Event Specifications
MESA USA National Engineering Design Competition –
Prosthetic Arm Challenge 2.0
MESA Day 2016

Arizona Addendum to National Specifications

WITH THE EXCEPTION OF THE FOLLOWING, ALL THE SPECIFICATIONS IN THE DOCUMENT WILL BE FOLLOWED.

NUMBER OF TEAMS: One (1) team per school can participate at the MESA Day state competition. Three (3) teams can participate at MESA Regionals.

TEAM MEMBERS 4 students (2 male, 2 female) required

COMPETITION COMPONENTS:

- All teams will compete in all performance tasks required by national competition specifications.
- All teams may compete in the performance tasks and poster display at MESA Day.
- Only teams that submit a Technical Paper will be allowed to do the oral poster presentation and therefore be fully eligible to compete for the opportunity to travel to the MESA USA National Engineering Design Competition in Utah.

TECHNICAL PAPER DEADLINE AND SUBMISSION:

- The technical paper must be submitted via e-mail to Arizona MESA on or before 5:00 pm, on **Friday, April 1, 2016.** The papers will be judged and scored prior to MESA Day. Papers shall be e-mailed to: Arizona MESA, Head Judge at *azmesa@email.arizona.edu*. Papers received after 5:00 pm will be assessed automatic 10 point deduction. No papers will be accepted after April 3.

BACKGROUND:

"It was 1997 and Judy Griffin was in her third day on a new factory job when she was given the task of working on a punch machine. With little training, her hands got caught up in the equipment and seven fingers were crushed…"My hands looked like ground-up hamburger," Griffin, of Kewanee, Ill., said Tuesday (September 10, 2013).She was in Moline for a news conference at ORA Orthopedics, where she showed off two new prosthetic devices, including a futuristic-looking one for her left hand described as "bionic fingers" in a news release…The industrial accident put Griffin in the hospital for more than three months, and she was afraid to go outdoors after she was released…The prosthetic devices allow Griffin, for the first time in 16 years, to more fully use both hands on a given task…Just hours after she received the devices, Griffin was able to hold a glass with her left hand and also use the hand to hold a knife and cut food…Griffin mentioned many activities that she hopes to be able to resume, including putting on make-up ("I didn't use makeup for years," she said), and simply grabbing household objects. She wants to crochet and to sew again, and also hopes to take up painting, arts and crafts and gardening…She said her grandchildren have never seen her with a left hand, and when she explained that she was getting a new hand, her 7-year-old granddaughter asked whether she would then talk like a robot. Griffin laughed at the memory and said she plans to go to her grand-daughter's school for show-and-tell to demonstrate her new fingers." - To read the full article visit - http://qctimes.com/lifestyles/health-med-fit/woman-s-futuristic-prosthetics-give-her-back-use-of-both/article_6e7102ab-5abd-5eb5-bb6e-293d59f825f4.html

CAREER PORTRAIT:

People often compare the human body to a machine, made up of systems that work together to keep itself running. Like machines, though, pieces of the body can break down. This is where the exciting world of biomedical engineering comes in.

As a biomedical engineering major, you'll build a foundation for a future that could take many directions. You might look for the chemical signals in the body that warn of cancer. You might invent a new and improved type of prosthetic (artificial) hand. You might refine the robots that doctors are just beginning to use in some surgery. Biomedical engineering majors learn how to use engineering to solve health and medical problems. "[Biomedical engineering] aids many people … That really appealed to me, that I'd have a great impact on society." Vanessa, senior, biomedical engineering, Case Western Reserve

MESA USA
NATIONAL ENGINEERING DESIGN COMPETITION

2015-2016

Prosthetic Arm Challenge 2.0

Contents

Overview

In order to maximize each team's experience during this event, it is important to properly execute all aspects of the testing process and event administration. Although each MESA state may elect to present this event in different format(s), the MESA USA host site and the corresponding National Event Planning Committee will be required to adhere to the processes outlined below. Please note that the following processes not only outline the event but also the roles and responsibilities of student team members and advisors.

MESA USA Code of Sportsmanship

During the course of this event, MESA students, staff, advisors and supporting family members will be expected to act in a professional and courteous manner at all times. All judges' decisions are final. Staff, advisors and parents shall not engage judges during the event.

MESA USA
NATIONAL ENGINEERING DESIGN COMPETITION
PROSTHETIC ARM CHALLENGE 2.0
2015-2016

Competition Overview

MESA USA presents the engineering design competition specifications for the 2015-2016 year. The Prosthetic Arm Challenge 2.0 involves the development of a low-cost prosthetic device with integrated computer science components to complete a set of pre-defined tasks. High school and middle school teams selected to participate at the national event will compete in the three components below:

1) **Performance –** Teams will research, design, build, test and compete using a prosthesis designed to complete the following tasks:

   a) Distance Accuracy Task: greatest distance and accuracy achieved by throwing bean bags into the *Target Zone* in the fastest time.
   b) Object Relocation Task: fastest time achieved by placing all objects into and removing all objects from the specified container.
   c) Dexterity Task: greatest number of bolts and nuts correctly placed and secured onto the testing device in the fastest time.
   d) Design efficiency: greatest ratio of device performance to device mass plus greatest ratio of device performance to total cost of materials.

   Middle school teams will compete in tasks "a", "b" and "d". High school teams will compete in tasks "a", "b", "c", and "d".

2) **Technical Paper** – Teams will submit a 5-15 page technical paper which examines all aspects of their design process, all major design choices and related STEM concepts.

3) **Academic Poster Presentation** - Teams will present academic posters to a panel of judges and will then respond to judges' questions. The posters should include items such as data (e.g., charts, tables and graphs), photographs, drawings, other ideas, and any necessary written explanations which help to explain their final design's features and quality, including incorporation of Arduino programming and components.

Each competing team must consist of 2-4 students who are active members of a MESA center program in a MESA USA state. Individual states should encourage their respective teams to participate in all performance components at the statewide level. Individual states will determine the dates and location of their respective events.

The first place middle and high school teams from State events will travel to the national competition. These teams must compete in all tasks listed above. This event is scheduled to occur in **June 23-25, 2016** hosted by Utah MESA. Feedback/comments should be submitted via the attached *Activity Feedback Form*.

Scoring Summary

Final team rankings will be based on the total score which is derived by adding all of the component scores.

