



MESA DAY RULES 2019-2020 (FINAL – REVISED 2/20/20)

Prosthetic Arm

LEVEL:	Middle School
DIVISION(S):	Grade 6 th and Grades 7 th /8 th
COMPOSITION OF TEAM:	2-3 students per team
NUMBER OF TEAMS:	Preliminary – As determined by your local Center Regional – one team per division per Center
SPONSOR:	UCLA MESA College Prep USC MESA College Prep

OVERVIEW: Students will design, construct, and operate a simulated prosthetic arm that can accurately throw as many bean bags into the *Target Zone* as fast as possible. **Participation logistics, limits, and competition facilities may vary by host site. Advisors and students are responsible for verifying this information with their center director.**

An engineering lab book is a required component of this competition. The purpose of the Engineering Lab Book is for students to closely follow the practices of an engineer in the completion of their MESA Day project. The Engineering Lab Book will encourage students to take a purposeful and sustained approach to building their devices. MESA projects are not designed to be completed in a single class period or day, but to be the result of thoughtful research, planning, analysis and evaluation. The notebook should provide a written record of the thought and insight that a student put into their project, from initial ideas to the final completed project.

MATERIALS: For the device, all materials are legal with the exception of hazardous materials. There are no cost limitations; however, awards will be given to the most innovative designs utilizing low-cost materials.

Three format options are available for lab book submittals. See “**MESA DAY 19_20 General Lab Book Guidelines**” at <http://mesa.ucop.edu/>. Please check with your local center director for the format required for your preliminary event. Electronic submissions will be required at the Regional/State level.

The Host Center will provide the following:

- 12 – reinforced bean bags (Nylon Bean Bags Toy Assorted Colors 3.5 Inches x 3.5 inches, 24 Piece) Website: <https://tinyurl.com/y5wfjuo8>
- 1 – Homer All-Purpose Bucket (Home Depot Model # 05GLHD2 or similar)
- “Skee Ball” *Target Zone* taped to floor

GENERAL RULES:

- 1) The students' full name, grade level, school name, and MESA Center must be clearly labeled on the device. A 10% penalty in the score will be assessed for failing to properly label.
- 2) The device must have at least two artificial fingers. These fingers:
 - a. **MUST** open and close. At least two fingers are required to move.
 - b. **MUST** grab and release the bean bag. Team member may **NOT** use any other part of the prosthesis or parts of his/her own hand, wrist or arm to grab and release the bean bag.
- 3) The device must **NOT** be controlled or operated by either of the team member's fingers, hands, or wrists.
- 4) In order to simulate an amputated arm, participating team member must have his/her wrist, hand, and fingers immobilized during the competition. The team will determine own method for immobilization.
- 5) The device (i.e., artificial fingers) may only grab, release, and throw **ONE** bean bag at a time.
 - a. A bean bag that is dropped outside the bucket inside the boundaries of the *Working Area* must be grabbed by the artificial fingers and released back into the bucket before attempting to throw the dropped bean bag.
 - b. Bean bags outside of the *Working Area* are out of play and may **NOT** be retrieved.
- 6) No part of the device may cross the *Launch Line* when throwing a bean bag.
- 7) During the trial, the team member may use his/her unencumbered hand (i.e., non-prosthetic) to hold and move the bucket, but the bottom must remain in contact with the floor and within the defined *Working Area* at all times.
- 8) Digital media (e.g., photos, video recordings, etc.) will not be accepted for arbitration purposes.
- 9) Lab books are meant to clearly demonstrate and illustrate evidence of the application of the Engineering Design Process in the MESA project.
 - a. In addition to the requirements outlined for the Engineering Lab Book, the following should be included in the **DESIGN** section:
 - i. One sketch should be of the anatomy of the human arm and the other sketches of the device. These sketches **MUST** be hand-drawn or student's original computer-generated. Sketches should indicate a progression in the thinking and design of the device and be detailed. Sketches must be no smaller than one page and can either be drawn on the lab book page directly or attached.
 - ii. The sketch of the anatomy of the human arm **AND** the sketches of the device should include the following eight required and correctly labeled structures:
 - Radius/Ulna
 - Flexor Carpi Ulnaris
 - Radiocarpal Joint
 - Carpus
 - Carpometacarpal Joint
 - Metacarpus
 - Phalanges
 - **Tendons**
 - iii. List of materials for your prototype should be listed as a **table** and include materials utilized for the above eight required structures.

