a switching technique was implemented to give the ability to choose which DAQ system best suits the given simulation.

Autonomous Lawnmower Project

Nicholas Baine
Wright State University

The autonomous lawnmower project had three goals. The first goal was to design and operate an unmanned lawnmower using the art and science of navigation to rapidly and accurately mow a field of grass. Second was to train engineering students in the fields of navigation, sensor fusion, algorithm development, and mechanical design. Third was to develop multi-disciplinary team dynamics, cooperation, and leadership skills. The autonomous lawnmower used GPS and a compass to navigate the field and was equipped with a LIDAR system for obstacle avoidance. Information from these sensors was fed into a control algorithm that output wheel speed and direction to a motor controller, which in turn controlled the speed and direction of the lawnmower. The result of the project was a first place win in the 2007 ION Autonomous Lawnmower Competition.

A continued research on the benefits of directional antennas

Kyle Jurick
Wright State University

Through research and innovation in the 2.4 Ghz spectrum, this project introduces a new method for wireless communication through antennas. Rather than the traditional methods of either a fixed directional antenna, or a fixed omni-directional antenna, a self steering directional antenna has been introduced. The antenna maximizes the benefits of a directional antenna, while also giving benefits of an omni-directional antenna. The overall benefits to such a design are an extended network without the need of amplification, a more secure network, and stronger signal for each user on the network depending on the configuration. For a multi-user network such as a cellular network, antenna integration would be at the client point. For a single-user network such as a point to point satellite system only one self aligning antenna is required that could be placed at the client point or at the distribution point.

Design of UAV Capable of On-Board Power Generation and Surveilance

William Bennet, Jayme Carper, Nicholas Hankinson, Michael Sheridan, Keith Vehorn and Stephen Warrener
Wright State University

The objective of this work was the design, fabrication and testing of a small Unmanned Air Vehicle (UAV) capable of generating power on-board the aircraft as well as conduct ground surveillance operations. The competition requirements were as follows: maximum take-off weight of 15 pounds, maximum take-off distance of 200 feet and maximum orbit time of 10 minutes. The Wright State University team was the only group to successfully generate power on board and had the best surveillance configuration with a movable camera mount. All other teams used on-board batteries to dissipate power and used a static camera The team won the award for Best Design from the competition. The competition was sponsored by the Air Force Office of Scientific Research and hosted by AIAA and AFRL.

Missile miss distance measurements

Jaime Bestard and Gregory J. Czarnecki
Air Force Research Labs, WPAFB

Miss distance is a definitive measure of a missile’s accuracy. Modeling and simulation (M&S) in the test and evaluation (T&E) process relies on indispensable miss distance data. This presentation demonstrates a recently developed approach to obtaining miss distances during live fire test and evaluation (LFT&E). Cameras with non-orthogonal lines of sight provided video for analysis and finding miss distances at a one order-of-magnitude increase in accuracy over previous methods. Stereovision and geometry concepts combined with inexpensive optics and image processing methods were used to analyze video data. Furthermore, the creation of a deployable data collection kit with automated analysis software result in an affordable and easily deployable system available for future LFT&E.

Biomechanics II: **1:00-3:20 PM** **Room E157A**

Intervertebral Disc Replacement Devices

Kara Muckley[1] and Tarun Goswami[1,2]
[1]*Department of Biomedical, Industrial and Human Factor Engineering*
[2]*Department of Orthopaedic Surgery and Sports Medicine*

Intervertebral discs act as cushions between each vertebra, allowing the spine to withstand loads and move properly. Disc problems may develop including degenerative disc disease, herniated discs, and injuries from trauma. Reduced movement and pain is associated with these problems because collapse, spontaneous or post-traumatic tears, and fibrosis of the disc may cause pressure on surrounding nerves. Increased loading or a shift in the way loads are distributed on the vertebrae may also occur, causing irritation and pain as well as abnormal bone growth. When nonsurgical methods are ineffective at treating these disorders, surgical alternatives include decompressive surgery, fusion, dynamic stabilization, and disc replacement. There are many disc replacement devices in different stages of development. The presentation will summarize information available on the devices, particularly the design rationale, materials, range of movement, fixation method, testing, and certification status. A timeline showing evolution of disc replacement devices will also be presented.

Review of the Relationship of Bone Disease to Bone Characteristics

Richard Murdock[1] and Tarun Goswami[1,2]
[1]Department of Biomedical, Industrial and Human Factor Engineering
[2]Department of Orthopaedic Surgery and Sports Medicine

Bone diseases affect bone characteristics through structural and chemical compositional changes. Changes to either of these factors will have a significant effect on the mechanical properties of the bone with the normal result being a weaker, more fragile, bone. Reduced mineral concentrations, especially calcium, and changes to collagen formation have a large impact on the properties of bone. Examining the link between specific bone diseases and their effect on the physical structure, chemical composition, and mechanical properties is essential to understanding the impact of the disease and to assess if treatments to the disease are successful. Furthermore, the nano-scale structure of the bone is essentially the “building block” of the whole bone and should be the starting point for this characterization. At this level, any changes have a multiplicative effect on the stability of the bone. This nano-scale research of bone microstructure will be continued as a Doctoral research project.