Device Performance ..... 150 points
Device Efficiency
  Greatest ratio of device performance to device mass ..... 25 points
  Greatest ratio of device performance to total cost of materials ..... 25 points
Technical Paper ..... 100 points
Academic Poster Presentation ..... 150 points
Total Points ..... 450 Points

Objective

Teams will build a low-cost Prosthetic Arm for someone who has no use of his/her arm, either through amputation or paralysis. The device must meet the criteria outlined in the rules and be designed to perform the following tasks:

Middle School

(a) Distance Accuracy Task: greatest distance and accuracy achieved by throwing bean bags into the *Target Zone* in the fastest time. *(2 trials)*

(b) Object Relocation Task: fastest time achieved by placing objects into and removing objects from the specified container. *(2 trials)*

High School

(a) Distance Accuracy Task: greatest distance and accuracy achieved by throwing bean bags into the *Target Zone* in the fastest time. *(2 trials)*

(b) Object Relocation Task: fastest time achieved by placing objects into and removing objects from the specified container. *(2 trials)*

(c) Dexterity Task: greatest number of bolts and nuts correctly placed and secured onto the testing device in the fastest time. *(2 trials)*

Both - Design Efficiency – greatest ratio of performance score to device mass plus greatest ratio of performance score to total cost of materials

Materials

- Hazardous materials may not be used in the construction or operation of the device, including but not limited to lead.
- There will be an $80 pre-tax price limit for materials. Teams may use on-line national retail prices for materials as long as they provide the proper documentation as defined in the rules below.

Safety

1. Standard safety practices including the use of protective eyewear must be observed.
2. Students must operate their device in a safe manner. The device may only be activated when directed by the judges. Teams using UNSAFE PROCEDURES may have trials disqualified at the discretion of the judges.
3. The device must not pose a danger to students, officials, spectators or cause damage to the host facility, as determined by the judges.

Inspection, Impound and Operation

1. Device inspection will take place prior to being impounded for the performance events. Inspection will include demonstration of device operation for all tasks to the judges.
2. Devices must be in testing condition prior to device inspection. If devices do not meet specification check, design changes will not be allowed. Only devices passing inspection will be allowed to participate in the performance tasks.
3. A completed itemized budget sheet with documentation **must** be submitted at inspection. Any device that is over budget or missing complete documentation will be NOT be allowed to compete in the Device Performance.
4. All repair materials and parts to be used during the competition must be impounded with the device. Devices will be released for trials but will remain impounded between tasks.
5. Each device must be ready for competition when called or forfeit that trial.
6. If, during the operation of a device, it is found to violate rules those trials will be disqualified.

Assigning Points to Performance

1. The Total Performance Score will be determined by the sum of the points earned in each task.
2. Scores for each task equal the ratio of each device's performance relative to the winning device's performance on that task. Those scores are weighted according to the maximum points for each task:

   Middle School Tasks: 75 points each **High School Tasks: 50 points each**

3. Ties are allowed in each task

Performance General Rules

1. Teams must design, build and operate their prosthesis.
   A. This prosthetic device must be a generalized tool which includes all parts necessary to accomplish all defined tasks. No parts may be removed and no new parts may be added.
2. The device must have at least two artificial fingers which:
   A. **MUST** open and close.
   B. **MUST** grab and release the specific objects for each task. Teams may NOT use any other part of the prosthetic arm or parts of their own hand, wrist or arm to grab or release the objects.
   C. **MUST** be controlled by Arduino programming and components.
3. The device must NOT be controlled by the team member's own wrist, hand or fingers on which the device is attached.
4. Adjustments, including Arduino programming, and repairs are allowed and must be done under supervision of a judge. Repairs are allowed using ONLY duplicate replacement parts and materials.
   A. Time for adjustments and repairs will be determined by the host.
5. Participating team members must have their wrist, hand and fingers immobilized for the tasks to simulate an amputated arm or paralysis. This immobilization must be separate from the device, to ensure that the device is not controlled by the team member's own wrist, hand or fingers. The team will determine their own method for immobilization and must demonstrate this for the judges during specification check and impound.
6. For each of the tasks, a different team member **MUST** perform each trial.
7. Team members may use their unencumbered hand to activate Arduino components and to hold the bucket, crate, or dexterity testing device during the tasks.
8. Devices cannot exceed the $80 pre-tax price limit for materials.
9. Teams **MUST** submit a completed itemized budget sheet for their device and **MUST** provide documentation to support each and every price listed.
   A. The budget must include a list of each and every part and/or material of the prosthesis and its corresponding unit dimensions, retail price, price per unit, quantity used, total cost and retail source.
   B. All parts received through barter, trade, donation, recycling, etc. must be included in the itemized budget. Retail prices for these items must be researched and documented.
   C. Printed documentation verifying the retail prices (i.e. a store receipt or print out of on-line retail prices) must be attached to the itemized budget sheet for each and every part and material whether purchased or not.
   D. The cost will be based only on the actual materials used in the construction of the prosthesis; therefore, teams will need to calculate the cost per unit for their budget. For example, a 1.75 mm ABS Filament SmartReel (240 m) cost $39.99 (for 3-D printing). This breaks down to $0.167 per meter. If a team uses 50 meters, the cost would be $8.33.
10. Teams that do not conform to the Performance General Rules will **NOT** be allowed to compete in the device performance, thus resulting in zero points for the device performance.
11. Once competition begins, student teams may not have contact with non-competitors, including but not limited to Advisors, other teachers, and parents. Student teams are solely responsible for interaction with judges and addressing problems with their prosthetic arms.

Performance Task Details -

1. **<u>Distance Accuracy Task – Grab and Toss</u>**
   A. The purpose of this task is to demonstrate the prosthetic arm's ability to:
      i. Grab an object from inside a container
      ii. Lift object vertically
      iii. Correctly time the release of the held object
   B. The objective of this task is to successfully throw as many bean bags into the *Target Zone* as fast as possible.

Test Configurations and Equipment:

C. A 2 meter square will be marked as the *Working Area*. Only the team member actively participating during the task will be permitted inside this *Working Area*.
   i. One edge will be designated the *Launch Line*. (See Diagram 1)

D. A step pyramid will be designated the *Target Zone*. (See Diagram 1)
   i. The base of the *Target Zone* will be centered and parallel 2 meters to the *Launch Line*.
   ii. The *Target Zone* will be divided into 5 scoring zones. Each scoring zone will be 30 cm in height. The dimensions of each scoring zone are:
      a. Zone 1 = 1.5 m (150 cm) x 30 cm
      b. Zone 2 = 1.25 m (125 cm) x 30 cm
      c. Zone 3 = 1 m (100 cm) x 30 cm
      d. Zone 4 = 0.75 m (75 cm) x 30 cm
      e. Zone 5 = 0.5 m (50 cm) x 30 cm

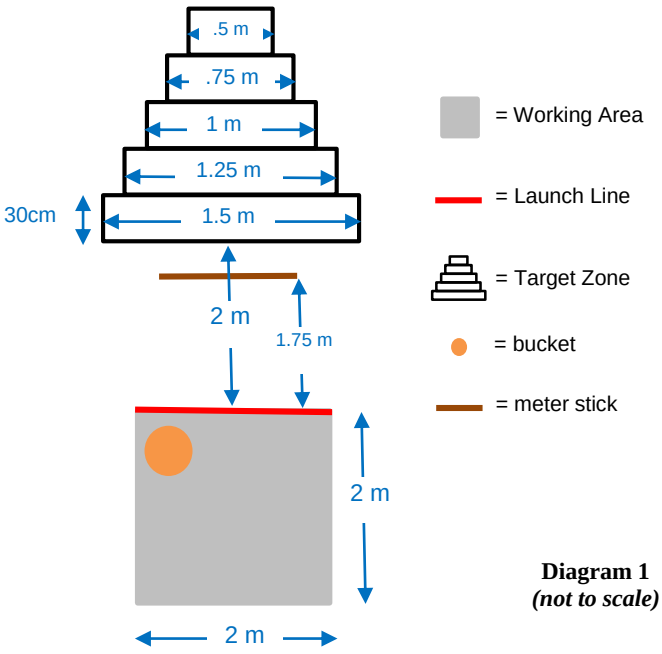


Diagram 1
(not to scale)

E. A meter stick (one meter) will be centered and parallel 1.75 m (175 cm) to the *Launch Line*, and will be taped to the ground.

