UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Senior Design Project Description for Fall 2016 Project Title: Opto-Mechanical Design of 1/5th Scale Freeform Telescope (UNCC_TELE)

Supporter: UNCC Charlotte, Center for Freeform Optics

Supporter Technical Representative: ASSIGNED

Faculty Mentor: __X__ ASSIGNED _____ TBD (check one)

Single Team __X__ Dual Team _____ (check one)

Personnel (EN/ET): _____ E, _____ Cp, _____ Cv, __2__ M, _____ SE

(Complete if the number of students required is known)

Expected person-hours: (250 per student)

Description of Project:

Freeform optics allow the near arbitrary redirection of light in three-dimensions. They are poised to revolutionize optical systems for both imaging and non-imaging applications replacing centuries of optical designs based on axial symmetry (flats, spheres, aspheres) with freeform designs. Among the potential advantages of freeform optical systems are: (1) drastically reduced size; (2) reduced sensitivity to positioning errors; and (3) the ability to perform entirely new optical functions. Freeform optics affect both imaging optics such as cameras and telescopes and non-imaging optics such as solar concentrators and freeform reflectors for energy-efficient lighting. While this project focuses on an imaging application – the design and construction of a scaled-down telescope – the concepts are applicable to non-imaging applications relevant to the energy industry as well.

This project is part of a larger project funded by the Air Force Research Laboratory (AFRL) and the Center for Freeform Optics (CeFO, http://centerfreeformoptics.org/) a collaborative NSF I/UCRC between UNC Charlotte and the University of Rochester and 15 non-academic members including AFRL. The overall project is 3-5 years and will culminate in the design, construction and testing of a 250 mm diameter class telescope whose field of view will be set to meet the diffraction-limit for a specific set of up to three operational f/numbers over a wavelength range from the NIR to the visible (500 nm). The system will have light-weighted silicon carbide freeform optics with the primary mirror having a diameter of approximately 350 mm. The project has four prongs: (1) optical design; (2) opto-mechanical design and fabrication; (3) metrology and (4) software integration. This senior design project will focus on prong (2). Senior Design Students will be asked to take an existing freeform optical design provided by the University of Rochester, generate an opto-mechanical design for the large scale telescope, scale that design down by 5x, and design and fabricate a working prototype at that scale. Students will work with and report monthly to and receive guidance from mentors at UNC Charlotte, the University of Rochester, AFRL and other CeFO members.

Initial Project Requirements (e.g. weight, size, etc.):

Some changes to the specifications may be allowed based on early interactions with the optical design team at the University of Rochester and AFRL.

Volume: Circular Cylinder 75 mm in diameter and 75 mm in length

Mass: < 5 kg

Tolerances on Optics: Form: 750 nm P-V; Finish: 2 nm Sa with 250 micron Low Pass Filter; MSF

Errors: 150 nm P-V.

Positioning of Optics: Cartesian Coordinates: ±50 micrometers; Angular (tip/tilt): ±200 micro-radians; Angular (clocking): 0.5 mrad.

Adjustment for System Tuning/Focus: TBD

Expected Deliverables/Results:

The deliverable is a 5x reduced scale freeform telescope and qualitative imaging results. Metrology from Mahr profiler on freeform optics will also be required.

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

Machining; CNC Machining; Ultra-Precision Diamond Machining; Basic Optics – Lenses and Mirrors; SolidWorks (or equivalent) Design; Finite Element Analysis.