MESA
Math · Engineering · Science
Achievement

Moon Base

MESA Day Competition for 2022-2023

What makes a successful MESA Civil Engineering competition?

1. A project that is exciting for students who may be intimidated by other MESA competitions

2. Hands-on and integrates civil, mechanical, and construction engineering

3. Easy for Advisors to guide students
   a. Accessible
   b. The materials are not intimidating for students and teachers

4. Everyone feels accomplished

5. Family friendly - families can be engaged in the project

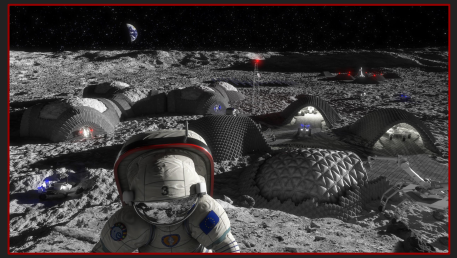
Overview

Your task is to design a safe structure to house new moon-based research activities. Students will design and construct an original structure using only recycled cardboard that can withstand the highest amount of impact, is lightweight, and meets the specific size requirements outlined in the Rules.

Levels: Middle School & High School

Divisions:
6th, 7th/8th, 9th/10th, 11th/12th Grades

Composition of Teams:
2-3 Students Per Team



Materials

The ONLY allowable material is deconstructed, post-consumer, not plastic coated, unpainted cardboard without seams with up to a maximum 5mm thickness per piece of cardboard (e.g. layering of cardboard is allowed per Rule #2).

Joints and Connections

What is allowed to create joints and connections?

Carved, mortise, and tenon, or other systems using exclusively cardboard or paper products are allowed.

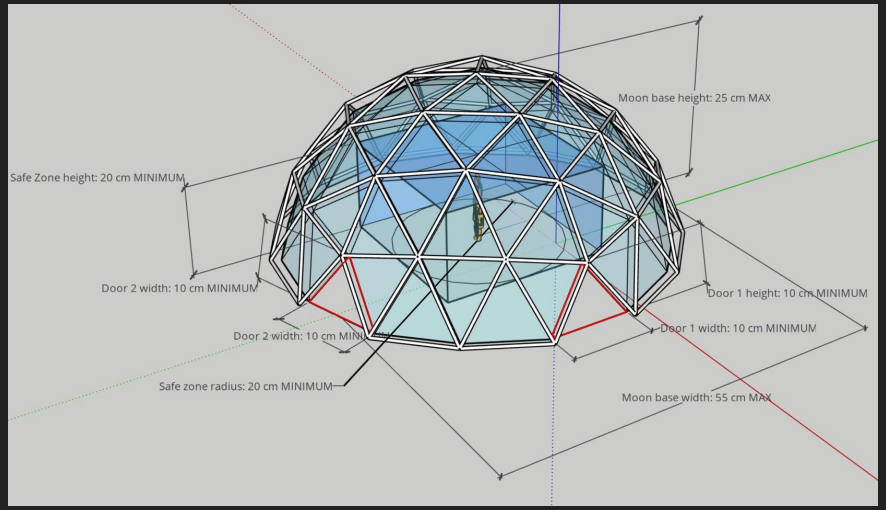
What is NOT allowed?

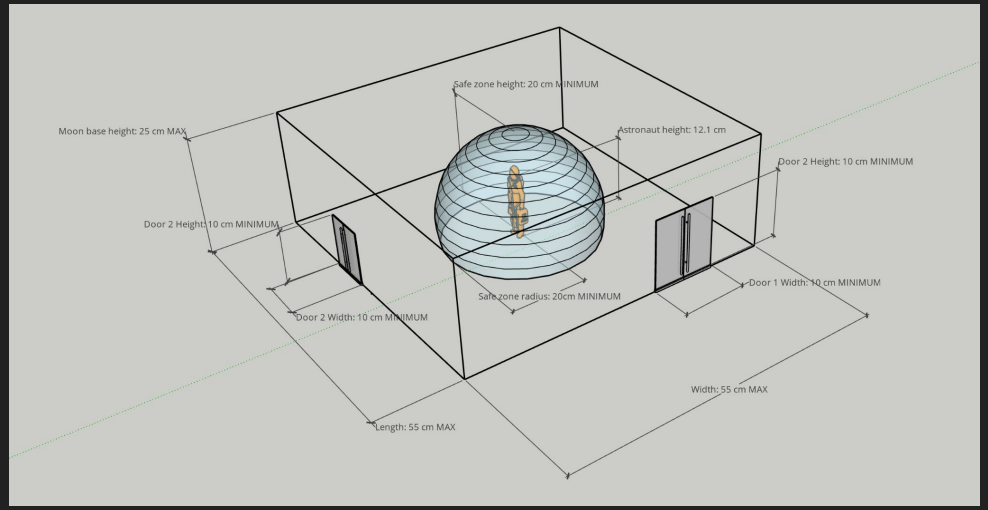
No glue, tape, or other external adhesive of any type can be used in any way or form.

Structure Specifications

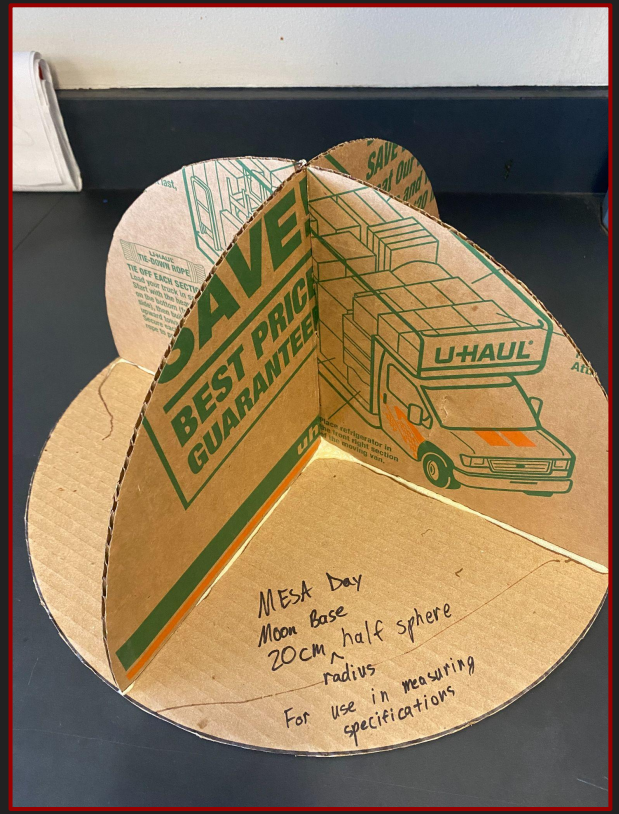
Rules 4-6

1. Maximum length = 55 cm; Maximum width = 55 cm; Maximum height = 25 cm
2. Minimum interior clearance = must fit a 20 cm radius half sphere in the center.
3. Maximum Structure Weight = 600 grams (HS), 800 grams (MS)
4. Structure must have two openings (doorways) of any shape with a MINIMUM dimension of 10 cm across and 10 cm in height.
5. The entire structure must NOT have a base/floor.





Safe Zone Measurement Tool & Checklist



C: INSPECTION AND SCORE SHEET FOR MOON BASE

High School – Grades 9/10 and Grades 11/12

Student Names: _____

Grade: 9/10 or 11/12 (circle one)

School: _____ Center: _____

INSPECTION LIST:	YES	NO
Only recycled, deconstructed, post-consumer, not plastic coated, unpainted cardboard is used.....	☐	☐
No glue, tape, or other external adhesive of any type is used.....	☐	☐
Width of individual cardboard pieces is no thicker than 5mm.....	☐	☐
Maximum length of the structure is not greater than 55cm.....	☐	☐
Maximum width of the structure is not greater than 55cm.....	☐	☐
Maximum height of the structure is not greater than 25cm.....	☐	☐
Minimum interior clearance has a minimum of a 20cm clearance.....	☐	☐
Maximum structure weight is 600g.....	☐	☐
Structure has two openings (doorways) with a minimum of 10cmx10cm.....	☐	☐
The structure does not have a base/floor.....	☐	☐
Moon Base is labeled properly (students' full name, grade, school name, and MESA center).....	☐	☐

Testing Results

$I/M = m_i * g * (H * 10^{-2}) / m_s$

Where: m_i is the mass of the hitch ball in grams; g is the gravity, 9.81 m/s^2; H is highest impact elevation in centimeters; and m_s is the mass of the competing structure in grams.

Mass of the Hitch Ball (in grams)	Multiplied by 9.81 (force of gravity)	Final Height multiplied by 10^{-2}	Multiply the result in column 2 to the result in column 3	Divided by the weight of the Moon Base (in grams)
		125cm		
Example: 1154g	Example: 1154g x 9.81m/s^2 = 11,320.74	Example: 125cm x 10^{-2} = 1.25m	Example: 11,320.74 x 1.25m = 14,150.925	Example: Structure weight 231g 14,150.95/231g = 61.26

Final Team Score	
Moon Base Labeling Penalty (10%)	-
Engineering Lab Book Penalty (20% or 50%)*	-
Final Score	

* Engineering Lab Book Penalty (see "MESA Day General Lab Book Guidelines")

- ☐ Incomplete = missing 1 or 2 specified criteria = 20% penalty
- ☐ Missing = not submitted or missing 3 or more specified criteria = 50% (not eligible to place in both ribbon and medal categories)

Creative Structures

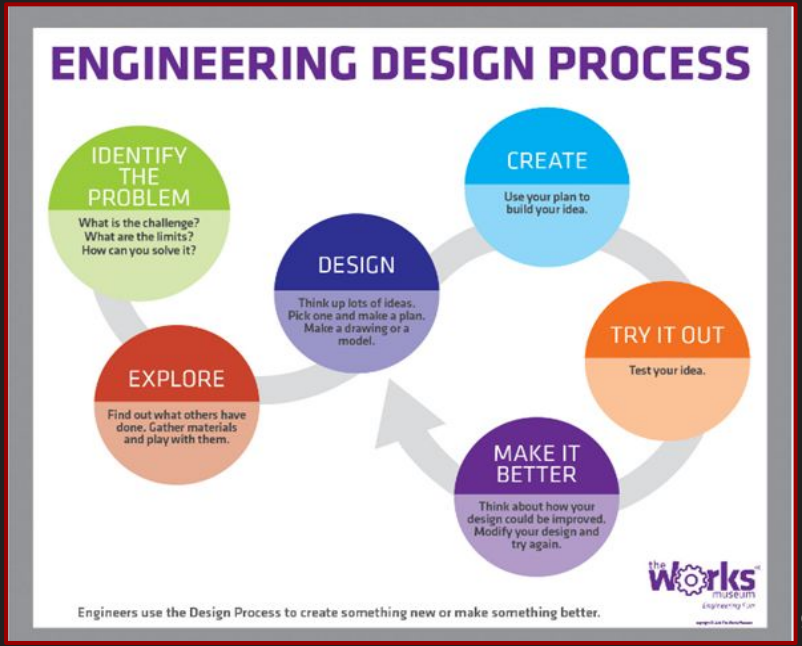
Engineering Lab Book

The lab book is meant to clearly demonstrate and illustrate evidence of the application of the Engineering Design Process in the MESA project.

Electronic submissions will be required. Teams should use an electronic portal/application such as Google Docs to keep and maintain a lab book.

Please check with your local MESA center for the deadline and submission platform to submit your team's lab book for local and for regional events.

A deduction of 20% of the team score will be assessed for an incomplete lab book and a deduction of 50% of the final score will be assessed for a missing lab book.



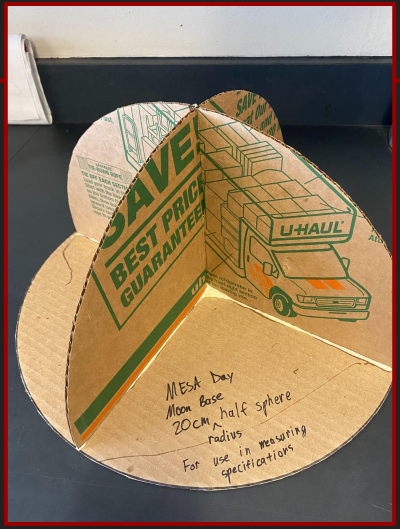
Engineering Lab Book continued…

Criteria	
A	Is the lab book properly labeled? *(Names, Grades, School, MESA Center)*
1	Identify the Need (at least 2 sentences for each) *State what is the challenge being worked on? What are the limits/constraints? How do you think you can you solve it.*
2	Explore *Conducting research (one real world example, description, list 3 cited/referenced sources), gathering materials, try using materials*
3	Design *Brainstorming ideas (at least 3 iterations) each represented by a picture, sketch or drawing. Creating a plan for selected idea (at least 5 sentences). A list of materials for the prototype.*
4	Create *Building a prototype. Describing the building of the prototype (at least 5 sentences). Including a final picture of the project.*
5	Try it Out *Testing idea/prototype. Attempting at least 3 trials/attempts. Measuring each trial result (by specific performance criteria like distance traveled, time, etc.). Providing evidence of the use and application of at least 2 appropriate mathematical concepts in the tests.*
6	Make Better *Evaluate results. List at least five ways project can be improved*

Day of the Competition

Pre Specs Testing

1. The structure receives a specification check to determine whether it conforms to the weight, dimension, and construction rules.
2. The competing structure is weighed and its mass “m_s” recorded in grams.



Testing the Structures

If the structure did not touch the astronaut, the height of the impact will be increased by increments of 25 cm up to 200 cm (i.e., 75 cm, 100 cm, 125 cm, 150 cm, 175 cm and 200 cm).

Judging

1) The structures will be judged by their Impact-to-Mass Ratio, "I/M" calculated as:

   $I/M = m_I * g * (H * 10^{-2}) / m_s$

   Where: m_I is the mass of the hitch ball in grams; g is the gravity, 9.81 m/s^2; H is highest impact elevation in centimeters; and m_s is the mass of the competing structure in grams.

2) A deduction of 20% of the team score will be assessed for an incomplete lab book and a deduction of 50% of the final score will be assessed for a missing lab book.

Post Specs Testing

After the project has been tested, there will be a forensic inspection to ensure that there are no additional materials used on the internal structure and no cardboard is thicker than 5mm. Structures that do not meet the requirements will not place.

Overview of this year's changes

1. Two sets of rules, with the only difference being the maximum weight requirement - 600g for high school and 800g for middle school

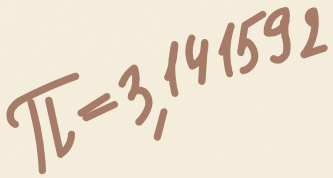
2. Removed the use of "paper products"

3. Structures may not have a base/floor

4. Added two new diagrams to demonstrate that structure shapes can be creative as long as they're within the minimum and maximum requirements

5. Included a Safe Zone measurement tool

6. Included a judges' checklist at the end of the rules



Let’s talk about Moon Base Curriculum!

We set out to create:

01

Updated Rules

Drawing on feedback from 2021-22

02

Resources

Brought together a team to create and organize resources

03

Curriculum

We had the goal of eventually developing out curriculum

Developing Resources: Step 1

We identified four key areas for Moon Base resources:

a. Structural Design/Civil Engineering
b. Material Sciences/Chemical Engineering
c. Computer Science (CAD)
d. Math (Geometry & Physics)

Step 2: We found our experts

Content Experts:

1. Lizzie Hager-Barnard, Director of K-12 Outreach, Berkeley Engineering
2. Dr. Cristian Gaedicke, Engineering Faculty, CSU East Bay

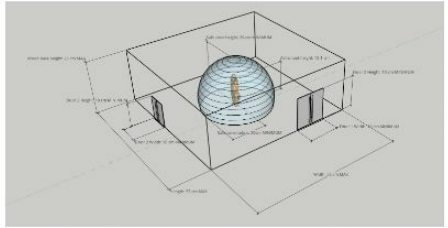
Educational/Curriculum Experts:

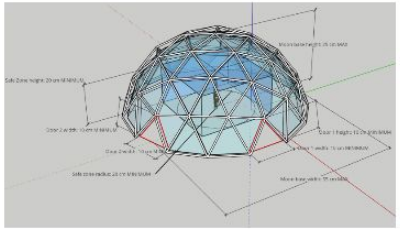
1. Carole Ng, SJSU MESA Advisor, High School Computer Science Teacher
2. Susan Caguyong, CSUEB MESA Advisor, 7th/8th Grade Science Teacher

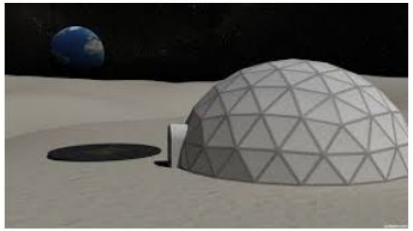
Step 3: Putting it all together

MESA

Moon Base Curriculum







MESA

Curriculum for the Moon Base Project

Were you paying attention?

Let’s find out…

Trivia Time!

Questions?

Thank you for joining us

Before you go, please fill out our survey!