F. The Distance Accuracy Objects will be a total of 12 (twelve) Nylon Bean Bags.
   i. 5 inch by 5 inch (12.7 cm by 12.7 cm) nylon bean bags from www.orientaltrading.com (Reinforced Bean Bags # IN-61/4000) or equivalent.
   ii. Nylon Bean Bags will be placed inside a Home Depot's "Homer's All-Purpose Bucket" (Model # 05GLHD2) or equivalent.

G. A stop watch or other type of timer will be used to record trial times.

Task Preparation:

H. The team will be given up to one minute to prepare, attach and demonstrate its prosthesis, to place the Nylon Bean Bags anywhere inside the bucket, and to place the bucket anywhere inside the *Working Area*. If at the end of one minute the team is not ready to perform the task, the trial will be declared a mistrial and this process will process will be repeated for the second trial.

I. When the prosthesis is prepared, attached and ready or at the end of one minute, the designated team member will stand outside of the *Working Area*.

Task Details:

J. The judge will give the start order and begin the timer.
K. Once the start order is given, the team member may enter the *Working Area* and will have a maximum of 1 minute (60 seconds) to grab and accurately release the bean bags into the *Target Zone*. The judge will notify the student when 30 seconds, 20 seconds and 10 seconds remain.
L. ONLY bean bags inside the bucket may be used for tossing.
M. The team member may hold the bucket with the unencumbered hand.
N. The trial will end when any of the following occur:
   i. The team may call the end of the trial **after and only after** 3 (three) bean bags have been accurately tossed completely inside the boundaries of the *Target Zone*. The team may signal the end of the trial by calling out "done." The judge will immediately stop the timer and record the time elapsed as the trial time.
   ii. One minute has passed. The judge will call out "time" and stop the team from throwing any of the remaining bean bags.
   iii. The member has thrown all of the available bean bags. Teams that throw all bean bags without accurately tossing at least 3 (three) completely inside the boundaries of the *Target Zone* will be given the full trial time.
O. The trial will be declared a mistrial when any of the following occur:
   i. When a team member grabs and tosses more than one bean bag at a time; or
   ii. When any part of the prosthesis or the team member's body including hand crosses the *Launch Line* when tossing a bean bag.
P. **At the end of the trial,** the judge will count the number of bean bags inside the boundaries of each scoring zone and record the time used to complete the task.
   i. Bean bag MUST be completely inside the boundaries of the scoring zone in order to receive that score.
      a. If any portion of the bean bag overlaps scoring zones, team will receive the lesser of scores for that bean bag.
      b. If any portion of the bean bag is outside the boundaries of the *Target Zone*, team will receive 0 for that bean bag.
Q. Repeat procedure for 2nd trial. The second trial must be completed by a different team member.
R. The best performance of the two trials will be used in the scoring.

Assigning Points to Performance:

S. Scores for scoring zones:
   i. 5 for each bean bag completely inside the boundaries of scoring zone 1
   ii. 10 for each bean bag completely inside the boundaries of scoring zone 2
   iii. 15 for each bean bag completely inside the boundaries of scoring zone 3
   iv. 20 for each bean bag completely inside the boundaries of scoring zone 4
   v. 25 for each bean bag completely inside the boundaries of scoring zone 5
T. Team Distance Accuracy Score ($\mathbf{D_t}$) = greatest team score-to-time ratio (score/seconds)
   i. Team score-to-time ratio = total score divided by the trial time
U. Task Winner ($\mathbf{D_w}$) = greatest score-to-time ratio (score/seconds) for any team
V. Task Points = Team Score ($\mathbf{D_t}$) divided by ($\mathbf{D_w}$) times maximum points, or
   Task Points = $\mathbf{D_t}$ / $\mathbf{D_w}$ x 75 or $\mathbf{D_t}$ / $\mathbf{D_w}$ x 50

Example

Task Winner	Team 5	Team 5 Points
Task Winner (D_w) = 4.8	Trial 1: 120 score /60 s = 2.0 Trial 2: 90 score /40 s = 2.25 Team Score (D_t) = 2.25	Middle School Score = (2.25/4.8) x 75 = 35.16 pts High School Score = (2.25/4.8) x 50 = 23.44 pts

2. Object Relocation Task – Pick and Place

A. The purpose of this task is to demonstrate the prosthetic arm's ability to:
   i. Grab objects of varying size, shape, consistency and weight
   ii. Lift objects vertically and move them laterally
   iii. Place objects into and remove objects from container

B. The objective of this task is to move objects in and out of the designated container as fast as possible.

Test Equipment and Configuration:

C. A standard six foot table with approximate dimensions of 180 cm (L) x 74 cm (W) x 75 cm (H) will be divided with tape into three zones each approximately 60 cm in length. (see Diagram 2)
   i. The two end areas will be the Task Areas and each will be used for the container or objects.
   ii. One of the end areas will be divided into two areas (Areas 1 and 2), each 60 cm x 37 cm. One will be the starting task area and the other finishing task area.
   iii. The area in the middle will be The Void.
   iv. A perimeter approximately one (1) meter around the table may be marked. Only team member actively participating during the task will be permitted in this Working Area.

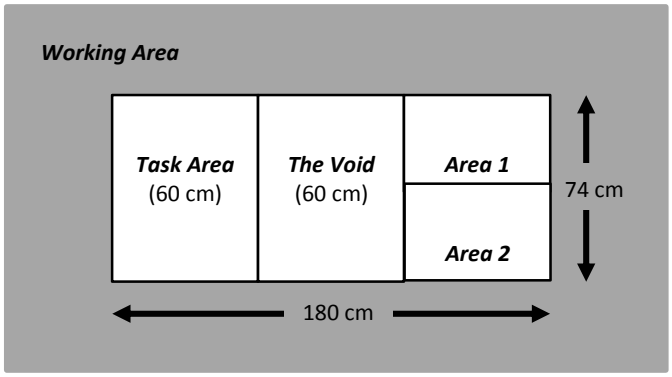


Diagram 2

D. The container to be used for this task will be a plastic crate with approximate dimensions of 10.5″ H x 13.75″ W x 15.25″ L (similar to the Sterilite milk crate #1692). This container will be lined to prevent objects from falling out.