Design of Novel Total Ankle Replacement Models

Shawn Gargac[1] and Tarun Goswami[1,2]
[1]Department of Biomedical, Industrial and Human Factor Engineering
[2]Department of Orthopaedic Surgery and Sports Medicine
Ashkahn Golshani
Boonshoft School of Medicine, Wright State University

Total ankle replacement (TAR) has recently emerged as a successful alternative to ankle arthrodesis (fusion). Unfortunately the current models have been plagued by many complications including fractures, loosening, component subsidence, and poor wound healing. We have developed three novel TAR models. The objectives of our designs are to restore normal ankle range of motion and stability, reduce the amount of bone resected, reduce surgery time, and offer an increased implant lifespan. An extensive literature search was conducted, followed by anthropometric measurement of radiographs. Design challenges included the complicated geometry and biomechanics of the ankle, high joint stresses, wear, and surgical constraints. Further work is currently being conducted by the authors and includes finite element analysis, gait analysis, fatigue testing, cadaver studies, and development of surgical technique and instrumentation.

Temporomandibular Joint Disorders: A review of Treatment Options and Implants

Shirishkumar Ingawale[1] and Tarun Goswami[1,2]
[1]Department of Biomedical, Industrial and Human Factor Engineering
[2]Department of Orthopaedic Surgery and Sports Medicine
Gary Ensor
Department of Medical Education, Miami Valley Hospital, Dayton

Temporomandibular Joint (TMJ) is the most used, highly sensitive, and the most complex joint in human body. The Temporomandibular Disorder (TMD) plagues over 10 million people in the United

States alone. The treatment options for TMD range from physical therapy, to several non-surgical, to surgical methods. When non-surgical therapies become ineffective, the surgical methods such as arthrocentesis, arthroscopy, discectomy, or joint replacement are employed. Continuous efforts are put in to achieve minimal invasive surgical techniques. In certain TMD conditions, reconstruction with either partial or total joint prosthesis is the only potential treatment option. Our research focuses on developing 3-D models using CT images of healthy and diseased TMJs for finite element analysis to predict biomechanical behavior of a TMJ implant. This presentation will review information on TMJ anatomy, TMDs, various treatment options, and different TMJ implant designs and their performances.

Dislocation of Total Hip Replacement in Recipients

Samantha Crossen, Jessica Allen, and Tarun Goswami
Wright State University

The hip is one of the body's greatest weight bearing joints. The joint undergoes stresses and strains from normal activity and disease that may cause deformation and extensive pain in the joint, resulting in the need to perform a total hip arthroplasty. Even though, more than 193,000 hip replacements are performed in the United States each year, with an overall success rate of greater than 90 percent, a common obstacle with total hip replacements is the risk of dislocation, occurring within the first eight weeks after surgery. These dislocations are thought to be due to the design of the ball and stem of the replacement joint. Therefore, the geometry of the ball and stem of the total hip replacement needs to be revised to reduce the number of hip dislocations that occur after surgery to improve the quality of life of the recipient.

Total Hallux Metatarsophalangeal Joint Replacement

Allison Van Horn, Alex Sheets, and Tarun Goswami
Wright State University

Severe discomfort to the hallux metatarsophalangeal (MTP) joint, commonly known as the great toe joint, can lead to a lower quality of life. An outward angulation of the great toe results in the phalanges of the great toe overlapping the second toe, hallux valgus. A bunion forms becoming agonizing and can lead to rheumatoid arthritis (RA). There are non-surgical and surgical procedures that can reduce pain and restore better range of motions. Basic treatment is to brace the toe or wear shoes that are less constricting to decrease the forces on the joint. The brace can lead to proper distribution of impact forces on the MTP joint as well as the ankle and leg. The surgical approaches are for patients with RA or injury to the joint. The methods consist of bone spur removal, joint resurfacing, or total joint replacement. A new innovative total MTP joint replacement is therefore needed.

A Test Apparatus for the Characterization of a Festo Pneumatic Muscle Actuator

Jennifer Serres, David B. Reynolds and Chandler A. Phillips
Department of Biomedical, Industrial and Human Factors Engineering, Wright State University

Since their origination in the 1950s as a means to operate low force prosthetic devices, pneumatic muscle actuators (PMA) have been commercialized by companies such as Bridgestone, Shadow Robot Company and Festo. Due to their simple design and operation, the PMAs available from these companies are now utilized in a wide range of environments ranging from medical equipment to industrial workstations with the major challenge being control. A test apparatus has been developed in the Bioengineering Laboratory at Wright State University which allows for experimentation on a Festo PMA. This system contains a Festo PMA horizontally arranged between a load cell and a DC servo motor via a cable and pulley. The PMA is activated by increasing internal bladder pressure, resulting both in peripheral expansion and longitudinal contraction, which is monitored by a linear variable differential transducer. This apparatus plays a key role in the evaluation of proposed dynamic models.

Materials/Materials Processing I: 1:00-2:20 PM Room E157B

Elevated Temperature Oxidation Resistance of Boron Modified Titanium Alloys

Deborah Sweeney and Raghavan Srinivasan
Wright State University

It has been established that the addition of trace amounts (~0.1 wt%) of boron to titanium alloys refines the as-cast grain size by an order of magnitude. Reports also indicate that the room temperature corrosion resistance of the boron containing alloys may be substantially greater than conventional titanium alloys. In this study, the effects of boron addition on oxidation resistance were investigated, since conventional titanium alloys have limited corrosion resistance in air above 600°C. Thermo-gravimetric analysis (TGA) techniques were used to investigate the oxidation of alpha-beta titanium alloys with boron and without boron additions, by exposure to oxygen and air at different temperatures. These findings will be presented in conjunction with the overall characterization of boron modified titanium alloys. Results will include microstructural characterization of the oxide layer and the formation of the alpha case.

