



MESA DAY CONTEST RULES 2011 - 2012

Robotic Arm

LEVEL:	Grades 11 and 12
TYPE OF CONTEST:	Individual / Team
COMPOSITION OF TEAMS:	1 - 2 students per team
NUMBER OF TEAMS:	3 teams per Center
SPONSOR:	Ben Louie, Associate Director, USC MSP Center

OVERVIEW: Students will design and build an original robotic arm to grab, lift, and pour a 50 ml graduated cylinder filled with 50 ml of sand into a standard coffee mug. Students will also create a display board that includes a synopsis, scaled plan renderings, and a materials table.

MATERIALS: Any materials, except those that might cause injury, may be used by the student(s), taking into consideration cost and weight efficiency.

The following materials will be provided by the host center:

- 50 ml plastic graduated cylinder (with permanently molded graduations – 26 mm diameter and 200 mm height / 1 in. diameter and 7.87 in. height)
- 50 ml of sand (weight between 71.5 g and 87.4 g / 2.52 oz and 3.08 oz)
- Standard coffee mug
- Standard 6 foot table

RULES:

1. The display board and robotic arm must be the original work of the student(s). Judges may ask questions to verify the authenticity of the display and robotic arm.
2. Both the display board and robotic arm should be clearly labeled with student name(s), school and center. ***If display board or robotic arm is not clearly labeled with student name(s), school and center, a 6.5 point penalty will be deducted from the grand total score.***
3. The robotic arm should perform three tasks: grab, lift, and pour the 50 ml graduated cylinder with 50 ml of sand.
4. Any materials may be used in the construction of the robotic arm, except those that might cause injury. **Robotic arm kits, hydraulic/pneumatic robot arm kits, and any other ready-made arm kits are NOT allowed**; however, parts from kits are allowed. Note that maximum points will be awarded to designs that have the lowest cost to construct and the lowest weight.

5. The robotic arm **MUST** be operated by the push of button(s) or the flip of switch(es) as in a mechanical arm, a push or pull of syringe(s) as in a hydraulic/pneumatic arm, a pull of string(s) as in a Rube Goldberg device, etc. or any combination. **Students may NOT perform the actual function of grabbing, lifting, or pouring** (e.g. students may not grab or lift graduated cylinder with a pair of tongs, may not lift graduated cylinder by pulling up on a string, or may not pour the sand/turn graduated cylinder by rotating a tube with hand). Robotic Arm may NOT be controlled by strings as in a marionette or string puppet.
6. The entire base of the robotic arm **MUST** fit within the *Model Zone*, a 1.5 foot square. Any part of the robotic arm that may be in contact with the table **MUST** be within the *Model Zone*. (See Attachment A: Competition Setup)
7. The display board should meet minimum and maximum size requirements. (See JUDGING # 1a)
8. The display board should be freestanding. The display board should include the following:
 - a) A synopsis of the project of 200 to 250 words should be attached to the front of the display. (See JUDGING # 1b)
 - b) A scaled plan rendering of the robotic arm should be attached to the front of the display. The rendering should include a three-view drawing depicting the robotic arm designed and built that includes dimensions. Drawings can either be hand-drawn or computer generated; if computer generated, drawings **MUST** be student's original work. Photographs are not allowed in place of scaled drawings. (See JUDGING # 1c)
 - c) A materials table should be attached to the front of the display. The materials table should include a detailed listing of all materials used with a cost breakdown for each material used in the robotic arm and how each material was acquired. (See JUDGING # 1d)
9. The robotic arm **MUST** be competition-ready when checked in for inspection. No modifications to the robotic arm are allowed after it is submitted to the judges for inspection. The display should be submitted for judging at the same time the robotic arm is checked in.

JUDGING:

The competition will be judged in two components. Judges will receive the "Score Sheet for Robotic Arm" from the MESA Day Host Center.