E. The 10 objects to be placed into and removed from the container are as follows:
   i. One - Pack of 100 Index Cards (5 points)
   ii. One – Roll of 1" x 60 yards masking tape (5 points)
   iii. One – Composition Notebooks, approx. 100 pages, approx.. page size 7.5″ L x 9.5″ W (10 points)
   iv. One - empty 0.5 L bottle of water (10 points)
   v. One - 2 inch vinyl kick ball/hacky sack (15 points)
   vi. One – 12" rulers (15 points)
   vii. One - Unsharpened No. 2 pencil (20 points)
   viii. One - CD or DVD (20 points)
   ix. 2 unidentified objects that will vary in size but will be no heavier than a 500 g. (25 points)

F. A stop watch or other type of timer will be used to record trial times.

Task Preparation:

G. The 10 objects will be placed on the table. Teams may choose to place the objects in either Area 1 or Area 2, and may choose how to place the objects within that area. The container will be placed by the team anywhere in the Container Area.

H. The team will be given up to one minute to prepare, attach and demonstrate its prosthesis, to choose a task area and to arrange the objects in the selected Area. If at the end of one minute the team is not ready to perform the task, the trial will be declared a mistrial and this process will be repeated for the second trial.

I. When prosthesis is prepared, attached and ready and objects are prepared or at the end of one minute, the designated team member will stand outside the Working Area.

Task Details:

J. The judge will give the start order and begin the timer.

K. The team member may enter the Working Area and will have a maximum of 1 minute (60 seconds) to complete the task. The judge will notify the student when they have 30 seconds, 20 seconds, and 10 seconds remaining.

L. During the task, the team member will grab one object at a time to place into the container. Once an item is placed into the container it can be removed and placed into the chosen Finishing Area. An item must be released and the prosthesis must be fully outside of the open plane of the crate before attempting to remove the object.

   i. An object may be slid to the edge of the table to be lifted. An object cannot be slid into The Void. An object slid or moved over into The Void must be returned (slid/carried) to the Starting Area using only the prosthesis before attempting to place them into the container.

   ii. An object that is dropped in The Void, outside the container, or on the floor is out of play and cannot be re-attempted. A penalty equal to the point value of the object will be assessed.

   iii. The object MUST be carried across the entirety of The Void by the terminal device. Objects cannot be thrown across The Void.

M. The team member may hold the container with the unencumbered hand. The container should not be lifted from the table. If the container is lifted completely off the table or falls off the table the timer will be stopped and the trial will be declared a mistrial.

N. The trial will end when any of the following occur:

O. The team may call the end of the trial after and only after at least 5 (five) items have been placed into the Finishing Area. The team may signal the end of the trial by calling out “done” or “time.” The judge will immediately stop the timer and record the time elapsed as the trial time.

P. One minute has passed. The judge will call out “time” and stop the team from attempting any more objects.

Q. The member has attempted to move all of the available objects. Teams that attempt all of the objects without moving at least 5 (five) into the Finishing Area will be given the full trial time.

R. At the end of the trial:

S. Any object held by the device when time is called will not count. This object will not be considered for scoring purposes.

T. Any object broken will not count. These objects will be assessed a penalty equal to that if they had dropped the object.

U. The judge will record the time needed to complete the task.

V. The judge will record which items have be placed into the Finishing Area.

W. The judge will record any broken or dropped items for penalty points.

X. Repeat procedure for 2nd trial. The second trial must be completed by a different team member.

Y. The best performance of the two trials will be used in the scoring.

Assigning Points to Performance:

A. Scores for scoring zones:
   i. 5 points for the pack of Index Cards
   ii. 5 points for the roll of masking tape
   iii. 10 points for the composition Notebook
   iv. 10 points for the empty 0.5 L bottle of water
   v. 15 points for the 2 inch vinyl kick ball/hacky sack
   vi. 15 points for the 12" ruler
   vii. 20 points for the unsharpened No. 2 pencil
   viii. 20 points for the CD or DVD
   ix. 25 points for the unidentified objects
B. Team Object Relocation Score (Pt) = greatest team score-to-time ratio (score/seconds)
C. Team score-to-time ratio = total score less any penalties divided by the trial time
D. Task winner (Pw) = Greatest Team Objection Relocation Score for any team
E. Task Points = Team score (Pt) divided by (Pw), times max points, or
   Task Points = Pt / Pw x 75 or Pt / Pw x 50

Example		
Task Winner Task Winner (Pw) = 4.8	Team 5 Trial 1: 120 score /60 s = 2.0 Trial 2: 90 score /40 s = 2.25 Team Score (Pt) = 2.25	Team 5 Points Middle School Score = (2.25/4.8) x 75 = 35.16 pts High School Score = (2.25/4.8) x 50 = 23.44 pts

3. Dexterity Task – Nuts and Bolts

A. The purpose of this task is to demonstrate the prosthetic arm's ability to:
   i. Demonstrate fine motor control
   ii. Grasp small objects
   iii. Rotate an object around an axis
B. The objective of this task is to secure all nuts as far as possible onto the corresponding bolts as fast as possible.

Test Equipment and Configuration:

C. A standard six foot table with approximate dimensions of 180 cm (L) x 74 cm (W) x 75 cm (H) will be used.
D. A perimeter approximately one (1) meter around the table may be marked with tape. Only the team member actively participating during the task will be permitted in this *Working Area*.
E. A testing device will be placed on top of the table.
   i. The testing device will be made from 2 (two) 1 foot x 6 inch x 1 inch boards attached perpendicular to each other (See diagrams 3 and 4).
      a. Standard Lumber

Nominal	Actual	Actual-Metric
1″ x 6″	¾″ x 5 ½″	19mm x 140mm

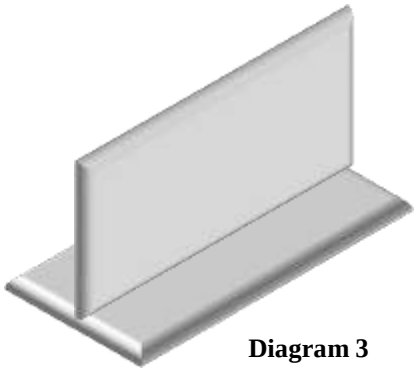


Diagram 3

TOP VIEW

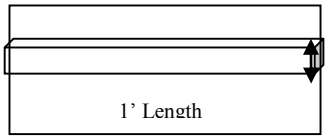


Diagram 4

ii. The vertical board will have 3 (three) pre-drilled holes made from drill bits A, B, and C as described below (see Diagram 5). The center of the holes will be centered vertically on the board, and evenly spaced horizontally across the board.

a. Hole "A" = US Drill Bit 23/64″ (0.359375 in or 9.128125 mm) – Home Depot Model 48-89-2729 / Store SKU # 767398 or equivalent

b. Hole "B" = US Drill Bit or Paddle Bit 1/2″ (0.5 in or 12.7 mm) – Home Depot Model 48-89-2738 / Store SKU # 771919, Model # 88824 / Store SKU # 959154, or equivalent

c. Hole "C" = US Drill Bit or Paddle Bit 11/16″ (0.6875 in or 17.4625 mm) – Home Depot Model # 48-89-2744 / Store SKU # 774206, Model # 1768419 / Store SKU # 958190, or equivalent