Pushout Testing to Determine Fiber-Matrix Interface Properties of Fiber Reinforced Ceramics

Joy Davis
SOCHE

Ceramics are enabling for several high temperature applications, but are brittle and prone to catastrophic failure. A ceramic's toughness can be increased by using fiber reinforcement. Typically the fiber reinforcement is coated to create a weak fiber-matrix interface that increases damage tolerance by causing crack deflection and fiber pull-out. Rare earth phosphate coatings are now being explored because of their oxidation resistance, high melting temperature, and low hardness. Fiber-matrix interface properties can be characterized using several methods including pushout testing. A pushout testing procedure was developed to measure sliding stresses of several rare earth phosphate coatings on sapphire fibers. Results will be presented and discussed.

Ageing response of Boron modified Beta Titanium alloys

Balakrishna Cherukuri and Raghavan Srinivasan
Wright State University

Minor boron additions (as low as 0.1 wt %) to titanium alloys have shown significant grain size refinement. Beta titanium alloys exhibit good mechanical properties and hardenability. In the present study, two boron modified beta titanium alloys (Beta21S and Ti5553) were used to investigate the effect of boron on the ageing kinetics. The alloys were solution treated above beta transition temperature followed by water quenching and subsequent ageing was carried out at different temperatures (480 C to 660 C). The volume fraction and size of the alpha phase platelets were monitored to understand the kinetics of precipitation. Results include microstructures, micro-hardness measurements and X-ray diffraction analysis.

Coatings to Improve Oxidation Resistance of the Uneven Graphitic Structures

Anil Kumar Karumuri, N. Sharma, Eric Lutz and S. M. Mukhopadhyay
Wright State University

Formation of continuous and adherent ceramic coatings such as nitrides and carbides on carbon structures can extend their high temperature oxidation resistance and mechanical strength. However most such coatings involve vapor phase deposition requiring high cost, toxic chemical precursors and releases of undesirable by-products. The goal of this project is to investigate simple, non-toxic solution based dip-coating techniques using nanoscale particles in suitable binders. These are found useful in coating uneven, high porosity graphite structures with a variety of oxidation resistant compositions for different applications. Carbon foams were coated with BN, SiC, and mixed phases. The effectiveness of each coating in reducing oxidation loss of carbon foam has been investigated, and will be presented. Microstructure, composition, and chemical states have been characterized by Field Emission Scanning

Electron Microscopy (FESEM) and X-Ray Photoelectron Spectroscopy (XPS). The quality of films obtained so far, and scope of future improvements will be discussed.

<u>Heat Transfer and Thermal Sciences I:</u> **1:00-2:40 PM** **Room E163A**

Water-Cooled Load Bank for Aircraft Power Systems Analysis

Caleb Barnes and George Diehl
PCKA

Modeling, simulation, and analysis of aircraft power systems often require applying electrical loads to a generator in order to perform desired experiments. Conventional load banks utilize electrical resistors to apply loads which dissipate large amounts of heat to the air. This may become an issue in smaller rooms with insufficient ventilation. To overcome this problem, a new load bank system was designed utilizing water heater elements which will dissipate the heat generated to the supplied process water. This system consists of three 50 kW load banks, each containing ten 5 kW water heater elements. Control demands of the test setup call for both AC and DC variable loads. Any desired load profile may be achieved by activating heater elements individually and varying the current through one heater element in each load bank. The design allows for the full functionality of a standard load bank without significant increase in room temperature.

A Novel Way to Tailor Thermal conductivity of Carbon foams

Mohammad Almajali, Khalid Lafdi, and Omar Huzayyin
University of Dayton, Department of Mechanical and Aerospace Engineering

Much focus has been placed on the thermal management of electronics in recent years. An overall reduction in size of electronic components as well as advances in chip technology, leading to ever higher power dissipation, have increased the necessity for innovative cooling designs using high thermal conductivity heat sinks. While pure aluminum foams and fins have been instrumental in the design of cooling systems, it remains important to find alternative foams with low density, low porosity and high thermal conductivity. In the current study, carbon foams (97% porosity) were copper electroplated for different periods of time to achieve desired copper thicknesses and foam porosity. Samples thermal conductivities were measured and analytical model was developed to calculate the resulted thermal properties and final porosity. The copper coated carbon foam can attain a thermal conductivity of 180 W/mK with final porosity of 0.5. Both experimental and theoretical studies were in agreement

Anisotropic thermal conductivity in adhesive joints

Sabyasachi Ganguli and Ajit Roy
Air Force Research Laboratories, MLBC
Liming Dai
University of Dayton

Currently out of plane thermal conductivity (Kz) in adhesive joints fails to meet the needed Kz at the overall system level. In order to utilize the superior thermal conductivity of the MWNTs along the axial direction; vertically aligned MWNTs have been used in this study. Vertically aligned MWNTs has been partially infused with epoxy. Selective reactive ion etching (RIE) of the epoxy revealed the nanotube tips. In order to reduce the impedance mismatch and phonon scattering at the interface, gold is thermally evaporated on the nanotube tips. Bulk thermal conductivity measurements show marked improvement in thermal conductivity.

