Marshall Problem/Project Statement - Senior Design Topic

Problem/Project Title: Detail Design and Analysis of a Variable Area, Deployable and Retractable Sunshield

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Indicate which discipline(s) is/are most appropriate to work on this problem (e.g., aerospace, mechanical, electrical, chemical, industrial, civil, computer, physics, materials, test, nuclear, earth science, other)

Mechanical, Materials, Thermal analysis, Stress analysis

Marshall Problem Statement

Background: The big picture with references to previous work (Why would a senior design student be excited about this work?)

Deployable mechanisms are quite common on spacecraft. They range from solar array hinges to engine fuel pumps to hatch mechanisms holding the ISS together. MSFC has a need to develop a deployable and retractable sunshield. The current design, based upon the Near Earth Asteroid (NEA) Scout Solar Sail Deployer, has been prototyped and has a proof of concept. Recent design developments would allow for newly incorporated features such as: a thicker membrane material, a new folding scheme (employing some origami techniques), and a shield spool that allows shield retraction, just to name a few. This system could scale in deployable area, making it appealing to a wide range of space missions. One high profile mission has already invested resources into this development, and many more are showing interest as the design matures.

Recent/on-going research on the problem (What resources, if any, are available to the senior design team, such as equipment, software, facility utilization)

The Sunshield Deployer was designed this past fall and a 3D printed prototype has been assembled and tested with a small proto-board. Before the design can mature much further, analysis must be performed in a few areas:

1. *Stress—what components will fail under launch and what are the weakest joints?*
2. *Thermal—how can we improve the conductive paths to distribute heat from the motor?*
3. *Materials—what materials would be best fit for the structure, bearing surfaces and shield?*

The team may use NASA databases for materials, ES21 printers for prototyping, and ES20 designers as resources to review and improve their models and optimize the design.

Details of the problem; design constraints, requirements (if any), outcome expected. One semester Senior Design course lasts 15 weeks; two-semester course lasts 30 weeks. (What do you expect the senior design team to accomplish?)

Design Constraints and Requirements:

1. System shall deploy and retract a sunshield of at least 36 square meters.

2. System shall deploy and retract at least 10 cycles
3. System materials shall meet NASA outgassing requirements of 1% Total Mass Loss (TML) and 0.1% Collected Volatile Condensable Mass (CVCM)
4. System shall use Composite Booms
5. System shall survive a launch environment given in GSFC-STD-7000, Table 2.4-3.
6. Mechanism shall survive a local environment of -30 to 55 C (therefore components should be sized and selected to meet levels of -50 to 75 C for testing and design purposes)
7. Mechanism shall have at least a 4.0 torque margin (Motor max **driving** torque/max deployment/retraction torque)
8. You have included some operational environment info. Is there is anything else like mass props(e.g, *I*) or vibration concerns

Expected Outcome:

1. Update design to accommodate boom and shield area requirements
2. Select a motor that can meet the torque estimates, thermal and material requirements.
3. Estimate thermal
4. Select shield material and thickness with a conceptual folding scheme
5. Determine high stress areas in primary structure and ideas for reducing loads/stresses
6. Estimate Mass, Volume and Power Requirements.

Senior Design Project Rules:

1. Weekly telecons will be scheduled to maintain proper progress and prevent dead-end ventures.

2. Deliverable(s) required (e.g., one semester course – a written final report; two semester course – written final report and a prototype/model (if practical))