Sample Materials Table

Structure	Material
Radius/Ulna	Mailing Tube
Flexor Carpi Ulnaris	Bungee cord
Radiocarpal Joint	Hinge

JUDGING:

- 1) Devices will be checked for specifications prior to the start of the competition. Disqualified teams after this initial check will have an opportunity to compete if they meet ALL of the following conditions:
 - a. Accept an automatic “Mistrial” and therefore no score for Trial #1.
 - b. Make repairs/modifications as necessary to bring the device to proper specifications and be ready to compete when called for Trial #2.
 - c. Make repairs/modifications only in the designated area as indicated by the judges.
 - d. Failure to adhere to any of a, b, or c will result in the disqualification being upheld.
- 2) Teams that are not disqualified but wish to make repairs and modifications may do so, but they MUST be ready to compete when called for Trial #1.
 - a. Repairs are only allowed with duplicate parts and materials.
- 3) Each device will be allowed two (2) non-consecutive trials.
- 4) At the beginning of each trial, team member must demonstrate immobilization (see Rule 4).
- 5) Each device must be ready when called or team will forfeit that trial.
- 6) Each team will be given up to 60 seconds to prepare, attach, and demonstrate prosthetic arm, to place and prepare bean bags inside the bucket, and to place bucket anywhere inside *Working Area*. If at the end of the 60 seconds the team is not ready, the trial will be declared a mistrial and this process will be repeated for the second trial.
- 7) The judge will give the start order and begin the timer.
- 8) The team member will enter the *Working Area* and will have a maximum of 1 minute (60 seconds) to grab and release each of the 12 bean bags. The judge will notify the team when 30 seconds, 20 seconds, and 10 seconds remain.
- 9) The judge(s) will score each bean bag according to its final landing spot after it is thrown (i.e., the final position of the bean bag if it slides) inside each scoring zone. See exception below in Part ‘d’.
 - a. Points will be given for bean bags with an initial and final landing spot inside the *Target Zone*.
 - b. If any part of the bean bag initially lands and finally rests on the border of two scoring zones, points will be given for the lower scoring zone.
 - c. If a bean bag is pushed out of a scoring zone or into another scoring zone by a subsequently thrown bean bag, the initial score given for that bean bag does NOT change.
 - d. NO points will be given for bean bags or any part of bean bags initially landing and resting outside the *Target Zone*.
 - i. NO points will be given for these bean bags that are pushed into the *Target Zone* by a subsequently thrown bean bag.
 - e. The judge’s call regarding scoring is final and cannot be challenged.
- 10) The judge will stop the timer when the last bean bag has been thrown. Or, the judge will call “time” after one minute has passed. The judge will record the time needed to complete the trial.

SCORING:

- 1) Team points-to-time ratio = total points divided by trial time in seconds (00.00)
 - a. Points for each scoring zone (maximum of 1,200 points)
 - i. 30 point zone = circle 75 cm diameter (see diagram below)
 - ii. 60 point zone = circle 30 cm diameter
 - iii. 80 point zone = circle 25 cm diameter
 - iv. 100 point zone = circle 15 cm diameter
 - b. Time needed to complete trial (maximum of 60.00 seconds)
- 2) Maximum of 4 points awarded for two sketches and materials table
- 3) Final Score = best points-to-time ratio plus (+) sketches/table points

- a. The best points-to-time ratio of the two trials will be used
- 4) A deduction of 20% of the final score will be assessed for an incomplete engineering lab book and a 50% deduction will be assessed for a missing engineering lab book.