Effect of carbon materials on thermal wear of sliding surfaces

Shadab Shaikh and Khalid Lafdi
University of Dayton, Department of Mechanical and Aerospace Engineering

Prediction of surface temperature distribution and control of frictional heat causing thermal wear at the interface pose a big challenge in tribo-system design. A theoretical study was carried out to study temperature distribution for sliding surfaces and a model for thermally induced wear process. The relations for surface temperature for the rubbing bodies were formulated using the moving heat source theory and a thermal wear model was developed based on the aspect of micro-asperity contact at the sliding interface. The model was used to evaluate the wear performance of carbon-composite materials tested experimentally in literature. The results for temperature distribution and wear-rate showed a good matching with experimental work from literature. The study demonstrated the strong influence of frictional heat on the wear process and its effects on the performance of a tribo-system. The influence of carbon materials in minimizing the effects of frictional heat and thermal-wear were also emphasized.

Thermal behavior of a new carbon suspension in polyoelefin oil

Dan DeBrosse and Khalid Lafdi
University of Dayton, Department of Mechanical and Aerospace Engineering
Li Lingchuan
University of Dayton Research Institute

Suspensions of nano-scale particles in liquid (nanofluids) have demonstrated increases in thermal conductivity that exceed the predictions of theories developed for larger-scale particles. These particles also remain in suspension for much longer periods of time. The thermal conductivity of suspensions of thin metal coated carbon nanofibers in poly-alpha-olefin oil was measured using a flash diffusivity technique. The suspensions demonstrated an increase in thermal conductivity up to 75% at a volume fraction of 0.4%. Results are included for several volume fractions and particle compositions.

Propulsion Rockets I: 2:40-3:20 PM Room E163A

Design and Analysis of a Mach 3 Dual Mode Scramjet Engine

Christopher Corbin and Mitch Wolff
University of Dayton
Dean Eklund
Air Force Research Laboratory/RZAT

As space technologies increase, so does the interest in inexpensive, responsive space access. The Quicksat Space Operations Vehicle has been designed as the first element in a Two Stage to Orbit Reausable Launch Vehicle. Quicksat uses air breathing propulsion which enables capabilities which cannot be accomplished with current chemical rocket engines. The first stage is a combination of 6 turbine engines which accelerate the vehicle to Mach 3.75 and 4 dual-mode scramjet (DMSJ) engines which accelerate the vehicle from Mach 3.75 to Mach 8 where staging occurs. The acceleration under turbine power is much less than under DMSJ power. This study will look at the feasibility of operating a DMSJ engine down to Mach 3 by modifying a combustor that has been designed for testing at the Air Force Research Laboratory.

A Comparison of Gaseous and Particulate Emissions for JP8 and Fischer-Tropsch Fuels in a Well-Stirred Reactor

Garth Justinger, Scott Stouffer, Rich Striebich and Charles Tseng
University of Dayton Research Institute
Robert Pawlik and Joe Zelina
Air Force Research Laboratory/RZTC

Interest in alternative fuels has led to the consideration of the Fischer-Tropsch (FT) process for converting non-conventional hydrocarbon feedstocks into a practical gas turbine fuel. The gaseous and particulate emissions characteristics were measured for a Well-Stirred Reactor (WSR) operating on JP8 and a synthetic FT fuel over a range of rich equivalence ratios from 1.85 up to the rich blowout limit.

While the combustion temperatures and major species concentrations were similar for the two fuels, major differences were seen in the sooting characteristics of the two fuels. During the experiment, soot aerosol samples were extracted through quartz filters and the filters were analyzed by using a LECO apparatus to perform Temperature Programmed Oxidation (TPO) to determine the total carbon mass deposited on the filters. It was shown that the soot emissions for the JP8 fuel were 6-12 times higher than those for the FT fuel at the same equivalence ratio.

Biomedical Engineering: **1:00-3:20 PM** **Room E163B**

A Novel Approach to Control the Growth, Orientation and Shape of Human Osteoblasts

Jerry Czarnecki and Khalid Lafdi
University of Dayton, Department of Mechanical and Aerospace Engineering
Panagiotis Tsonis
University of Dayton, Department of Biology

Carbon-based materials are considered to be promising materials as implants because of their unique mechanical and biocompatibility properties. The present study investigates the use of carbon-based materials as a functional interface for medical implants. Results suggest that osteoblast (the bone-forming cells) proliferation and growth rate, determined by fluorescent microscopy, is a function of carbon structure. Furthermore, osteoblasts grown on different carbon-based materials including monolytic and composite types exhibited proliferation that is based on carbon orientation. The use of carbon nanotubes (CNT) as a bone-implant interface is in progress.

Time-series evolutionary experiments using Junk DNA

John Lannon, Shawn M. Hanes and Sridhar Ramachandran
Indiana University SE, Department of Informatics

The emerging field of bioinformatics is the development of methodologies to take advantage for analyzing large biological databases in search of information that can be applied to specific problems in the life sciences. We address the usefulness of the Junk DNA as effective bioinformatics tools towards addressing open problems in genomics, population genetics, and biology in general. Thousands of copies of short interspersed repeats (SINEs) are scattered essentially randomly through the human genome. Although copies of each repeat subfamily are identical at the time of their insertion, they become subject to individual substitutions after insertion. As the relative time of insertion is known for many of these repeats, such "junk DNA" can be used to provide a sizeable number of time-series data points for studying substitution effects in a variety of genomic contexts.