FRONT VIEW

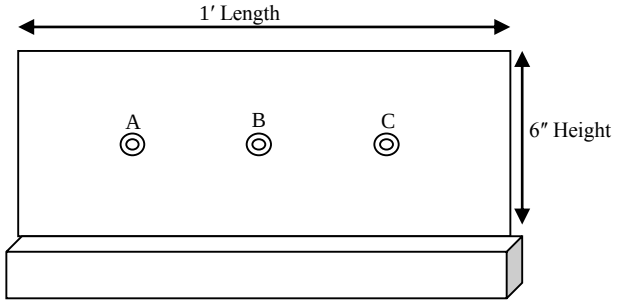


Diagram 5

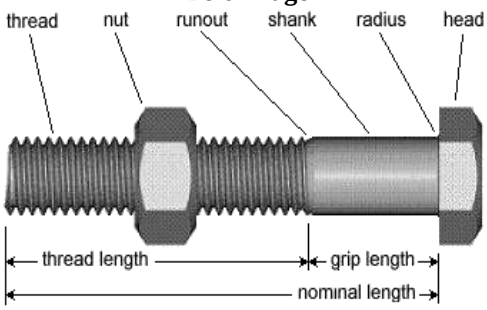
F. Bolts and Nuts are as follows (Metric, Zinc plated class 8.8 steel from www.boltdepot.com):

i. Set "A" – (1) 8mm x 1.25mm x 70mm hex bolt and corresponding 8mm hex nut
   a. Product #6230, Product #4788

ii. Set "B" – (1) 12mm x 1.5mm x 70mm hex bolt and corresponding 12mm hex nut
   a. Product #6341, Product #6877

iii. Set "C" – (1) 16mm x 2.0mm x 70 mm hex bolt and corresponding 16mm hex nut
   a. Product #6292, Product #7360

Bolt Image



G. Measurement Equipment: 4 inch digital Caliper
   i. HarborFreight.com, Item #47256 or equivalent

Task Preparation:

H. The team will be given up to one minute to prepare, attach and demonstrate its prosthesis and to prepare the dexterity equipment. If at the end of one minute the device is not ready to perform the task, the trial will be declared a mistrial and this process will be repeated for the second trial.

i. The testing device may be placed anywhere on the table.

ii. The bolts and nuts may be placed anywhere on the table.

I. When device is prepared, attached, and ready and the dexterity equipment prepared or at the end of one minute, the designated team member will stand outside the *Working Area.*

Task Details:

J. The judge will give the start order and begin the timer.
K. The team member may enter the *Working Area* and will have a total of 2 minutes (120 seconds) to secure all three (3) hex bolts and nuts. The judge will notify the team when 30 seconds, 20 seconds and 10 seconds remain.
L. The task will proceed as follows:
   i. The member will grab one of the bolts with the device and insert the bolt into the corresponding pre-drilled hole.
   ii. The member will then grab either the corresponding nut with the prosthesis and secure the nut onto the bolt, or another bolt and insert that bolt into the corresponding hole.
   iii. The nut must completely pass a marking on the bolt to be scored in the higher scoring zone.
M. The member may hold the bolt with the unencumbered hand by holding the bolt head ONLY. The member may only hold the bolt head in place and is not allowed to twist or screw in any way.
N. The testing device is allowed to be rotated, but the flat bottom board must remain in contact with the table at all times. (See Diagram 3). The team member may rotate or hold in place the testing device with the unencumbered hand.
O. If a bolt or nut is dropped, it must be picked up by the prosthesis.
P. Once a nut is secured, the prosthesis may be used to strike the nut to advance it further on the bolt.
Q. The trial will end when any of the following occur:
   i. The team may call the end of the trial **after and only after** all three (3) bolts and all three (3) nuts have been secured. The team may signal the end of the trial by calling out "done." The judge will immediately stop the timer and record the time elapsed as the trial time.
   ii. Two minutes have passed. The judge will call out "time" and record the full trial time of 120 seconds.
   iii. If an item is dropped and is not able to be picked up, the judge will record the full trial time of 120 seconds.
   iv. If the team member is found to have aided in the securing or screwing of the bolt, a MISTRIAL will be declared
R. Repeat procedure for 2nd trial. The second trial must be completed by a different team member.
S. The best performance of the two trials will be used in the scoring.

Assigning Points to Performance:

T. Scores for Scoring Zones on each bolt
   i. 5 for each nut secured on a bolt
   ii. 50 for each nut secured past 0.5 cm
   iii. 65 for each nut secured past 1.0 cm
   iv. 80 for each nut secured past 1.5 cm
   v. 95 for each nut secured past 2.0 cm
U. Team Dexterity Score (X_t) = greatest team score-to-time ratio (pt/sec)
   i. Team score-to-time ratio = total score divided by the trial time
V. Dexterity Task winner (X_w) = greatest score-to-time ratio (pt/sec) for any team
W. Task Points = Team Dexterity Score (X_t) divided by (X_w), times 50 points
   Task Points $= X_t/X_w \times 50$

Example

Task Winner Winning Dexterity Score (X_w) = 3.00	Team 5 Trial 1: 210 score/120 s = 1.75 Trial 2: 210 score/100 s = 2.10 Team Dexterity Score (X_t) = 2.10	Team 5 Points High School Score = (2.10/3.00) x 50 = 35 pts

2015-2016 MESA USA
National Engineering Design Competition
Prosthetic Arm Challenge 2.0
Technical Paper
100 points

Objective
To offer a close examination of your team's engineering design process, especially as it relates to all major design choices and STEM concepts.

Deadline
- *Local/State. Check* with your local MESA office for the procedure for local/state competitions.
- *National Competition. For teams advancing to the national competition,* the technical paper must be submitted via e-mail to Utah MESA on or before 4:00 pm in your local time zone, on **June 3, 2016** (subject to change)**.** Papers should be submitted by a student team member. The papers will be judged and scored prior to the National Competition. Late papers will be assessed a 10 point deduction, no papers will be accepted after **June 5, 2016.**
- Papers must be e-mailed to: Utah MESA, Head Judge at nationalcompetition@mesausa.org. Check the MESA USA national website at mesausa.org for further information. ***Please note that the host and Head Judge are not responsible for any Internet service delays or misguided papers. It is the responsibility of the student team members to ensure that the paper is delivered successfully prior to the deadline.***

Length
The paper should not be less than five pages or more than fifteen pages in length (excluding the title page and appendix). Thorough but concise papers are encouraged.