Component I: Display and Robotic Arm

1. Points will be awarded for each of the following: **(10 points maximum)**
 - a. The display board including the stand and all of its components fits into a space that is 3 feet high by 3 feet wide by 2 feet deep (e.g. standard tri-fold presentation board). The display is freestanding at the time of judging. **(up to 1 point)**
 - b. A synopsis of the project, 200 to 250 words, should be on the front of the display. The synopsis should include the purpose of the project, explanation of the robotic arm, and scientific and engineering ideas involved in the project. **(up to 3 points)**

- c. The display board has a scaled plan rendering of the robotic arm on the front. Each of the three-view drawings (front, side, and top views) should be on separate 8 ½ x 11 sheets with dimensions; each of the 3 drawings should include dimensions. Each arm structure should be identified on each of the 3 drawings. Students should identify the scale used (e.g. 1 inch = 1 foot). **(up to 3 points)**
- d. The display board has a table of all materials utilized with retail price, price per unit, quantity used, total cost, and how each material was acquired. At the bottom of the table, the ***grand total cost*** for the robotic arm should be calculated. **(up to 3 points)**
- i. All cost of materials utilized should be calculated (e.g. if fasteners were obtained free from school, the retail price should be researched and the total cost of the fasteners used should be calculated). If parts are used from kits, cost of the part should be researched, calculated and identified. Students should also calculate the cost per unit [e.g. a 3 pack of foam board (20 in. x 30 in.) cost \$9.00 with \$3.00 per sheet and \$0.005 per square inch]. Points will be awarded to robotic arms based on the lowest total cost. A sample follows:

Robotic Arm – Materials Table

Arm Structure	Material	Retail Price	Price per Unit	Quantity used	Total Cost	Acquired
1. Humerus	foam board	\$3.00	\$0.005 / sq. in.	300 sq. in.	\$1.50	Office Depot
2. Radius/Ulna	card board	\$1.20	\$0.002 / sq. in.	200 sq. in.	\$0.40	School
3. Elbow Joint	fastener	\$2.39	\$0.0239 / each	1	\$0.02	School
4. Carpus	mailing tube	\$6.69	\$0.1556 / in.	10 in.	\$1.56	Lyon Art Supply
GRAND TOTAL COST					\$3.48	

- 2. Points will be awarded to robotic arms based on cost. ***If an accurate or reasonable cost for construction of the robotic arm is not detailed, student(s) will receive 0 points.*** If cost is questionable, student(s) must submit supporting documentation (e.g. receipts). **(10 points maximum)** *See Score Sheet*
- 3. Points will be awarded to robotic arms based on total weight. All components of the robotic arm will be weighed. **(10 points maximum)** *See Score Sheet*
- 4. Points will be awarded for creativity and innovative engineering design. Is the robotic arm creative in accomplishing the tasks? Does the robotic arm utilize an innovative engineering design to accomplish the tasks? **(10 points maximum)**

Component II: Operation of the Robotic Arm

- 5. The robotic arm must accomplish the tasks within 30 seconds. **(20 points maximum)** *See Score Sheet*

6. Bonus points will be awarded to robotic arms that pour all 50 ml of sand into the standard coffee mug in less than 15 seconds in the same trial. (**5 bonus points**)
7. The robotic arm may NOT be taped or attached to the table.
8. During setup and before the “START” order, the robotic arm may NOT be in contact with the graduated cylinder or coffee mug.
9. Student(s) may not interfere with the robotic arm in the grabbing, lifting or pouring function. See *RULE # 5*
10. Each robotic arm will be allowed 2 non-consecutive trials.
11. Each robotic arm must be ready for competition when called and must be ready within 2 minutes or forfeit that trial.
12. One team member will be responsible for the initiation of the robotic arm operation and will indicate to the judge that the robotic arm is in the ready position.
13. Each robotic arm must be in a hands-off ready position before the “START” order is given.
14. The team member must wait until the judge gives the “START” order.
15. In initiating and operating the robotic arm, both hands of the team member must be within the *Model Zone*, 1.5 foot square.
16. Only one “False Start” will be allowed per trial; a “False Start” is defined when the arm is triggered before the “START” order. Two “False Starts” during trial disqualifies that trial.
17. Repairs and modifications are allowed between trials. Repairs and/or modifications must be made by the student(s).
18. The order of competition will be randomly selected.
19. A “STOP” order will be given at the end of 30 seconds and the judge will remove the coffee mug from competition area.