Utilization of Cellular Automata to Predict Osteoblast Growth on a 2D Carbon Veil

Mary Kundrat, Khalid Lafdi, and James Joo
University of Dayton, Department of Mechanical and Aerospace Engineering

Cell, tissue and organ engineering has become an integral part of current advancements in the health care profession. With the overall increase in life expectancy, there is an unfulfilled demand for repairing and replacing dysfunctional organs and tissues. Present day solutions to dysfunctional organs and tissues, involve utilizing materials that carry with them several limitations and disadvantages. This study uses the concepts of cellular automata (CA) to predict the behavior and proliferation of osteoblasts, on two-dimensional carbon veils, to determine the capabilities and potential of employing a carbon based nanocomposite, in various tissue engineering applications. The computational predictions are compared to experimental data to prove the CA accurately forecasts bone cell behavior. The comparison concludes the CA model is beneficial in designing an appropriate biocomposite concept, specifically intended to assist in successful tissue replacement and regeneration.

Implantable Biosensors for Glucose Measurement

Krishna Desai[1] and Tarun Goswami[1,2]
[1]*Department of Biomedical, Industrial and Human Factor Engineering*
[2]*Department of Orthopaedic Surgery and Sports Medicine*

A number of sampling sites are possible for potentially non-invasive sensing and they include saliva, sweat and skin. The use of salivary glucose was investigated to find the blood glucose level but no correlation was found between them. Several researchers looked at the relationship between sweating and hypoglycaemia (Lower Glucose Level), but results from these studies were also not conclusive. Infrared and near infrared analysis has been utilized to monitor the glucose on the surface of the skin non-invasively. Because of problems encountered in all these testing sites, the subcutaneous tissue has been the main focus as the most appropriate testing site for glucose measurement as it has shown that the subcutaneous glucose concentration reflects the blood glucose concentration.

Glucose Monitoring Devices

Carissa Brunsman- Johnson[1] and Tarun Goswami[1,2]
[1]*Department of Biomedical, Industrial and Human Factor Engineering*
[2]*Department of Orthopaedic Surgery and Sports Medicine*

The American Diabetes Association estimates 20.8 million people diagnosed with diabetes mellitus and another 6.2 million that are unaware that they have the disease. Studies performed by the Diabetes Control and Complications Trial (DCCT) concluded that to prevent the complications associated with diabetes, the glucose level in the blood must be maintained in a normal physiological range, especially for those treated with insulin. This requires self monitoring of blood glucose levels by the patient. The FDA has set target accuracy levels for glucose monitors at +/- 5%. Even though the manufacturing of home glucose monitors has become a billion dollar market, there is still no monitor available at a reasonable cost that is capable of this accuracy. This research reviews glucose monitors in both non-implantable and implantable categories, new advancements in bio-sensors technologies, and difficulties in detecting glucose levels.

Alu elements in Cancer ontology research

Shawn Hanes, John Lannon and Sridhar Ramachandran
Indiana University SE, Department of Informatics

Approximately 98% of the eukaryotic genome is made up of regions that do not code for proteins. These non-transcribed sequences, or “Junk DNA”, are widely believed to consist largely of useless DNA leftovers from past evolutionary permutations. However, this so-called Junk DNA is far from useless to bioinformaticians. A major category of Junk DNA within the human genome is the Short Interspersed Nuclear Elements (SINEs) that account for as much as 10% of all genomic sequence. SINE elements are genomic hitchhikers and there are approximately one million copies of the Alu family of SINEs alone. Genomic rearrangements are important causes of both cancer and inherited disease. There is increasing evidence of the involvement of Alus with some of the recurrent chromosomal rearrangements observed in human tumors. We discuss the need for a more comprehensive map of the distribution and densities of Alus throughout the genome to facilitate cancer ontology research.

Bone Morphogenetic Proteins

Carla Thompson[1] and Tarun Goswami[1,2]
[1]*Department of Biomedical, Industrial and Human Factor Engineering*
[2]*Department of Orthopaedic Surgery and Sports Medicine*

Treatment for spinal disorders such as scoliosis and spinal fractures is being revolutionized by bone morphogenetic proteins (BMP). Currently, spinal fusion surgery is the treatment for spinal disorders. Autograft is a surgical technique, which transplants bone chips from the pelvis to the spinal vertebrae in order to fuse the vertebrae. Some problems with bone grafting include: pain from surgical areas, morbidity, and infection. In 1965, Dr. Marshall Urist pioneered the field of osteoinduction by identifying BMP, which is a protein present within the bone matrix that is capable of bone growth. Since

the discovery of BMP, at least twenty BMP family members have been identified with the use of recombinant gene technology. Based on literature reviews, more clinical studies are required to determine the effectiveness of gene therapy and the molecular mechanisms concerning bone formation and fracture healing. Overall, some members of the BMP family have received FDA approval.

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

Effective Laser Shock Peening Process Design

Gulshan Singh and Ramana V. Grandhi
Wright State University

Laser Shock Peening (LSP) is a surface treatment technique that has been applied to improve fatigue and corrosion properties of metals. The ability to use a high energy laser pulse to generate shock waves, inducing a compressive residual stress field in metallic materials, has applications in multiple fields such as turbomachinery, airframe structures, and medical appliances. Monitoring the dynamic, intricate relationship of peened material experimentally is challenging. And with an increasing number of complex applications and stringent requirements for each application, limited experimental and simulations capabilities are not sufficient for effective LSP process design. A comprehensive procedure is required that can perform simulations of multiple treatments of LSP at the same location and sequential LSP at multiple locations, different overlapping configurations of LSP locations, and complex geometries. The goal of this research is to design an effective LSP process to achieve favorable residual stress profiles for improved fatigue life.

