CARLETON UNIVERSITY

Department of Mechanical and Aerospace Engineering
AERO 2001

Fall 2020 Design Project

Satellite Shield

Assigned: Assigned Sept. 14, 2020.

Sept. 17: Groups Selected

Oct. 1: Project Proposal Due

Oct. 22: Conceptual Sketches and Design Due.

Dec. 1: Design Presentation

Dec. 11:

Design Report and Drawings: due 16:30 , Friday, Dec. 11, 2020 – to be submitted electronically to culearn as a PDF.

CAD model of completed design: Final modifications to a project shared with the TA can be made until 16:30 , Friday, Dec. 11, 2020. To be submitted electronically in culearn.

Peer and Self Evaluation: due 16:30 , Friday, Dec. 11, 2020 – to be submitted electronically to culearn as a single word document or PDF.

Objective

Teams of three to four will design a deployable radiation shield for a CubeSat. Designs will be evaluated for their creativity, practicality and completeness of design details. The design must also satisfy the constraints set out below.

1 Design Requirements

A CubeSat is a small, cubic Satellite weighing about 1 kg and measures about 10cm on a side (see https://www.asc-csa.gc.ca/eng/satellites/cubesat/what-is-a-cubesat.asp). For a particular science experiment, a CubeSat requires a deployable shield that will be positioned between the satellite and the sun, so that radiation reaching the satellite is only from the Earth (or outer space).

The shield itself is made of a thin material that can be assumed to have the same mechanical properties as a 12-micron thick Mylar (like a typical "emergency blanket").

You are tasked with designing a mechanism that will allow the shield to be inside the cube at launch, deploying once in space so that it is a 40x40 cm square, oriented with one face directed at the center of the satellite, and held exactly 40 cm away as shown in the sketch at the end of this document.

The design must meet the following requirements and constraints (as part of your proposal stage, you will expand on these and make them more specific to your own design)

1.1 Requirements and Constraints

- During launch, the entire mechanism and the shield must fit inside a 10cm x 10cm x 2cm volume. Less volume is better.
- It should be as light as possible while still being robust.
- Deployed position should hold the shield at the correct position.

You are tasked with the **mechanical design only**. You should design the details of the stowed and deployed positions, and how the mechanism fits together. You should also design the mechanism by which the deployment occurs (a hatch, flap, etc.) and the points of attachment between all parts of your design and the CubeSat body. However, you need not concern yourself with details like how the deployment is triggered or powered, nor how the satellite maintains is position relative to the sun.

Note that similar designs to this may exist. You can borrow ideas from such sources, but you must clearly indicate your sources with proper citations. **You must make clear that you are not taking credit for someone else's existing idea,** but you are allowed to use existing ideas to inspire your work.

This is a detailed conceptual design with 3D CAD model, working and assembly drawings, but you are **not required to build a physical model**.

2 Deliverables, Deadlines, and Evaluation

There will be 6 components to the project evaluation:

Project Deliverables	Due Date and Submission Details	Grade
2.1. Project Selection Proposal	Submit to TA in scheduled CAD Lab Oct. 1, 2020.	0%
2.2. Concept Sketches	Submit to TA in scheduled CAD Lab, Oct. 22, 2020.	10% of project (2% of final mark)
2.3. Concept-of-Design Review	Present to TA in scheduled CAD Lab, Oct. 22, 2020.	15% of project (3% of final mark)
2.4 CAD 3D Model	Submit to TA in scheduled CAD Lab, Dec. 3, 2020.	10% of project (2% of final mark)
2.5. Design Presentation	Present to TA in scheduled Labs, Dec. 1&3, 2020.	15% of project (3% of final mark)
2.6. Design Drawings & Report	16:30 Fri. Dec. 11, 2020: submit a single PDF (one per group) containing complete report and all drawings.	50% of project (10% of final mark)
2.7. Self and Peer Evaluations	16:30 Fri. Dec. 11, 2020: submit as a PDF or Word file to culearn (one per student).	