Conventions (Format, Language, Grammar, etc.)
Each of the standards listed below, though they are scored at a lower level (2 pts max), make an enormous difference in your team's ability to create a well-organized, compelling paper. Don't forget to check your paper length, make sure all sections are included, provide a title page, and adhere to the font, spacing, layout and grammar standards below:

a. The paper length, not including cover, title pages and Appendix, should be 5 to 15 pages.
b. Remember to include the key sections in your paper (listed below)
c. Your title page should include authors/ team members, school, MESA state and date.
d. Be sure to use 1" margins and double space your text using 12 pt. Times New Roman font.
e. Remember to use spelling, sentence, paragraphing and transition conventions that are appropriate to standard business English throughout the paper.

Written Presentation
The paper should be typed, double-spaced, and have a cover sheet. When possible, graphics should be computer generated. The above conventions should be followed. Readability will help your paper achieve a higher score in the judging.

Contents
The paper should include the following (see the R*esource Document* for descriptions of these):

A. Title Page (not included in the page count)
B. Abstract
C. Table of Contents
D. Introduction
E. Discussion
F. Conclusions
G. Recommendations
H. Bibliography
I. Acknowledgments
J. Appendix (not included in the page count)

Electronic Format
Technical papers MUST be submitted in Portable Document Format (.PDF). Teams shall ensure the submitted final product can be read using Adobe Reader (10.0 or newer) and that it matches your original, printed document. The maximum file size for submission will be 9MB.

Authorship
The authors must be members of the student team participating in the competition. The paper must be the original work of the authors. If professional assistance was sought in any aspect of the design process, or the creation of the paper or poster/presentation, authors should specifically explain how in this paper and also include their names in the appropriate section.

Criteria for Evaluation and Scoring
Shown below are the main areas that will be considered in the evaluation of the technical paper. See the scoring materials section for specific details and overall criteria.

- Discussion of Design Process Methods / Approach (30 pts)
- STEM Concepts and Analysis (30 pts)
- Quality and Thoroughness (30 pts)
- Conventions (10)

With the scoring criteria rubric, please keep in mind that judges will score all design goals based on the evidence you provide. For all items except for the conventions, these will be scored on a scale of 0 to 5. While the judges' rubrics may be more specific, please know that most scores will generally be based on the following:

- (5)-Exceptional. Exceeds all aspects of the standard when possible.
- (4)-Meets all aspects of the standard very effectively.
- (3)-Meets all aspects of the standard somewhat effectively;
- (2)-Almost meets the standard. May be inaccurate or unclear.
- (1)-Attempts to meet the standard but provides information which is irrelevant or unnecessary.
- (0)-No attempt appears to have been made to meet this standard.

2015-2016 MESA USA
National Engineering Design Competition
Prosthetic Arm Challenge 2.0
Academic Poster Presentation
150 points

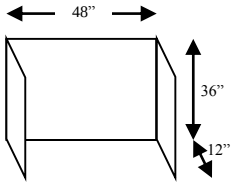
Overall Objective

To overview the functionality of the team's final device. Teams will present their device and relevant aspects of the design process from their technical paper. The focus of the display and presentation should only be the actual device presented for performance. Students will organize and deliver a focused, coherent presentation that provides an overview of the development of their design including research, experimentation and conclusions. The judges should understand the speech and become engaged in the presentation. Displays and speeches must be the original work of the team. The poster and presentation will each be worth 75 points.

Materials Provided

- Easel or ample wall space for poster – or cafeteria style table (30" x 72" x 29").

Poster Requirements



Poster example only

1. Size and Type. Teams may use either one 36" x 48" tri-fold presentation board or a single 36" by 48" poster. If you choose not to design a poster, keep the following in mind for your trifold board display:
   a. the entire display must be on the table and not extend beyond the table top
   b. displays may be taped to the table for stability.
2. Posters should include a title at the top of their poster.
3. Posters should include an official MESA logo.
4. A team card must be included and should include:
   a. School Name
   b. Grade level representing
   c. State representing
   d. Team members' names.
5. Posters should include the following Poster elements (see the *Resource Document* for descriptions):
   a. Abstract
   b. Design Features and Drawings including:
      i. One 11" x 17 " Orthographic drawing
      ii. Two creative models or isometric drawings
      iii. One Arduino Block Diagram
   c. Results and Data including:
      i. Two data tables
      ii. Two data charts or graphs
   d. Analysis
   e. Conclusion and Recommendations
6. All major sections should be clearly labeled.
7. Your team's Engineering Design Notebook should be placed near your poster/display – or be provided during your presentation – so that your team, or judges, can refer to it.
8. Electronic media are not allowed.
9. Except for the tri-fold presentation board, no element of your school's previous year's display may be reused. All elements must be original for this year.

Presentation Rules

1. Presentation attire will be the official MESA USA National Engineering Design Competition t-shirts. A 5-point deduction will be applied for teams not wearing the official t-shirts.
2. The Design Poster, Props, models, design notebook or other visual aids should be used.
3. Each team may speak for a maximum of ten (10) minutes. A 5-point deduction will be applied for presentations exceeding 10 minutes. Judges will expect to regularly hear directly from all team members throughout the presentation.
4. If judges allow audience members at poster presentations, teams may invite audience members at their discretion to attend the presentation. Once the presentation begins, audience interruptions will not be permitted. During the judges' question-and-answer period, no audience questions are allowed.
5. Presentations should include the following Presentation elements (see the *Resource Document* for descriptions of these):
   a. Introduction
   b. STEM Explanations and Quality
   c. Design Process and Approach
   d. Analysis
   e. Conclusion
6. All key concepts should be well understood by all team members. The use of any advanced concepts, techniques, algorithms or other materials that would not normally be included in middle or high school subjects must be explained. Whether these ideas were incorporated based on suggestions by people you sought out in your research, by volunteer STEM professionals at your school, or through other advanced text or web resources, your presentation must reflect the team's comprehension and capacity to explain such concepts.
7. Teams will be randomly selected to determine speaking order.
8. Students must give their presentations in the order drawn. No exceptions or late arrivals are allowed.
9. Judges will provide time signals at 3 minutes, 1 minute, 30 seconds, and 5 seconds before time is called.
10. Once the presentation is complete, the judges will conduct a five (5) minute question-and-answer period. These questions will be brief and to the point, and solely to ascertain student knowledge of the project.

Criteria for Evaluation and Scoring of Academic Poster Presentation (150 pts)

Shown below are the main areas that will be considered in the evaluation of the poster (75 pts) and the presentation (75 pts). See the reference documents and scoring materials section for specific details and overall criteria.

Team Poster (75 pts.) includes:

- Abstract (20)
- Design Features and Drawings (15)
- Results Data and Analysis (30)
- Organization and Creativity (10)

Team Presentation (75 pts.) includes:

- Introduction (10)
- STEM Explanations and Quality (25)
- Design Process / Approach (25)
- Oral and Visual Overall (15)

With the scoring criteria rubric, please keep in mind that judges will score all design goals based on the evidence you provide. For all items, these will be scored on a scale of 0 to 5. While the final judges' rubrics may be more specific, in general, the 0-to-5 scale will generally be based on the following:

- (5)-Exceptional. *Exceeds* all aspects of the standard *when possible*.
- (4)-Meets all aspects of the standard *very* effectively.
- (3)-Meets all aspects of the standard *somewhat* effectively;
- (2)-*Almost* meets the standard. May be inaccurate or unclear.
- (1)-*Attempts* to meet the standard but provides information which is irrelevant or unnecessary.
- (0)-*No* attempt appears to have been made to meet this standard.