Simulating Laser Shock Peening Process

Hemanth Amarchinta and Ramana V. Grandhi
Wright State University

Several processes are being used on aircrafts and other structures to increase their life and inspection time. Laser Shock Peening (LSP) is one of them used now-a-days to increase the fatigue life by including compressive residual stresses into the material. Shot peening, Burnishing were traditionally used in the industry to induce compressive stresses. LSP has the advantage of more depth penetration and covers wide range of geometries. Simulating LSP process is essential, due to the cost involved in performing the tests. Finite Element Method is used in this study to simulate the process and comparisons were made with experiments. LSP is a high speed (in nano seconds) and high pressure (in GPa) process. ABAQUS is used in the study.

Drilling of Cooling Holes through Thermal Barrier Coated Hastelloy using a Picosecond Laser System

Carl Druffner, Scott Cornell and Larry Dosser
Mound Laser and Photonics Center
Sivaram Gogineni
Innovative Scientific Solutions
W.M. Roquemore
Air Force Research Laboratory

As the power output of picosecond laser systems has increased, new opportunities in laser machining have developed. Cooling holes in turbine parts are typically drilled through the engine material using high power (>100+ W), long pulse duration (ms) laser systems. These types of laser systems allow for quick processing, 1 sec per hole, but have the tradeoff of a large heat affected zone with large amounts of recast material surrounding the hole. Picosecond laser systems allow for material removal with a very small heat affected zone with almost no recast surrounding the machined area. In this work, we explored using a picosecond laser system to drill holes in bare and thermal barrier coated Hastelloy. Relevant results and the data analysis will be presented at the conference.

Systems Engineering / Optimization: **3:40-5:20 PM** **Room E156C**

The Emergence of Agent-Based Modeling

Brian Heath and Ray Hill
Wright State Universit

Over the years Agent-Based Modeling (ABM) has become a popular tool used to understand the many complex, nonlinear systems seen in our world. As a result, there are many publications which explain ABM, when they can be used, how to build and analyze them, potential research opportunities, as well as many successful applications. However, these publications do not often go into much depth about the theories and fields that would eventually lead to ABMs emergence. Therefore, it is worthwhile to rediscover what lead to ABM in hopes of providing a clearer comprehension of the field, showing the potential benefits of understanding the diverse origins of ABM, and hopefully sparking further interest into some of the theories and ideas of Computers, Complexity, Chaos, and Cybernetics that resulted in the ABM of today. By reviewing the origins of ABM, new insightful views into the past, present, and future of ABM are shown.

Risk-Based Design Plots for Aircraft Damage Tolerant Design

Heather Dwire and Ravi Penmetsa
Wright State University
Eric Tuegel
Air Force Research Laboratory

Traditional risk-based design process involves designing the structure based on risk estimates obtained during several iterations of an optimization routine. This approach is computationally expensive for large-scale aircraft structural systems. Therefore, the concept of risk based design plots that can be used for both structural sizing and risk assessment are introduced. These plots are obtained using normalized probability distribution models of load and material properties and are applicable for any arbitrary load and strength values. Risk based design plots serve as a tool for failure probability assessment given geometry and applied load or they can determine geometric constraints to be used in sizing given allowable failure probability. This approach would transform a reliability based optimization problem into a deterministic optimization problem with geometric constraints. A flat plate with a center hole will be used as an example to demonstrate the methodology.

Combining object detection algorithms to improve the performance of an automated target detection system

Priya Ganapathy and Julie A. Skipper
Department of Biomedical, Industrial and Human Factors Engineering

In an automated target detection system, object detection algorithms are image and target dependent and algorithms that work best for a certain image and/or target fail to perform optimally on a slightly different image and/or target. We have developed a versatile approach that combines the results of various detection algorithms to optimize detectibility of desired objects in any image. The combined response planes (outputs) from different detection algorithms further accentuate and provide a final confidence measure of target presence or absence. We are assessing different combination schemes to efficiently detect the features of interest. The performance of these approaches depends on their ability to represent conflicts or redundancies between different detection algorithms. The use of 1) Dempster-Shafer evidence theory 2) an average Bayesian classifier and 3) majority voting to combine the individual response planes will be evaluated using receiver operating characteristic (ROC) curve analysis.

Enriched Multipoint Cubic Approximations for Large Scale Optimization

Ronald Roberts and Robert A. Canfield

Air Force Institute of Technology

This research develops an approximation technique to efficiently optimize general problems with nonlinear objective and/or nonlinear constraints. The technique creates a cubic approximation based on a reduced design space of previous design points. The reduced space is enriched using the gradient information at previous design points, if available. The approximated Hessian matrix is significantly smaller than the full-space Hessian matrix, thus reducing required memory. The Enriched Multipoint Cubic Approximation is shown to accurately reproduce the function and gradient values at each previous design point. A scalable design problem for a cantilever beam is used to verify the algorithm for a large number of design variables. Enriched Multipoint Cubic Approximation results demonstrate that as the number of design variables increases, the number of iterations required to converge to an optimum solution does not dramatically increase.

A Model for Multi-Product Demand Forecasting and Production Planning under Uncertain Environment

Singh Prajapati and Xinhui Zhang

Wright State University

Production planning problems play a vital role in the supply chain management area, by which decision makers can determine the production loading plan-consisting of the quantity of production and the workforce level- to fulfill market demand. This study first addresses demand forecasting for the Rittal Corporation Company in Springfield (OH) US, where the demand patterns are seasonal. As every forecast model have two notions related to forecast: (1) forecasts are not exact; (2) forecast over long horizons are less certain than those over short horizons. So, to deal with uncertainty in the demand pattern, forecasting is followed by the stochastic production planning model, in which the total cost consisting of production cost, labor cost, inventory cost, and overtime cost are minimized. The robustness and effectiveness of the developed model are demonstrated by the practical results.

