SURI Research Proposal Application	
Title of Research Proposal:	Development of a Laser Measurement System for Deployable Structures
Major:	Mechanical Engineering
Select Session:	Ten weeks (6 credits)
Description of Project:	<u>Introduction</u>: The purpose of this project is to develop a measurement system to depict the shape of large deployable truss structures, 40 meters in length, that are planned for use in space as support structures to mount optics, sensors, and antennas. The measurement system will be used to collect test data that will be compared with numerical predictions of structural shape. The research will support a metrology development project being conducted by Dr. Jonathan Black, who is a faculty member in the Department of Aeronautics and Astronautics at the Air Force Institute of Technology. Dr. Black has developed the concept of a hybrid measurement system that combines photogrammetry and laser displacement measurement technologies. The system will be used to determine the three dimensional shape of a deployed truss structure during ground testing and possibly in space. Photogrammetry is a technique where 3-D coordinates are determined from a series of 2-D images. However, photogrammetry can be limited in resolution and frequency response. A laser based measurement system has higher resolution and data capture rate, but requires more time to collect data of each location, making the technique unsuitable for measuring large areas. A hybrid system will take advantage of the strengths of both techniques and is a significant advancement in measurement technology for characterizing large, flexible structures. <u>Proposed Research</u>: This project will focus on the development of the laser measurement system. It is important to note that VMI Cadet Neil Stewart (ME ’09) is currently working with Dr. Black to obtain a summer internship at AFIT to develop the photogrammetry portion of the measurement system. The system requires that the laser be in a fixed position. The laser will be projected onto specific locations using a mirror on a motorized mount. The mirror will be moved using a program developed in MatLab that determines the

	order in which locations are measured to reduce the data collection time. The control program and similar hardware will be integrated with the photogrammetry system at AFIT. <u>Methodology</u>: • Obtain x, y, z coordinates of targets on a 1.3 meter boom which is of similar construction to a larger deployable boom. The coordinates will be obtained using photogrammetry. • Construct a motorized mirror mount that allows altitude and azimuth adjustments. • Create a control program, using MatLab, to position a mirror so that the laser can be moved between targets. • Validate the control program using laser vibrometer and 1.3m boom. <u>Significance of Proposed Research</u>: • Measurement systems and protocols for characterizing large space structures do not exist. • The project offers a significant advance in measurement technology for characterizing larger, flexible spacecraft structures. • Project offers the opportunity to work directly with the Department of Aeronautics and Astronautics at the Air Force Institute of Technology.
Bibliography:	Jenkins, Christopher, ed. Recent Advances in Gossamer Spacecraft. Reston, Virginia: American Institute of Aeronautics and Astronautics, Inc., 2006. Busck, J., and Heiselburg, H., "Gated Viewing and High-Accuracy Three-Dimensional Laser Radar," *Applied Optics*, Vol. 43, No. 24, 2004, pp. 4705-4710. Bopp, H., and Krauss, H., "An Orientation and Calibration

	Method for Nontopographic Applications," *Photogrammetric Engineering and Remote Sensing*, Vol. 44, No. 9, 1978, pp. 1191-1196.
Timeline:	Week 1: Obtain coordinates for measurement locations on a 1.3 meter boom using photogrammetry. Week 2-3: Construct motorized mirror mount and configure motion control hardware. Week 3-7: Develop control program. Week 7-9: Test and revise program. Week 10: Write reports.
VMI & other facilities to be used:	Nichols Engineering Building (Rm. 205) – Nichols Engineering Building (Rm. 318) - Engineering Machine Shop
Date & Time of Submission:	2/15/2008 5:23:04 PM