2015-2016 MESA USA
National Engineering Design Competition
Prosthetic Arm Challenge 2.0
Device Performance
150 points

Inspection and Performance Datasheet

MESA Center:_____ MESA School: _____ Level: MS HS

Advisor/Teacher:_____ Student Team:_____

INSPECTION LIST:

	YES	NO
Device is a generalized tool and includes all parts necessary to accomplish all tasks	☐	☐
Includes at least two artificial fingers that open and close	☐	☐
Fingers grab and release the specific objects for each task	☐	☐
Fingers are controlled by Arduino programming and components	☐	☐
Team has demonstrated immobilization of the wrist, hand and fingers separate from the device	☐	☐
The team provided a complete itemized budget with references and documentation	☐	☐
Device does not exceed the $80 pre-tax price limit	☐	☐

Device Mass (not including all replacement parts and materials): _____kg Device Total Cost: $_____

PERFORMANCE:

Distance Accuracy Task

Trial 1	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
# of bean bags					
Trial Time (*00.00* seconds)					

Trial 2	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
# of bean bags					
Trial Time (*00.00* seconds)					

Object Relocation Task

Trial 1:
Trial Time:_____(s)
Number of Items dropped/broken:_____
Items in finish area:

☐ Index Cards	☐ Masking tape
☐ Notebook	☐ 0.5 L bottle
☐ Kick ball/hacky sack	☐ Ruler
☐ Pencil	☐ CD or DVD
☐ Wild Card Item (1)	☐ Wild Card Item (2)

Trial 2:
Trial Time:_____(s)
Number of Items dropped/broken:_____
Items in finish area:

☐ Index Cards	☐ Masking tape
☐ Notebook	☐ 0.5 L bottle
☐ Kick ball/hacky sack	☐ Ruler
☐ Pencil	☐ CD or DVD
☐ Wild Card Item (1)	☐ Wild Card Item (2)

Dexterity Task (high school only)

Trial 1:
Bolt 1 points:_____ Total Points (P):_____
Bolt 2 points:_____ Trial Time (T):_____
Bolt 3 points:_____

Trial 2:
Bolt 1 points:_____ Total Points (P):_____
Bolt 2 points:_____ Trial Time (T):_____
Bolt 3 points:_____

Points for Scoring Zones:
- 5 for each nut secured on a bolt
- 50 for each nut secured past 0.5 cm
- 65 for each nut secured past 1.0 cm
- 80 for each nut secured past 1.5 cm
- 95 for each nut secured past 2.0 cm

Lead Judge Signature:_____ **Student Signature:**_____

TECHNICAL PAPER SCORING CRITERIA (MESA USA NEDC PAC 2.0)	TEAM: SCHOOL: CENTER/STATE:

Overview: Values circled reflect the degree of evidence for design goals: (5) Exceptional/Exceeds Standard When Possible; (4) Meets Very Effectively: (3) Meets Somewhat Effectively; (2) Almost Meets/Inaccurate or Unclear; (1) Attempts/Irrelevant; (0) No attempt. *Please note: to meet any design goal below, all aspects listed in the standard (i.e. row) must be met.*

Discussion of Design Process Methods / Approach. (30) a-Design Process , b-Roles, c-Efficacy of each stage, d- Hardware Integration, e-Software Development, f- Reason for design choices.							
a. Clear overview of team's **design process.**	5	4	3	2	1	0
b. **Details roles** of all team members at all stages of design.	5	4	3	2	1	0
c. Details **nature & efficacy of each stage** of design process reflects (including brainstorming, research, etc).	5	4	3	2	1	0
d. Detailed discussion of process used to integrate electronics hardware into the function of the design.	5	4	3	2	1	0
e. Discussion of the development of the software applications used in the electronic components, including the logic used to achieve programming goals. Program Pseudocode included in appendix.	5	4	3	2	1	0
f. Clearly explains **how design process/testing informed all major design choices**.	5	4	3	2	1	0
Subtotal						**/30**
STEM Concepts & Analysis. (30) a- Math/Science Concepts, b-Engineering/Tech Concepts, c-Data Presented Visually, d-Data exploration, e- all design variables, f- specific variables.						
a. Precise, succinct explanation of 3-4 Math/Physics/Science concepts that informed design, including advanced concepts if used.	5	4	3	2	1	0
b. Precise, succinct explanation of 3-4 Engineering/Technology challenges/solutions, including advanced concepts if used.	5	4	3	2	1	0
c. Very relevant **tables/graphs/ reflect key data** for each major design prototype or modification. Includes at least 3.	5	4	3	2	1	0
d. Paper includes related data analysis or operations used to **explore the data.**	5	4	3	2	1	0
e. All relevant **design variables** clearly explained, including those not addressed.	5	4	3	2	1	0
f. Clear explanation of **specific variables** team addressed/optimized for and why.	5	4	3	2	1	0
Subtotal						**/30**
Quality & Thoroughness. (30) a-All Support Sections, b- Extra Mile, c- Cost-Labor Summary, d- Notebook Quality, e-Testing Procedures, f-Relevant Bibliography						
a. **All Supporting Sections included:** References, Acknowledgments, Appendix.	5	4	3	2	1	0
b. **Extra Mile.** Clear description of extra measures team made to be more conscientious in ensuring design's quality went beyond the call of the specifications.	5	4	3	2	1	0
c. **Cost-Labor Summary.** Very detailed list of student time commitment as well as volunteer support.	5	4	3	2	1	0
d. At least 3 tidy, scanned/photocopied **images from design notebooks** reflecting thoroughness & planning.	5	4	3	2	1	0
e. Very clear description of **testing procedures.** Includes 2-3 relevant diagrams or pictures.	5	4	3	2	1	0
f. **Bibliography:** At least 8 highly relevant sources that are appropriately formatted (APA, IEEE, or other standard format).	5	4	3	2	1	0
Subtotal						**/30**
Conventions. (10) a-Length, b-Sections, c-Title Page, d-Font & Layout, e- Grammar. *In this section only, a two (2) reflects fully meeting the standard; a one (1) reflects that it was almost met; and a zero (0) reflects zero evidence addressing the standard.*						
a. Length: 5-15 pages (not including cover, title page & appendix)				2	1	0
b. All Key Sections included.				2	1	0
c. Title page includes authors/team members, school, MESA state & date				2	1	0
d. Font & Layout: double-spaced, 12, Times New Roman. 1" margins.				2	1	0
e. Grammar, spelling, sentence, paragraphing & transition usage are appropriate to standard business English throughout the paper.				2	1	0
Subtotal						**/10**
Judge Name: **TOTAL**						**/100**