Biomechanics III: **3:40-5:00 PM** **Room E157A**

Application of an Adaptive Simulated Control System for Industrial Pneumatic Muscle Actuators

Maria Gerschutz, Chandler A. Phillips, David B. Reynolds

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

Physical therapy (PT) requires assistive technology to help maintain and restore muscle strength. The PT knee extension task isolates the quadriceps muscle group necessary for knee stability. With diminished muscle strength, patients may require assistance to complete or attempt this common PT task. Recent technological advancements have allowed the incorporation of augmented orthotic devices with industrial pneumatic muscle actuators (PMAs). PMAs are large-scale devices that provide high force assistance with low displacement. Similar to all pneumatic actuators, industrial PMAs have difficulty in control and accuracy. These difficulties are primarily caused by nonlinearities associated with pressure changes in the bladder. An adaptive simulated control system (ASCS) utilizing a phenomenological PMA model and a knee extension physical model was developed. The ASCS was implemented and analyzed for feasibility and control accuracy.

Carbon Nanoparticle Flow Behavior Near Respiratory Mucus

Christin Grabinski, Shadab Shaikh, and Khalid Lafdi
University of Dayton

A numerical study was carried out to study the behavior of nanoparticles within the respiratory system. Many studies have modeled the flow behavior of nanoparticles after inhalation; however, few have studied the effect of the mucus layer that lines and protects the respiratory tract. In this study, the Lagrangian multiphase approach was implemented in computational fluid dynamics software, and a detailed parametric study was performed to predict the deposition of carbon nanoparticles on the mucus layer. This study revealed that interfacial tension caused by a temperature difference between inhaled air and mucus played a significant role in nanoparticle deposition. Specifically, deposition increased with increasing temperature gradient and mucus surface tension, and decreased with increasing inhaled air velocity, humidity, and nanoparticle diameter. An experimental set-up was designed to validate trends found in the model. The results of this study confirm that mucus can affect nanoparticle behavior in the respiratory system.

Bone Tissue Growth on Microcellular Carbon Foam

Elizabeth Maurer and Sharmila M. Mukhopadhyay
Mechanical & Materials Engineering, Wright State University and Applied Biotechnology Branch, AFRL/RHPB
Saber Hussain
Applied Biotechnology Branch, Human Effectiveness Directorate AFRL/RHPB

Graphitic carbon foam is a relatively new material for potential applications in heat sinks, radiators, and net-shape aerospace composites It has interconnected porosity , low density with controllable thermal and electrical properties. Graphite is also a bio-compatible material, but not much research has been done on the possibility of using microcellular foams as scaffolding for in-vivo tissue growth. This study aims at investigating such options in bone implants. Biocompatibility of foam with osteoblasts is being studied. In addition, various coatings on the foam are being investigated to help with the adhesion and proliferation of the bone cells. Mechanisms of cell growth with and without surface treatments are being compared. This will potentially lead to methods of speeding up bone-implant bonding (faster healing) and also enhancement of bond strength and durability.

Biolung

Rikki Chokshi[1] and Tarun Goswami[1,2]
[1]*Department of Biomedical, Industrial and Human Factor Engineering*
[2]*Department of Orthopaedic Surgery and Sports Medicine*

Lung failure can be caused by many chronic diseases like emphysema, asthma and other diseases. Lung transplantation is difficult in lack of donors. Biolung with pulmonary assist device may be an option. Many temporary assist devices are developed but no one device has been proven to be an effective method. Biolung is used during surgical procedures like cardiopulmonary bypass, open heart surgery and also after the procedures to heal the lung. The design goal for this device are to decrease the overall device size and remove areas of blood flow in the fiber bundle to improve gas exchange efficiency and to minimize thrombus formation.

<u>Heat Transfer and Thermal Sciences II:</u> **3:40-5:00 PM** **Room E163A**

Carbon Nano-additives to Enhance Latent Energy Storage of Phase Change Materials

Shadab Shaikh, Khalid Lafdi and Kevin Hallinan
University of Dayton

Latent energy storage capacity was analyzed for a system consisting of carbon nanotubes doped phase change material. Three sample types were prepared: shell wax with single wall carbon nanotubes (SWCNT), multi wall carbon nanotubes (MWCNT) and carbon nanofibers (CNF). Differential Scanning Calorimeter was used to measure the latent heat of fusion. A maximum enhancement of approximately 13 % was observed for wax/SWCNT composite corresponding to 1% loading of SWCNT. The change in latent heat was modeled using an approximation for intermolecular attraction based on Leonard Jones potential. A theoretical model was formulated to estimate the overall latent energy of different samples. The predicted values of latent energy from model showed a good agreement with the experiments. It was concluded that the higher molecular density of the SWCNT and its large surface area were the reasons behind the greater intermolecular attraction for wax/SWCNT composite which resulted in its maximum latent energy.

