UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Senior Design Project Description

Company Name	Air Force Research Laboratory	**Date Submitted**	7/31/17
Project Title	Space Debris Mitigation (AFRL_SPACE)	**Planned Starting Semester**	Fall 2017

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project. 250 hours are expected per person. Complete the following table if this information is known, otherwise the Senior Design Committee will develop based on the project scope:

Discipline	Number	Discipline	Number
Mechanical	4	Electrical	3
Computer	2	Systems	1
Other ( )			

Project Overview:

Rocket bodies from decades of launch of satellites into Earth orbit are the largest component of space debris by mass, and they may pose a significant present and future threat to operation of space systems in certain orbits. Most of these objects will remain in place for several more decades before they re-enter the Earth's atmosphere and eventually burn up. The Air Force and others are interested in long term reduction in the number of large rocket bodies in low earth orbits, especially near-polar and sun synchronous orbits, to help preserve and extend the effective use of space. It may be feasible to attach propulsion systems to these bodies, but another, possibly less difficult alternative, is to clear critical orbits and accelerate de-orbiting through drag augmentation of the large debris objects. A specific technical challenge is the final engagement with rocket bodies, and the attachment and deployment of drag-enhancing devices to increase drag by an order of magnitude.

Initial Project Requirements:

This Senior Capstone Design project is to develop a satellite payload that can be deployed from the satellite, positively engage with a representative rocket body and deploy a drag enhancing device while staying attached to the rocket body. It is assumed that the satellite hosting the payload will maneuver near and maintain proximity with the rocket body at an initial distance of 5 meters. For a demonstration, the relative motion between the satellite and the rocket body will be up to 10 cm/s magnitude in translation– in any combination of three axes – and that the body

may be tumbling in one axis with a period of between 5 seconds and one minute (60 seconds), implying body rotation rates up to 60 degrees/s. The cylindrical rocket body will be 2 meters long, with a diameter of 0.75 m and is closed off at each end. The body test article has a mass of between 50 and 100 kg.

A final demonstration will include two major phases, to be conducted in sequence. First, the payload, installed in a simulated satellite, will deploy and separate from the satellite and grapple, capture or otherwise positively engage the tumbling rocket body. Second, while attached to the rocket body, and without having been compromised by the initial engagement, the payload will deploy a drag enhancement device or system. The drag enhancement will be designed to increase the ratio of the area to mass of the assembly (the rocket body combined with the drag enhancer) by 10 times compared to the area/mass of the rocket body alone. The size and mass of the payload packaged in the satellite should be minimized and the area it consumes on the face of the satellite in the direction of deployment should also be minimized. The satellite will include a video camera that may be used to locate and quantify motions of the rocket body. The overall system design should be for operation in space, and should accommodate, but not rely on gravity and atmospheric effects present in the ground demonstration.

Expected Deliverables/Results:

The University Design Challenge will culminate in a ground demonstration of the student designs; the student team will travel to an Air Force facility for the demonstration. A PDR and CDR will be held with the Air Force. A risk analysis and final report will be submitted to the Air Force. (These are not in addition to the UNCC SD requirements, but are in place of them).

Disposition of Deliverables at the End of the Project:

Hardware designs may be kept by AFRL at the conclusion of the ground demonstration, at the discretion of the judges.

List here any specific skills, requirements, knowledge needed or suggested (If none please state none):

(1) Basic understanding of dynamics. (2) Simulation skills to account for gravity and atmospheric effects. (3) Mechanical and Electrical design skills for including evaluation of mechanisms for deployment. (4) Test planning and testing skills to ensure capability of a finished design. (5) A preference is given to US Armed Forces Veterans or members of ROTC detachments.