AWARDS:

1. Medals will be awarded for 1st, 2nd, and 3rd place to the overall winners.
2. Ribbons for 1st, 2nd, and 3rd place will be awarded for **Creativity and Innovative Engineering Design**.
3. Only teams placing in the overall display and operation will qualify for Regional MESA Day.

ATTACHMENTS: A – Competition Set-Up
B – Specification Checklist for Students
Score Sheet for Robotic Arm

ROBOTIC ARM

Attachment A – Competition Setup

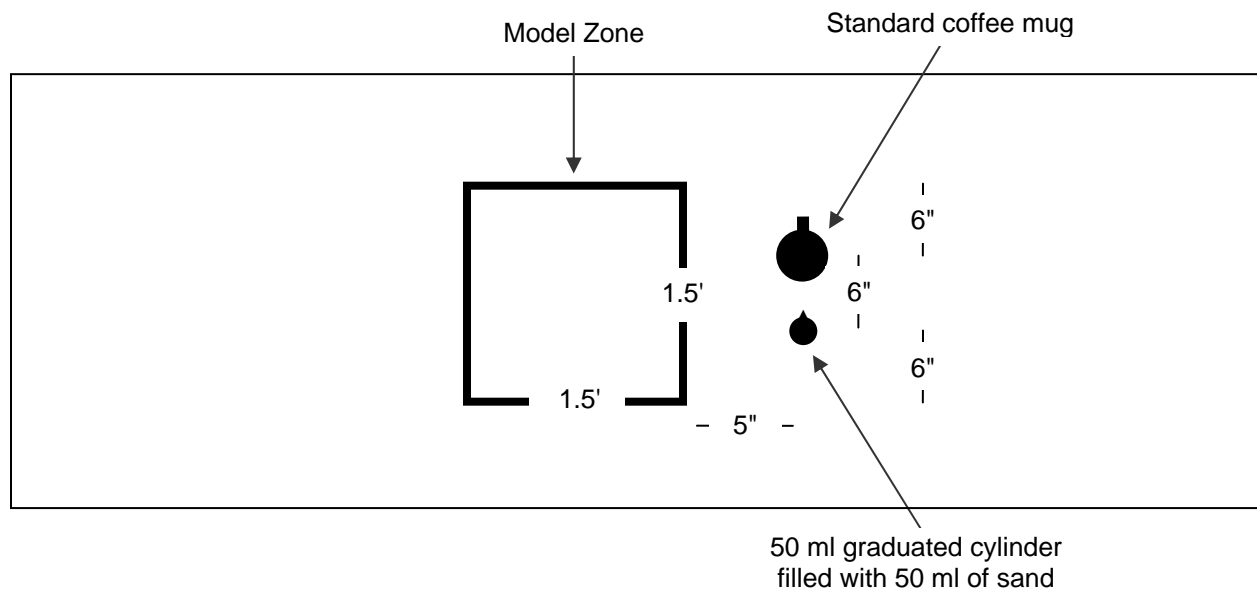
Materials provided by the host center:

- Standard 6 foot tables for displays
- One Standard 6 foot table for *Operation of Robotic Arm*
- 50 ml plastic graduated cylinder (with permanently molded graduations – 26 mm diameter and 200 mm height / 1 in. diameter and 7.87 in. height)
- 50 ml of sand * (weight between 71.5 g and 87.4 g / 2.52 oz and 3.08 oz)
- Standard coffee mug
- Masking Tape
- Stop Watch
- Scale (in ounces) to weigh robotic arms and sand
- Funnel and small dust broom and pan

* During set up, tap cylinder several times to remove pore space in sand.

Component II: Operation of the Robotic Arm

Top View of Table (*Drawing Not to Scale*)



Definitions

Model Zone: The model zone will be a 1.5 foot square (1.5') and will be identified with masking tape; measurement of 1.5 feet will be from the outer edges of the masking tape. The entire base of the robotic arm and any part of the robotic arm that may be in contact with the table must be within the model zone (the outer edge of the masking tape).

5": The centers of the graduated cylinder and coffee mug will be 5 inches from model zone (the outer edge of the masking tape).