Global Optimization of an Aircraft Thermal Management System

Chris Allen
Paul C. Krause & Assoc, Wright State University, Air Force Research Labs
Joseph C. Slater
Paul C. Krause & Assoc, Wright State University

Optimization algorithms utilize known information about the system to identify more feasible solutions that meet the requirements of the user. The algorithms require an objective function, or formula that models what is being optimized, in order to begin the search. For example, non-convex objective functions are best optimized using genetic algorithms (GA). They are characterized by their “survival of the fittest” solution processes that are known to efficiently optimize non-linear functions. Aircraft thermal components were modeled using complex Matlab Simulink block diagrams. Using data provided by Lockheed Martin, control areas within the model were located and optimization methods were devised. Optimization software incorporating a genetic algorithm was provided by P.C. Krause and Associates to perform testing. Results showed a decrease in fuel temperatures using the identified thermal control sequences. Data pulled from the GA detailed feasible drainage sequences that decreased fuel temperatures from previously collected baseline temperatures.

Design of an Acoustically Loaded Thermal Protection System for SHM

Randy Tobe and Ramana V. Grandhi
Wright State University
Mark Derriso
Air Force Research Laboratory

Hypersonic flight results in extreme thermal and acoustic loads on a vehicle’s outer surface. Thermal protection systems (TPS) are located at this outer surface to prevent the harsh environment from the main aircraft structure. Therefore, preventing TPS failure is critical for hypersonic flight. Some portions of a vehicle’s TPS are likely to include adjacent panels that are mechanically attached to the substructure. Early detection of fastener failure is critical since it is a main failure mode for these panels. This presentation discusses creation of a methodology which will aid in designing systems that enable effective structural health monitoring of fastener damage. The design process starts with an initial finite element design based on a structure. Then, the healthy and damaged states of the initial design are numerically characterized. Design variables of interest are then selected and optimized to improve differentiation between the healthy state and the defined damaged states.

Interfacial and Capillary Pressure Effects on the Performance of Wax/Foam Composites

Mohammd Almajali, Khalid Lafdi, and Shadab Shaikh
University of Dayton, Department of Mechanical and Aerospace Engineering

A numerical investigation study was performed to study the phase change behavior of wax/foam composite encapsulated in an aluminum casing. Two-energy equation model was implemented in the CFD software. Interfacial effects influencing the heat transfer process at the casing-composite junction and between the wax-foam surfaces within the composite were analyzed. In addition, the effect of capillary pressure developed within the foam matrix and its impact on the heat transfer process was incorporated using an area ratio parameter. The contact resistance at the foam-casing interface and the capillary pressure had a major influence on the thermal behavior of the system. The heat transfer rate was lowered down and the melting area was reduced by more than 30 %. For all the cases analyzed, the temperature profiles for the foam material showed a different pattern as compared to the temperature within the wax, which was due the effect of thermal non-equilibrium

Propulsion and Rockets II: 3:40-4:40 PM Room E163B

An Alternative Fuels Testing Laboratory

James Van Kuren, Mike Capalbo, Rick Haas, Michael Mukai, Jimmy Orbon, Joe Sweeney, and Ryan Underwood

Mechanical & Manufacturing Engineering, Miami University, Oxford, OH

The Alternative Fuels Project is an undertaking by students to perform tests on various types of alternative fuels. This team evaluated testing methods, equipment, and types of fuels for preliminary tests. The testing facility would supplement undergraduate teaching by allowing hands-on experience. The most affordable and versatile engine was a diesel which could accommodate multiple types of fuels. The fuels tested were diesel fuel, biodiesel, and multiple grades of butanol. The properties to be tested were: heating value, engine speed, torque, air and gas flow, pressure, temperature, and efficiency. The equipment needed to find these properties was purchased and implemented into the engine system. The mass flow rate and air-to-fuel ratios were calculated for each fuel type. 100% butanol was found to be the most efficient fuel, followed by biodiesel. Also, 100% butanol and 40% butanol (60% diesel) showed the lowest percentage of carbon dioxide in the emissions test.

Parametric Cycle Analysis of the Meyer Nutating Engine

Karleine Justice

Avetec

The Meyer Nutating Engine is an internal combustion engine with power ranging from 100-150hp and is suitable for unmanned aerial vehicles (UAV), land vehicles and other applications. The two 8 inch disks are connected by a single crank shaft. The crank shaft is Z-shaped and this Z-shape defines the “wobble” or nutating motion of the engine. The Nutating Engine is analogous with a 4-stroke piston-engine and the thermodynamic cycle has components of both the Otto Cycle and the Diesel Cycle. This hybridization is often referred to as a Dual Cycle. The Dual cycle consists of an intake stroke, compression stroke with air moved to an external accumulator, constant volume heat addition, constant pressure heat addition with power, power stroke, and the final stroke being exhaust to atmosphere. A MATLAB/Simulink model of the Nutating Engine has been developed to give a parametric analysis of the thermodynamics involved with the Dual Cycle.

Numerical Study of Two Innovative Scramjet Inlets Design Coupled to a Generic Combustor with a TVC and Using Hydrocarbon and Air Mixture

Faure Joel Malo-Molina and Datta V. Gaitonde

USAF-AFRL Air Vehicles

In this work, two innovative inlets (Jaws and Scoop) are compared to a generic rectangular inlet used as a baseline. Next the baseline flowfield results are averaged and used to conduct a preliminary parametric analysis of ten combustors with different injection locations and/or directions. Once the most promising combustor designs are identified, an analysis is conducted on full scramjet configurations (i.e., inlet and combustor sets). Previous work has examined the baseline and Jaws inlets. A parametric study of combustors has also been done in terms of species mixing efficiency and overall combustion optimization. Forthcoming research has been conducted on a coupling of the three inlets with a generic combustor. The three best combustors will be coupled with each of the three inlets, and an analysis will be conducted of each of the ten cases.