Visitor Research Report

Visitor Name: **Mr. M. Brett Pearce**
North Carolina State University

Area of Research: **Planetary Atmospheric Flight**

Period of Visit: **June 10, 2008 through August 8, 2008**

Goal:
The goal of this project was to continue development on a hypersonic aerodynamic program designed to calculate aerodynamic forces and moments in free molecular flow. The program, entitled "FreeMat", was developed with John Fuller (North Carolina State University) under NIA advisor Dr. Robert Tolson, and was geared primarily for aerobraking operations. I was tasked with developing a Graphical User Interface (GUI) and incorporating vehicle rotation into the program. Additionally, I served as support in debugging and code cleanup.

Strategy:
When this project began, I was relatively inexperienced in using MATLAB (the program in which FreeMat was written), so I began by experimenting with a number of tutorials and formulating basic GUI's. Once I had moderate skills built up, I began to create the first rough draft of the final GUI, continuously building programming skill. Once the GUI was outlined, I moved into incorporating the rotational calculations in the original FreeMat driver. This entailed researching the methodology behind the force and moment calculations, and then deriving the required rotational equations. Once derived, the equations were written into the program, and the programs results were checked analytically. When the operating accuracy of the program was confirmed, the driver was integrated back into the GUI, and both the driver and GUI were "polished up" (small tweaks for speed, ease of understanding code, and efficiency) for eventual publication.

Accomplishments:
During the course of this project, I gained substantial proficiency in the MATLAB programming language, particularly in the areas of programming GUI's. I also developed a new code and algorithm to calculate force and moments on a rotating body in a free molecular flow utilizing the FreeMat code. When the code was developed, it was checked against an analytical derivation of a simple case to verify the output. In the process of verification I had to develop a method of using MATLAB, MAPLE, and hand calculations to generate a number of analytical derivations to compare the program outputs. Following verification, the new code was incorporated into the GUI's structure. Under the guidance of Dr. Tolson and John Fuller, we were able to incorporate a number of error checks in the GUI program designed to minimize any possible fatal errors as well as increase speed and efficiency of use for the user.

Future Work:
There are number of areas that future work can continue on this program. First and foremost is the possibility of incorporating a method of calculating the stability derivatives for a given configuration. This was discussed, but was deemed too complex for the time period of this semester. It does, however, remain a viable form of future work on the program. The shading algorithm might also be a point of future work, since the rotational forces were derived under the assumption that shading is the same. When the vehicle rotates, it will introduce a small difference due to the shading changes (I.e., one part swings out of the flow whilst another comes into it). This could be another point for future work, although the law of diminishing returns could rule this out due to the small gains. The difference was estimated to be extremely small for normal rotation velocities and was safely neglected for this, but could be implemented for even more accuracy.

Pending Publications: None

Seminar Presented: No Presentations (Visiting Student)