6": The centers of the graduated cylinder and coffee mug will be 6 inches apart and 6 inches from the edges of the model zone (the outer edge of the masking tape).

ROBOTIC ARM

Attachment B – Specification Checklist for Students

- 2011 – 2012** MESA Day Rules were used.
- The display board and robotic arm are clearly labeled with student name(s), school and center.
- The entire base of the robotic arm fits within a 1.5 foot square. No part of the robotic arm that is in contact with the table is outside the 1.5 foot square.
- The **display board** fits into a space that is 3 feet x 3 feet x 2 feet.
- The display board is freestanding.
- A scaled plan rendering is attached to the display. The three view drawings are on three separate 8½ x 11 sheets, each with identified arm structures and dimensions.
- A materials table with associated cost for each material used and how each material was acquired is attached to the display. Materials table includes the retail price, the price per unit, the quantity used, and the total cost of each material. Materials table includes the grand total cost at the bottom of the table.
- Arm kit was NOT used.
- If parts of a kit were used, materials table includes cost of parts.

SCORE SHEET FOR ROBOTIC ARM

Grades 11 - 12

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

Student Name(s): _____

Center & School: _____

Judges: _____

Part I: DISPLAY Criteria (0 – 10 points total)

Up to 1 point:

Size/Freestanding _____

Up to 3 points for each criterion met:

Synopsis _____

Rendering _____

Display **and** Robotic Arm both labeled correctly? ____ Yes ____ No

If no, see end of score sheet for deduction.

Materials Table _____

Subtotal for Part I _____

Part II: ROBOTIC ARM COST and WEIGHT (0 – 20 points total)

Total Cost = _____ (from “Materials Table”)

Total Cost (10 points total – circle corresponding points below)

<i>Total Cost</i>	<i>Points</i>
Under \$8.00	10 points
\$8.01 - \$10.00	8 points
\$10.01 - \$12.00	6 points
\$12.01 - \$14.00	4 points
\$14.01 - \$16.00	2 points
Over \$16.01 <u>or</u> not included <u>or</u> inaccurate/unreasonable	0 points

Weight = _____ (ounces)

Weight (10 points total – circle corresponding points below)

<i>Total Weight</i>	<i>Points</i>
Under 8.0 ounces	10 points
8.1 ounces – 12.0 ounces	8 points
12.1 ounces – 16.0 ounces	6 points
16.1 ounces – 24.0 ounces	4 points
24.1 ounces – 32.0 ounces	2 points
Over 32.1 ounces	0 points

Subtotal for Part II _____

Part III: CREATIVITY and INNOVATIVE DESIGN of Robotic Arm (0 – 10 points total)

Up to 5 points for each of the below:

1. Creativity of Robotic Arm
2. Innovative Engineering Design of Robotic Arm

Top three receive ribbons. Ranking = _____ (*1st, 2nd, or 3rd*)

Subtotal for Part III _____

Part IV: OPERATION of Robotic Arm (0 – 20 points, plus 5 bonus points = 25 pts total)

Trial 1: _____ (ml of sand poured) _____ (time in seconds – within 30 sec.)

Trial 2: _____ (ml of sand poured) _____ (time in seconds – within 30 sec.)

Circle best of two trials below and award corresponding points:

<i>Sand Poured into Mug</i>	<i>Points</i>
50 ml	20 points
35 ml – 49 ml	15 points
20 ml – 34 ml	10 points
0.1 ml – 19 ml	5 points
0 ml	0 points

Bonus Points: Add 5 bonus points if robotic arm poured all 50 ml of sand into the coffee mug in less than 15 seconds in the same trial.

Subtotal for Part IV _____

COMMENTS AND TALLY SCORES

Comments:	Subtotal for Part I	_____
	Subtotal for Part II	+ _____
	Subtotal for Part III	+ _____
	Subtotal for Part IV	+ _____
	Labeling DEDUCTION *	- _____
	GRAND TOTAL	= _____

Maximum score is 65

*** DEDUCT 6.5 POINTS IF DISPLAY OR ROBOTIC ARM IS NOT CLEARLY LABELED WITH STUDENT NAME(S), SCHOOL AND CENTER**