Expectations for Project Deliverables

2.1. Project Selection Proposal:

a) The Proposal MUST have a title page. The title page must contain the following information: course name and number (e.g., Engineering Graphical Design, MAAE 2001); project identification (name of project); the submission date of the proposal; Project Group number, names & student numbers of group members, and date are to be positioned at the bottom center part of the title page.

b) The text of the proposal itself is limited to one (1) page (two pages including the title page).

c) The writing is to be 12pt with a minimum of 2.5 cm margins all round on 8.5 x 11 inch paper.

d) The Proposal **MUST BE SUBMITTED AS a PDF**.

e) The proposal must:

- Succinctly summarize the design problem as given in this document
- Define the design criteria/requirements, including
    - Performance standards to be met by the design (ideally numerical values of performance parameters). This should be in addition to those requirements set out in this document: they are specific to your group's planned approach to the problem.
- Define the design constraints:
    - Restrictions and limitations placed on the design by the team (e.g. robust, lightweight, etc.)

2.2. Concept Sketches:

a) The Concept Sketches MUST have a title page. The title page must contain the following information: course name and number (e.g., Engineering Graphical Design, MAAE 2001); project identification (name of project); the submission date of the proposal; Project Group number, names & student numbers of group members, and date are to be positioned at the bottom center part of the title page.

b) The Sketches **MUST BE SUBMITTED AS PAGES OF A SINGLE PDF FILE**.

c) Identify preliminary/conceptual solutions to your design problem. Each group member MUST contribute at least two, preferably more, conceptual solutions.

d) Sketch the conceptual solutions:

- Hand sketches
- Isometric/pictorial and/or 2- or 3-view (hand drawn at this stage):
    - Include notes, overall dimensions, etc. as required
    - Each concept should:
        - Outline the solution to the problem
        - Show the means used to achieve major functions

2.3. Concept-of-Design Review:

a) Select the "best" conceptual design, based on reasoned and quantifiable arguments. You will justify this selection to the project TAs via a timed **5-minute** on-line presentation during the CAD lab on **Oct. 22, 2020**. There will be another 5-minutes during which time there may be questions posed to the group.

b) Your presentation should highlight why you made the choices you did, and what you believe will be the advantages of your final design. You should present your work with a set of slides as well as through an oral presentation

c) Any number of members of the group may speak during the presentation, but all must participate in its preparation and be on-line during the presentation.

2.4 CAD 3D model

A virtual prototype is to be submitted as a detailed CAD model. The prototype should be a complete assembly of your design. Note that this is an additional requirement to the requirement of engineering drawings as part of the report, below. It is to be shared with your TA in a manner similar to your CAD assignments through the term.

The virtual prototype will be graded based on completeness of the modelling effort. You will also have an opportunity to present this work in order to convince the evaluators that the design will work as intended; the 3D model should be sufficiently detailed to demonstrate this.

2.5: Design Presentation

A 7-minute on-line presentation (plus 3 minutes for questions) will be used to explain your final design to the evaluators. It should include:

- how the design works and a description of its key features
- how the design clearly meets the specifications and requirements of the task
- You may choose to include renderings, exploded, views, animations, etc, as a way to clearly communicate your designs details and performance.
- One slide should summarize the contributions of each team member to the overall project.

2.6. Design Drawings and Report:

Drawings:

a) Use CAD to finalize your design by developing a "layout" model. Rendered isometric views of your layout should be included in the body of your report, as described in the sections below.

b) Using the drawing facility in CAD, generate a "3-view" layout drawing of your design, an assembly drawing, and working drawings for each part, detailed enough so that the component can be manufactured. See Earle – Chapter 12 for information on dimensioning and Chapter 15 for information on working drawings. These drawings are to be appended to your report, as described in the sections below.