MESA	POSTER PRESENTATION SCORING CRITERIA (MESA USA NEDC PAC 2.0)	TEAM: SCHOOL: CENTER/STATE:

Academic Poster Presentation Scoring Criteria (Part A + B = 150 points)

A. POSTER/DISPLAY CRITERIA (75 points)

Overview: Values circled reflect the degree of evidence for design goals: (5) Exceptional/Exceeds Standard When Possible; (4) Meets Very Effectively: (3) Meets Somewhat Effectively; (2) Almost Meets/Inaccurate or Unclear; (1) Attempts/Irrelevant; (0) No attempt. *Please note: to meet any design goal below, all aspects listed in the standard (i.e. row) must be met.*

Abstract. (20) a-Length & Audience, b-Problem & Purpose, c- Methods, Results & Analysis, d- Conclusions & Key Features.						
a. **Length**: 200-250 words. Engages & informs **audience**. Written very clearly & succinctly using minimal tech. terms.	5	4	3	2	1	0
b. Very clearly restates **design problem & summarizes team purpose** or motivation.	5	4	3	2	1	0
c. Very clearly summarizes **team's design approach/methodology** & testing **results & analysis.**	5	4	3	2	1	0
d. Very clearly **summarizes conclusions & final design's key features.**	5	4	3	2	1	0
Subtotal						**/20**
Design Features & Drawings. (20) a-Key Features; neatness & clarity; labeling; b- Orthographic Size & Scale; c-Outward Appearance/Isometric Drawing; d-Block Diagram & Functionality						
a. **Key Features** of final design prominently identified in poster. Illustrations are **detailed, easily read & interpreted** & neatly done. Very effective use of **labels/pointers** to highlight features of device or data.	5	4	3	2	1	0
b. Orthographic drawing is at most **11"x17"** & includes at least **front, side and top view** & design **dimensions** & **scale** with Title Card. Orth. drawing **details all key parts** of final design very clearly.	5	4	3	2	1	0
c. Two (2) creative models or isometric (3D) drawings very clearly illustrate **outward appearance** of final design as well as key design considerations.	5	4	3	2	1	0
d. One (1) Arduino Block Diagram both clearly labeled to outline prosthetic functionality.	5	4	3	2	1	0
Subtotal						**/20**
Results Data & Analysis. (25) a-Data Tables/Charts/Graphs; b-Clear Interpretation & Inferences Based on Evidence; c-Strengths/Shortcomings; d-Recommendations; e-Standard Structure.						
a. Results section includes (2) two very relevant, compelling **data tables** and (2) two very relevant, compelling data **charts or graphs**.	5	4	3	2	1	0
b. Analysis section includes: interpretation/analysis of data very clear & relevant; all inferences follow very logically from data/evidence.	5	4	3	2	1	0
c. Analysis section explains design's strengths & at least two (2) shortcomings.	5	4	3	2	1	0
d. Recommendations include three (3) ideas for future work. Written in first person w/ active verbs.	5	4	3	2	1	0
e. Standard Structure Overall. Results section does not include interpretation. Conclusion & Recommendations include no new data.	5	4	3	2	1	0
Subtotal						**/25**
Layout. (10) a- Compelling Layout., b- Size, Title & Team						
a. **Compelling Layout:** Very good use of space, neat, uncluttered, very easy to follow. Display captures attention very holds interest very effectively.	5	4	3	2	1	0
b. **Title, Team, Size & Sections.** Includes clear, compelling title/header & an official MESA logo. Team card with School/Members/State prominently displayed. Poster/display size maximum: one 36"x 48" tri-folds OR 1 single poster 36" x 48." All major sections included.	5	4	3	2	1	0
Subtotal						**/10**
DISPLAY Total						**/75**

Comments:

B. PRESENTATION CRITERIA (75 points)

TEAM:
SCHOOL:
CENTER/STATE:

Overview: Values circled reflect the degree of evidence for design goals: (5) Exceptional/Exceeds Standard When Possible; (4) Meets Very Effectively: (3) Meets Somewhat Effectively; (2) Almost Meets/Inaccurate or Unclear; (1) Attempts/Irrelevant; (0) No attempt. *Please note: to meet any design goal below, all aspects listed in the standard (i.e. row) must be met.*

Introduction. (10) a-Team Introduction, responsibilities & design rational; b-Design problem restatement with background.						
a. Creative introduction of **team members**, **responsibilities & design rationale.**	5	4	3	2	1	0
b. Clear **restatement of problem** with key design parameters/constraints and sufficient background (key facts and previous work)	5	4	3	2	1	0
Subtotal						**/10**
STEM Explanations & Quality. (25) a-Factors Not Addressed, b-Factors Addressed, c-Math/Science Concepts, d-Engineering/Tech Concepts, e-electronics integration discussion						
a. Clear explanation of relevant **factors the team chose not to address** and why.	5	4	3	2	1	0
b. Clear explanation of **specific factors/ variables team addressed**/optimized for and why.	5	4	3	2	1	0
c. A precise, succinct description of 3-4 **Math/Physics/Science concepts** that informed design, including advanced concepts if used.	5	4	3	2	1	0
d. A precise, succinct description of 3-4 **Engineering / Technology** challenges or solutions, incl. advanced concepts if used.	5	4	3	2	1	0
e. A precise, succinct description of the integration of the electronics to accomplish the specific tasks.	5	4	3	2	1	0
Subtotal						**/25**
Design Process / Approach. (25) a-Approach, Methods & Timeline, b- Research impact; c- Design & Testing Impact; d-Notebook as visual aid; e- All observations follow from R&D, f-Innovation						
a. Brief overview of team's design **approach, methods** and **timeline.**	5	4	3	2	1	0
b. Clear explanation of **how team's research informed at least two (2) design choices.**	5	4	3	2	1	0
c. Clear explanation of **how design & testing informed at least four (4) design choices**.	5	4	3	2	1	0
d. **All observations** & conclusions well-thought out, accurate, & clearly **follow directly from research & design process.**	5	4	3	2	1	0
e. A clear explanation of creative **design innovations** based on assessment of hypothetical clients' needs.	5	4	3	2	1	0
Subtotal						**/25**
Oral & Visual Overall. (15) a-Shared presentation/appearance, b-Projected Voice/Eye Contact/Design Notebook used as a visual aid, c- Engaging Focus/Flow.						
a. ALL students **share equally in presentation**. Student **demeanor & presence** well suited for event.	5	4	3	2	1	0
b. **ALL voices heard** & understood. **Eye contact** is distributed across the audience. Engineering Design Notebook used as a visual aid.	5	4	3	2	1	0
c. **Engaging Focus & Flow.** Team stayed very focused on the topic & transitioned very smoothly from point to point. **Engaging** activities & discussion captured & maintained audience/judge attention very well.	5	4	3	2	1	0
Subtotal						**/15**
Presentation Total (Pre-deduction)						/75
Deductions (e.g. 5 pts if not wearing National T-shirt; 5 pts if not within time limits)	-					/10
PRESENTATION Total						**/75**

Judge Name:

Comments: