**Department of Aerospace Engineering and Engineering Mechanics**
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**FOR UNDERGRADUATE WOMEN**

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*The Department of Aerospace Engineering and Engineering Mechanics is pleased to offer the following research project for the summer of 2008. Interested students are urged to contact the faculty member(s) directing the project that most interests them. By contacting the faculty member, you can discover more about the project, learn what your responsibilities will be and if possible, develop a timetable for the twelve-week research period.*

# NUMERICAL SIMULATION OF FLOW CONTROL IN SUPERSONIC INLETS

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## Project Description

Shock-wave boundary layer interaction control is critical to the performance and stability of supersonic inlets. The associated strong adverse pressure gradients increase boundary layer thickness (Delery 1986) and the likelihood of flow separation (Hamed and Kumar 1994), leading to reduced inlet pressure recovery and increased distortion at the engine face. Bleed through porous regions (Hamed and Shang 1991) has been used to control flow separation in supersonic inlets, by removing the low momentum flow in the shock-wave boundary-layer interaction regions. Since the flow removed at the various bleed locations is vented overboard, it is desirable to minimize the amount of bleed in order to reduce the associated drag penalties (Wasserbauer et al. 1937). Recent predictions by Anderson et al. (2006) suggest that micro-ramps and micro-vanes could be used to control shock-wave turbulent boundary-layer interactions; however the predicted increase in boundary layer thickness negatively impacts engine face distortion (Hamed and Numbers 1997) downstream of the interactions.

The objectives of the proposed research are to develop and validate a computational bleed model for supersonic inlet flow simulations that can represent steady and unsteady interactions of strong terminal shocks with porous bleed regions. Verification of the bleed model will be accomplished through three-dimensional computational parametric studies that resolve the flow inside the bleed passages in representative configurations used as part of inlet stability systems for mixed-compression supersonic inlets. Comparisons of the computed bleed mass flow, surface pressures and external boundary layer characteristics with bleed holes resolved; to those obtained with the bleed boundary condition invoked will be conducted to validate and identify further model improvements. The assessments will include the influence of outer flow Mach number, and shock strength and position relative to the porous bleed zone on the stream-wise distribution of bleed and/or blowing across multi rows of holes. The developed surface bleed model will be implemented into Wind-USA code and the validation cases will be documented.