AEROSPACE & MECHANICAL ENGINEERING

2009 COLLOQUIUM 2010

SEMINARS ARE OPEN TO THE PUBLIC

INFORMAL COFFEE PERIOD BEFORE THE SEMINAR IN ROOM 365, ENGR. BLDG.

UNIVERSITY OF NOTRE DAME, NOTRE DAME, INDIANA 46556

SPEAKER: **Professor John C. Bischof**
University of Minnesota
Departments of Mechanical Engineering,
Biomedical Engineering and Urologic Surgery
Minneapolis, Minnesota

TOPIC: **CELLS, MOLECULES AND NANOPARTICLES IN BIOMEDICAL HEAT TRANSFER**

DATE: Monday, March 15, 2010

TIME: 3:00 p.m.

PLACE: 136 DeBartolo Hall

ABSTRACT

Heat transfer plays a crucial role in many biomedical applications in cryobiology (biopreservation and cryosurgery) and hyperthermic biology (thermal therapies). In these applications, thermal excursions are used to selectively preserve or destroy cells and tissues. Biopreservation is an enabling technology to many biomedical fields including cell and tissue banking, cell therapeutics, tissue engineering, organ transplantation and assisted reproductive technologies. Thermal therapies including cryosurgery are increasingly important in all surgical sub-specialties for minimally invasive thermal destruction of tissues for cancer and cardiovascular disease treatment. In this talk work predominantly from our lab will be reviewed focusing on cellular and molecular phenomena that are important in defining outcomes of both cryobiological and hyperthermic biomedical applications. During these applications microscale cellular phenomena linked to viability are mechanistically shown to depend on the heat transfer process in vitro. These events include: cellular dehydration, intracellular ice formation, and membrane hyperpermeability and blebbing. In addition, new approaches to assess molecular targets of heating and cooling using calorimetric and spectroscopic methods (i.e. lipid hydration, protein denaturation and solute segregation) will be discussed. In vivo, new approaches will be reviewed to define gene regulated events (inflammation and apoptosis) and control them with targeted adjuvants such as TNF-a for cancer treatments. Finally, recent work will be reviewed with both iron oxide and gold nanoparticles showing their dramatic potential to both enhance and control thermal therapy outcomes through adjuvant (drug) delivery, tomographic visualization and inductive heating within the body.

NOTE: ***If you are interested in meeting individually with Prof. Bischof, please contact Evelyn at 631-5431***

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SPEAKER: **Andrei G. Fedorov**
Professor & Woodruff Endowed Faculty Fellow
George W. Woodruff School of Mechanical Engineering
Georgia Institute of Technology
Atlanta, Georgia
http://www.me.gatech.edu/MITf-Lab

TOPIC: **TOWARDS A SUSTAINABLE "CARBON ECONOMY" FOR TRANSPORTATION: ENABLING TECHNOLOGIES FOR DISTRIBUTED H_2/POWER GENERATION WITH CO_2 CAPTURE**

DATE: Tuesday, March 16, 2010

TIME: 3:30 p.m.

PLACE: 138 DeBartolo Hall

ABSTRACT

Rising greenhouse gas concentrations in the Earth's atmosphere are driving efforts to reduce anthropogenic emissions of CO_2, and all available pathways must be taken to reduce emissions. However, most efforts to capture CO_2 have focused on concentrated sources such as central power stations, and despite the fact that they contribute roughly one-third of global carbon emissions, distributed (point) sources associated with transportation and distributed generation have been largely neglected. It is nearly universally assumed that emissions from small-scale point sources cannot be directly sequestered in an economically plausible way. This common wisdom will be challenged by first establishing the feasibility of capturing CO_2 from distributed sources with concurrent production of hydrogen. Important requirements of related systems include rapid start-up and transient response to changing power demands, high energy efficiency, and lightweight, compact design.

Several system designs will be analyzed, with special consideration given to a novel CO_2/H_2 Active Membrane Piston (CHAMP) approach to precisely controlling reactions for maximizing hydrogen production and separating it from CO_2. The CHAMP concept meets design criteria in an elegant and cost-effective manner, with excellent prospects for accelerated development and commercialization.

NOTE: *If you are interested in meeting individually with Prof. Fedorov, please contact Evelyn at 631-5431*

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SPEAKER: **Juan J. Alonso**
Department of Aeronautics & Astronautics
Stanford University
Stanford, California

TOPIC: **THE PROMISES AND REALITIES OF MDO (MULTI-DISCIPLINARY OPTIMIZATION)**

DATE: Tuesday, March 23, 2010

TIME: 3:30 p.m.

PLACE: 138 DeBartolo Hall

ABSTRACT

The field of Multi-Disciplinary Optimization (MDO) has now existed for approximately 30 years and much has been accomplished in that period. But has MDO research truly lived up to the expectations that had been setup for it? One could argue that the idea of automatically designing complex multi-disciplinary systems was intrinsically flawed: a view of MDO as a tool to aid the designer is probably much closer to reality. Regardless, many interesting advances have taken place that have enabled truly revolutionary ideas and designs. This talk highlights three separate MDO-related projects from our recent work that pertain to three separate areas of active research in the MDO field. We begin with the introduction of high-fidelity modeling into the conceptual design of helicopter rotors using reduced-order modeling techniques and time-spectral adjoint methods for unsteady periodic flows. We then investigate the possibility of combining models of varying fidelity into multi-fidelity approximations that are amenable to design optimization of low-boom supersonic business jets. We then discuss the management of uncertainty and the analysis of risk in the operation of hypersonic propulsion systems. We end this talk with some conclusions about the remaining challenges in MDO that must be overcome before these techniques are used pervasively in industrial-level applications.

NOTE: ***If you are interested in meeting individually with Prof. Alonso, please contact Evelyn at 631-5431***

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SPEAKER: **Ralph J. Volino**
Mechanical Engineering Department
United States Naval Academy
Annapolis, Maryland

TOPIC: **UNSTEADY FLOW AND FLOW CONTROL IN TURBOMACHINERY APPLICATIONS**

DATE: Thursday, March 25, 2010

TIME: 3:30 p.m.

PLACE: 126 DeBartolo Hall

ABSTRACT

The flow through gas turbine engines is inherently unsteady due to the rotation of airfoil stages with respect to each other. A stationary vane, for example, sheds wakes which impinge on the rotor blades passing downstream. The blades in turn create varying amounts of flow blockage as they move across the passages between the vanes. The periodic pressure, velocity and turbulence fluctuations which result can have a strong effect on both aerodynamic performance and heat transfer. In this seminar, two unsteady flows will be considered. In the first, a surface is film cooled with pulsed jets and subject to periodic wakes from upstream rods. In typical experimental studies the film cooling jets are steady, but in engines periodic pressure fluctuations cause the jets to pulse. Pulsing might also be induced deliberately in an attempt to reduce cooling flow requirements and control jet liftoff. Detailed, time-resolved flow temperature measurements show the unsteady behavior of the jets and their response to wakes. Time averaged surface temperature measurements show the effect of pulsing and wakes on the film cooling effectiveness and heat transfer coefficient. In the second study, the flow through a cascade of very high lift low-pressure turbine airfoils is considered. Unsteady wakes are produced with moving upstream rods. Without flow control the high loading results in massive boundary layer separation at low Reynolds numbers. Separation control is accomplished with a row of pulsed vortex generator jets on the suction surface of each blade. If the pulsing frequency is sufficiently high, separation can be suppressed using very low jet mass flow, even at the lowest Reynolds numbers considered. Total pressure measurements show the effect of the jets on profile loss, and instantaneous velocity measurements show the response of the suction surface boundary layer to wakes and flow control during the pulsing cycle.

NOTE: ***If you are interested in meeting individually with Prof. Volino, please contact Evelyn at 631-5431***