MESA USA
NATIONAL ENGINEERING DESIGN COMPETITION
2010-2011

Wind Energy Challenge

UC IRVINE ADDENDUM

With the exception of the following, all the specifications in the Wind Energy Challenge Document AND the California Addendum will be followed.

**Oral Presentation Rule 6:** Each Team may speak for a maximum of 5 minutes. A 5-point deduction will be applied for presentations exceeding 5 minutes.

**Technical Paper Deadline:**

- **Middle School:** The technical paper must be submitted via e-mail to UC Irvine MESA on or before 5:00pm on Saturday, February 12, 2011. The papers will be judged and scored prior to MESA Day. Papers shall be emailed to UC Irvine MESA at mesa@uci.edu. Any papers received after 5:00pm on February 12, 2011, will not be graded and teams will receive 0 points for this portion of the contest.

- **High School:** The technical paper must be submitted via e-mail to UC Irvine MESA on or before 5:00pm on Saturday February 5, 2011. The papers will be judged and scored prior to MESA Day. Papers shall be emailed to UC Irvine MESA at mesa@uci.edu. Any papers received after 5:00pm on February 5, 2011, will not be graded and teams will receive 0 points for this portion of the contest.
With the exception of the following, all the specifications in the document will be followed.

Rule 18: Teams WILL consider the cost of shipment of device to the local events. Teams MUST design their device to be disassembled for shipment in a large suitcase(s).

Project Labeling – WEC device, technical paper and academic display must be clearly labeled with student(s)’ names, school and MESA Center.

A 25 point penalty will deducted from total score if either of the above are not properly labeled.

All other testing rules will still apply.

To preserve the integrity and the spirit of the competitions, judges of the technical paper and performance device of the Wind Energy Challenge may ask questions of any student team competitors pertaining to the drafting of their technical paper or the building of their device to validate the authenticity of their work. Failure to validate the work turned in may result in zero points for technical paper or zero points for device performance.
### 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.

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### 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.

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MESA USA
NATIONAL ENGINEERING DESIGN COMPETITION
WIND ENERGY CHALLENGE
2010-2011

Competition Overview
MESA USA presents its national engineering design competition specifications for the 2010-2011 year. The Wind Energy Challenge event involves the transfer of energy from the wind source to the defined tasks. The maximum amount of energy available to complete the tasks will be limited to that provided by the defined commercial fan and the task time constraints. High school and middle school teams selected to participate at the national event will compete in the four components below:

Performance – Teams will research, design, build, test and compete with a windmill device designed to capture and use the available wind energy to complete the tasks. The performance of the devices will be judged in the following tasks:
   a) Mechanical Power: greatest mass raised 75 cm in the least amount of time.
   b) Wind to Vehicle Kinetic Energy Transfer: greatest average kinetic energy achieved by the defined vehicle using average speed over the track distance.
   c) Electrical Power & Wind Direction Response: greatest average power output from the defined generator/electrical load during a 60 degree change in wind direction.
   d) Design Efficiency: greatest ratio of device performance score to device mass.

Middle school teams will compete in tasks a) and b). High school teams will compete in all three tasks.

Technical Paper – Teams will submit a 5-15 page technical paper that details the design, development, experimentation and understanding of their device.

Academic Display – Teams will present the findings of the above-described research in display format. The display should include items such as data (e.g., charts and graphs), photographs, drawings, other ideas, and necessary written explanations.

Oral Presentation – Teams will make an oral presentation based on investigation, experimentation, design, testing, and experiences related to their device. This presentation will be delivered to a panel of judges. After the presentation, teams will be asked questions by the judges.

Each team competing at the state and national level 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 June 23-26, 2011 hosted by Washington MESA. Feedback and comments are welcomed; please see the attached Activity Feedback Form.

Scoring Summary
Final team rankings will be based on the total score derived by adding all of the task scores.

<table>
<thead>
<tr>
<th>Category</th>
<th>Points</th>
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</thead>
<tbody>
<tr>
<td>Device Performance</td>
<td>150</td>
</tr>
<tr>
<td>Device Efficiency</td>
<td>50</td>
</tr>
<tr>
<td>Technical Paper</td>
<td>100</td>
</tr>
<tr>
<td>Academic Display</td>
<td>100</td>
</tr>
<tr>
<td>Oral Presentation</td>
<td>100</td>
</tr>
<tr>
<td>Total Points</td>
<td>500</td>
</tr>
</tbody>
</table>

sites.google.com/site/MESAUSAWEC
Objective
Students will build a Windmill that meets the criteria outlined in the rules and is designed to perform the following tasks:

Middle School
(1) Mechanical Power: greatest mass raised 75 cm in the least amount of time. (2 trials)
(2) Wind-to-Vehicle Kinetic Energy Transfer: greatest average kinetic energy achieved by the defined vehicle using average speed over the track distance. (2 trials)