Report:

The report should provide a description of your design such that the reader can understand your design and how it works. The report should be formatted as follows.

a) The report **MUST** include a title page, a table of contents page, the body of your report **(NOT TO EXCEED 3 PAGES OF TEXT)**, a references page, a page for the "3-view" layout drawing of your design, a page for the assembly drawing, and as many pages as required for the working drawings for each part.

b) The writing and presentation are to be of good quality, free of spelling errors, well-formatted and pleasing in appearance.

c) The writing is to be 12pt with a minimum of 2.5 cm margins all round on 8.5 x 11 inch paper.

d) The final report **MUST BE SUBMITTED AS a PDF.**

Specific details for each page/section are as follows:

- Title page. The title page must contain the following information: course name and number (e.g., Engineering Graphical Design, MAAE 2001); project identification (name of project); the submission date of the proposal; **Project Group number**, names & student numbers of group members, and date are to be positioned at the bottom center part of the title page.
- Table of contents.
- Body of the Report:
    - Introduction:
        a. Identify the design problem (need) selected.
        b. Provide general background that will help the reader understand the problem.
        c. Introduce the following sections of the report.
    - Description of Design:
        a. Requirements/constraints (specific to your approach).
        b. How does it work?
        c. How will it be manufactured/assembled, what is it made of, etc.
        d. Refer to rendered views and/or other drawings as required.
    - Summary/Recommendations:
        a. Assess and summarize the design. Was the design problem solved?
        b. Discuss any improvements required, anything else that should be done to make the design better.
- References: cite references where appropriate.
- 3-view Layout Drawing.
- Assembly Drawing.

- Working Drawings for all parts.

2.7. Self and Peer Evaluations (individual weighting)

All group members will complete a confidential evaluation form rating the overall quality of their own and their fellow team members' work on the design project portion of MAAE3901. This will be used to weight individual grades. In this way, students who contribute significantly less than the average will be penalized accordingly, while students who contribute significantly more may receive additional points.

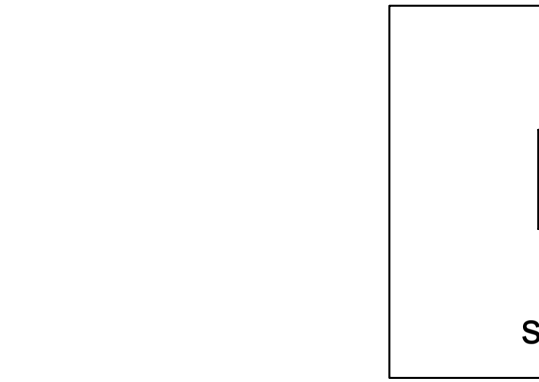
3 Marking

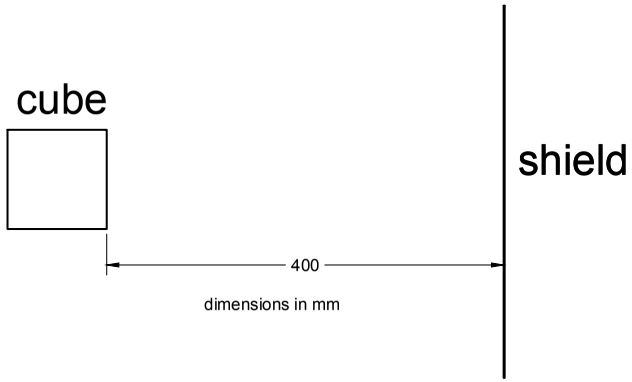
As noted in the course outline, the project is worth 20% of your final grade. The mark will be based on the quality of each component of the project and the requirements as described above. However, your Final Design Report will not be returned, so keep a copy for your own record.

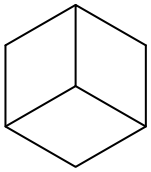
4 Questions and clarifications

It is often the case that project groups ask clarifying questions regarding the design project. To remain consistent, a discussion topic on the cuLearn forum shall be created regarding the design project. All questions should be posted there. From time to time, it may be necessary to clarify the interpretation of the rules. This will also be communicated through the cuLearn discussion forum.

Appendix: Schematic of deployed position of shield relative to cubesat







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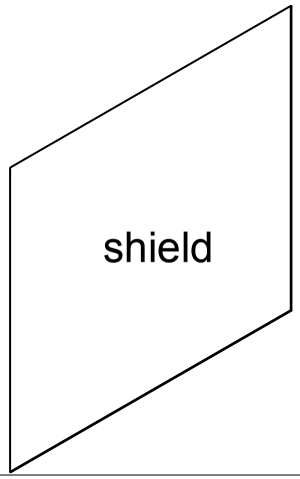

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