

Prosthetic Arm

LEVEL:	Grades 6 and 7/8
TYPE OF CONTEST:	Team
COMPOSITION OF TEAM:	2-3 students per team
NUMBER OF STUDENTS:	Preliminary – As determined by your local MESA Center Regional – 1 for 6 th Grade; 1 for 7 th /8 th Grade per Center
SPONSOR:	Ben Louie, Associate Director, USC MSP Catherine Douglas, Associate Director, UCLA MSP

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.

For the Engineering Lab Book, There are three format options for lab book submittals: Electronic Lab Book, Printed/Written Pages or Standard Lab Book. Please check with you 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, school name, grade 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** 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) Lab books are meant to clearly demonstrate and illustrate evidence of the application of the Engineering Design Process in the MESA project.

JUDGING:

Recommended: 5 judges

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)

- 1) Devices will be checked for specifications prior to the start of the competition. If devices are disqualified during the specification check, design changes will not be allowed.
- 2) 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:

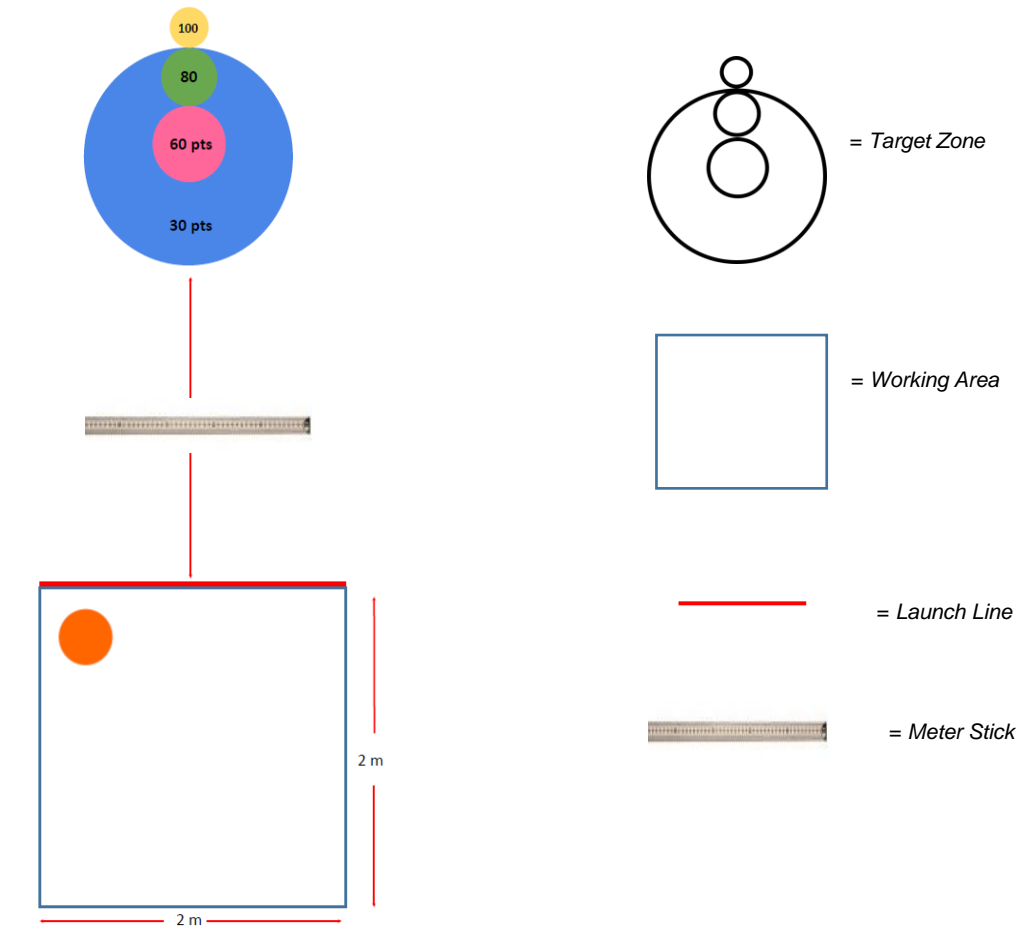
- Medals will be awarded for 1st, 2nd and 3rd place based on the greatest Grand Total Score.
- Ribbons will be awarded for Innovative Engineering Design utilizing low-cost materials.
- Only teams placing in the Total Score category will advance to Regional MESA Day.

ATTACHMENTS/APPENDIX:

- Competition Area Specifications
- Equipment
- Engineering Lab Book
- Inspection & Score Sheet for Prosthetic Arm
- Lab Book Requirement Rubric

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



ENGINEERING LAB BOOK

The Engineering Lab Book must be properly labeled (names, school, center, grade level, etc.) and contain and cover the following sections using the template provided:

1. IDENTIFY THE PROBLEM (at least 2 sentences for each question)

State what is the challenge being worked on? What are the limits/constraints? How do you think you can you solve it?

2. EXPLORE

Find out what others have done (research). Clearly list at least 5 sources (web pages, books, etc.). Identify (cite) and describe them.

3. DESIGN

Brainstorm ideas (at least 3 ideas) and record them. Each idea should be represented by a sketch or drawing.

- 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

Select one idea and create a plan (at least 5 sentences) to build a prototype from. Generate a list of materials for your prototype. Table should list all 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

4. CREATE

Using your plan, build your prototype. Include a picture of the actual project prototype.

5. TRY IT OUT

Test your idea/prototype. Attempt at least 3 trials/attempts of your test. Measure the results of your test (by project performance criteria). Provide evidence of the use and application of at least 2 appropriate mathematical concepts in your tests. This section must include the calculations for both 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 $d = rt$.
-

6. MAKE IT BETTER

Describe how you can make the project better and what modifications you will be making (at least 5 ways you can improve project). Build and prepare competition ready project. Include a picture.

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 _____

MESA DAY 2019-2020*Lab Book Requirement Rubric (criteria may vary by individual competition)***Project:** _____

Please use this rubric to assess lab book entries. An incomplete lab book (i.e., missing 1 to 2 specified criteria) will lead to a 20% deduction from the total project score. A missing lab book (i.e., not submitted OR missing 3 or more specified criteria) will lead to a 50% deduction from the total project score and will make team ineligible to place.

TEAM MEMBER NAMES: _____

SCHOOL: _____ CENTER: _____

LEVEL (circle one): 6th 7/8th 9/10th 11/12th

Section		YES	NO
	Is the lab book properly labeled? (<i>Names, Grades, School, MESA Center</i>)		
1	Identify the Need (at least 2 sentences for each) <i>State what is the challenge being worked on? What are the limits/constraints? How do you think you can solve it.</i>		
2	Explore <i>Conducting research (listing 5 cited/referenced sources), gathering materials, try using materials</i>		
3	Design <i>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.</i>		
4	Create <i>Building a prototype. Describing the building of the prototype (at least 5 sentences). Including a final picture of the project.</i>		
5	Try it Out <i>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.</i>		
6	Make Better <i>Evaluate results. List at least five ways project can be improved</i>		
TOTAL			
Lab Book Complete (mark with X)			

Is this considered an **incomplete** note book (circle one)? **NO** **YES (-20%)**Is this considered a **missing** lab book? (circle one) **NO** **YES (-50%)**

MESA DAY CONTEST RULES 2019-2020 (Updated Version 9.10.19)

Master Set

©University of California Regents

These rules are for the internal use of MESA staff and teachers only and should not be forwarded or used outside of MESA.