AWARDS:

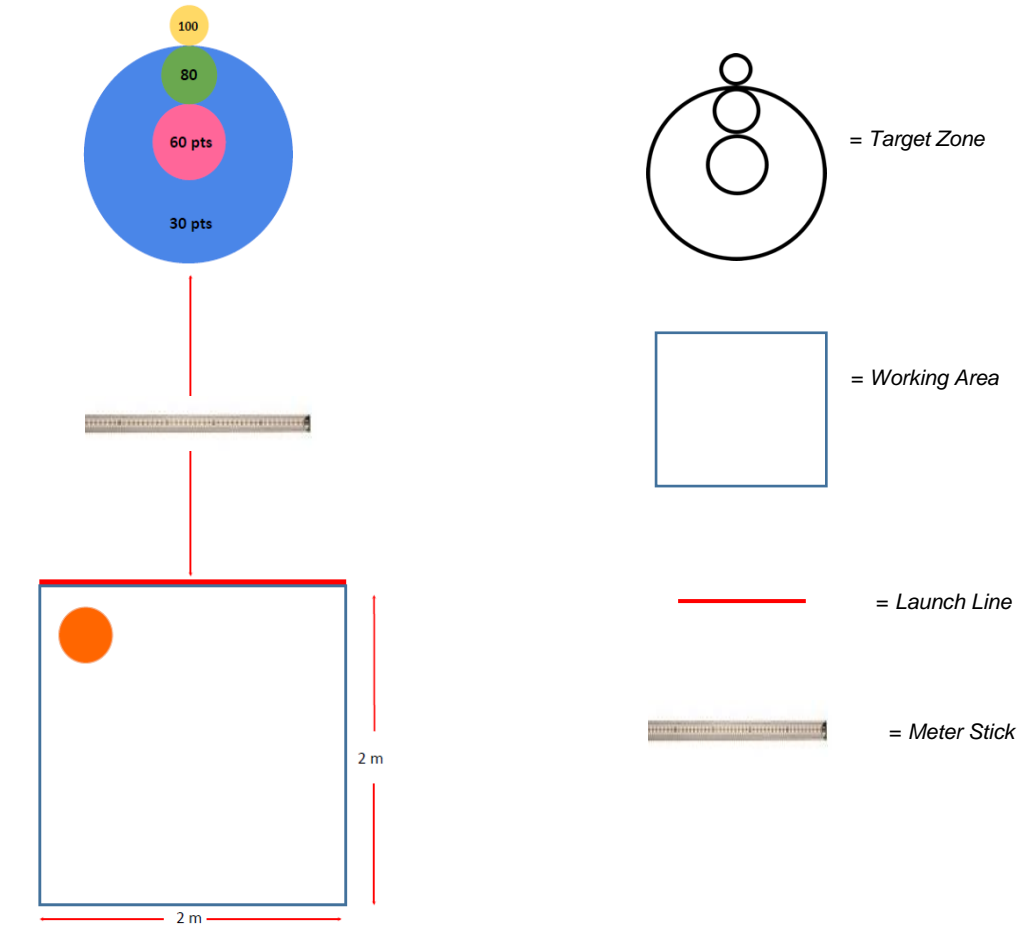
- Awards will be given per division: Grade 6th and Grades 7th/8th
- Medals will be awarded for 1st, 2nd and 3rd place based on the highest Grand Total Score.
- Ribbons will be awarded for Innovative Engineering Design utilizing low-cost materials.
- Only 1st Place teams in the Grand Total Score category in each division will advance to Regional MESA Day.

ATTACHMENTS/APPENDIX:

- Competition Area Specifications
- Equipment
- Judging Recommendations
- Engineering Lab Book Sample Mathematical Concepts
- Inspection & Score Sheet for Prosthetic Arm

Competition Area Specifications

- A 2 meter square will be marked as the *Working Area*. Only the team member actively participating during the task will be permitted inside the *Working Area*.
- One edge will be designated the *Launch Line*.
- A meter stick should be taped on the ground at 1 meter mark between both the Launch Line and Target Zone
- The *Target Zone* is the “Skee Ball” setup indicated in the diagram. Target Zone diagram is attached to rules.



Equipment

- 12 – reinforce ban bags (recommend additional bean bags as replacements)
Oojami Nylon Bean Bags Toy Assorted Colors 24 pieces
3.5 in. x 3.5 in. Website: <https://tinyurl.com/y5wfjuo8>
- 1 – Plastic Homer’s All-Purpose Bucket
(Model # 05GLHD2 or equivalent)
- “Skee Ball” *Target Zone* used in previous year competition
(See attached target diagram for printing)
- Meter Stick
- Measuring Tape
- Masking tape to outline the *Working Area*
- 3 stop watch to record trial time



Judging Recommendations

Five (5) judges are recommended with the following roles:

- Lead Judge – call teams up for trial, remind teams of rules and etc., keep time, announce beginning and end of trial, and make final call regarding scoring
- 1 – Launch Line Monitor
- 2 – Score recorders of thrown bean bags,
- 1 – Time Keeper (in addition to Lead Judge)

Engineering Lab Book Sample Mathematical Concepts

Sample concepts for the Try It Out section of the lab book may include the following:

- Calculate how much work is done by the artificial fingers in grabbing an object using $W = Fd$.
- Calculate the grab and release speed of the artificial fingers by using $d = rt$.

INSPECTION AND SCORE SHEET FOR PROSTHETIC ARM

Middle School – Grades 6 and 7/8

Copies of this inspection and score sheet will be provided by the MESA Day Host Center.

Student Names: _____ Grade: **6** or **7/8** (circle one)

School: _____ MESA Center: _____

Section below to be completed by Judges

INSPECTION LIST:	YES	NO
Device includes at least two artificial fingers that open and close (at least 2 fingers are required to move).....	<input type="checkbox"/>	<input type="checkbox"/>
Fingers grab and release bean bags	<input type="checkbox"/>	<input type="checkbox"/>
Device not controlled by fingers, hands, or wrists of either hand	<input type="checkbox"/>	<input type="checkbox"/>
Team has demonstrated immobilization of the fingers, hand, and wrist	<input type="checkbox"/>	<input type="checkbox"/>
Device labeled properly (students' full name, school name, grade and MESA Center)	<input type="checkbox"/>	<input type="checkbox"/>

Innovative Engineering Design (ranking – 1, 2, 3, etc.): _____

SKETCHES AND MATERIALS TABLE

Structure	Material Listed 0.1 points	Sketch of Arm Anatomy		Sketch of Final Device		Sub Total
		Present 0.1 points	Correctly Labeled 0.1 points	Present 0.1 points	Correctly Labeled 0.1 points	
Radius/Ulna						
Flexor Carpi Ulnaris						
Radiocarpal Joint						
Carpus						
Carpometacarpal Joint						
Metacarpus						
Phalanges						
Tendons						
TOTAL (maximum 4 points)						

TRIAL 1

Score	30 pt. Zone	60 pt. Zone	80 pt. Zone	100 pt. Zone	Total Points
# Bean Bags					
Total Zone Points <small>(zone pts x # bean bags)</small>					=
Trial Time (00.00 secs)					
Zone Points/Time Ratio					
Mistrial Reason:					

TRIAL 2

Score	30 pt. Zone	60 pt. Zone	80 pt. Zone	100 pt. Zone	Total Points
# Bean Bags					
Total Zone Points <small>(zone pts x # bean bags)</small>					=
Trial Time (00.00 secs)					
Zone Points/Time Ratio					
Mistrial Reason:					

Final Score (best of two trials + Sketches/Materials Table Points) _____
 Device Labeling Penalty (10% of Final Score) - _____
 Engineering Lab Book Penalty (20% or 50 % of Final Score) - _____
GRAND TOTAL SCORE _____