High School
(1) Mechanical Power: greatest mass raised 75 cm in the least amount of time. (2 trials)
(2) Wind-to-Vehicle Kinetic Energy Transfer: greatest average kinetic energy achieved by the defined vehicle using average speed over the track distance. (2 trials)
(3) Electrical Power & Wind Direction Response: greatest average power output from the defined generator/electrical load during a 60 degree change in wind direction. (2 trials)

Design Efficiency – greatest ratio of performance score to device mass

Materials
• Hazardous materials may not be used in the construction or operation of the device, including but not limited to lead.
• All other materials to build the device are legal and optional

Rules
General Rules
1. Teams must design, build and operate their own windmill device. This device will include all parts necessary to capture the wind energy and transfer it to the defined tasks. It may include multiple fan/turbine assemblies.
2. The device must be solely powered by the wind energy available from the defined commercial fan.
3. All designs that conform to the energy rules will be allowed to participate. All teams should carefully review design configuration to ensure that no additional energy is applied to the tasks.
4. Once performance competition begins, student teams may not have contact with non-competitors. Student teams are solely responsible for interaction with judges and addressing problems with their devices.

Test Configurations and Equipment
5. Fan, Device and Working Area: (Fig. 1)
   a. A six foot table will be used. Approximate dimensions of 30”x72”x29”.
   b. All parts of the windmill device must remain behind a line 50 centimeters from the end of the table.
   c. The Device Area shown is intended as a platform for the devices.
   d. The device may extend over the table edges to the sides and into the Working Area to complete the tasks.
   e. Devices may be taped to the table or floor surfaces.
   f. Teams may not touch their device once a task trial has begun.
   g. Teams will be allowed 2 minutes to configure their device before each trial.
Test Configurations and Equipment – continued

6. Mechanical Power – Raising a Mass (Figure 2)
   a. Fan speed will be set to high.
   b. Judge will use outlet strip to start the box fan wind source and start the timer.
   c. Judge will stop timer when entire mass is above 75 cm, and record time.
   d. Judge will use outlet strip to stop box fan wind source.
   e. Judges will weigh the detachable object and record the mass.
   f. Objects failing to reach 75 cm receive zero mass for that trial.
   g. Repeat procedure for 2\textsuperscript{nd} trial.

7. Wind-to-Vehicle (Figure 3)
   a. The fan speed will be set to High.
   b. Teams will place the entire vehicle behind the “Start Line”.
   c. Teams will design their device to move the vehicle from behind the Start Line” to the “Finish Line” as shown in Figure 3.
   d. Judges will use outlet strip to start box fan wind source and start the timer.
   e. Judges will stop the timer when any part of the vehicle crosses the “Finish Line” within the boundary.
   f. Vehicles failing to reach the “Finish Line” or leaving the track boundary during a trial will receive zero speed for that trial.
   g. Repeat procedure for 2\textsuperscript{nd} trial.

8. Electrical Power and Wind Direction Response (Figure 4)
   a. Student teams are required to use the specified generator to deliver electricity to the Electrical Load.
   b. Fan speed will be set to High.
   c. Fan motion will begin in Position #1 and rotate clockwise to Position #2.
   d. Judge will simultaneously start the box fan wind source, and the Stopwatch timer.
   e. Starting at 10 seconds the box fan – wind source will be slid from left-to-right at approximately 10 degrees per 10 second.
   f. Judge will record the Average Power delivered to the load between 10 and 70 seconds.
   g. Repeat procedure for 2\textsuperscript{nd} trial.
Test Configurations and Equipment - continued

Energy Source - Fan
9. Box Fan: Lasko Model 3733 – 20” 3-speed box fan or equivalent. These are 5-blade units that produce the following approximate wind speeds across their cross-sections when on the high setting:

| Average Wind Speed (meters/second) |
|-----------------|-----------------|
| Lasko 3733      | 2.60 @ 75 cm    |

10. No part of the windmill device may be placed farther than 50 centimeters from the end of the table.
11. An outlet strip will be used as the on/off switch for the fan, allowing desired fan speed to be set.

Electrical Load – Electrical Power and Wind Direction Task
12. Generator: KidWind – Wind Turbine Generator, SKU KWM001A or SKU KWM001B
13. Resistor & Base: Radioshack – 10 Ohm Carbon-Film Resistors (5-Pack), Catalog #: 271-013 or 271-1301 and 2-Position Dual-Row Barrier Strips, Catalog 274-656

Task Details -
14. Mechanical Power – Raising a mass
   a. The teams will provide all materials necessary to complete the task, including detachable object(s) to be raised during this task.
   b. The teams will select the mass and shape for the objects to be raised.
   c. The shape and volume of the object(s) and windmill device design must allow the objects to be raised from contact with the ground to a point completely above the target height of 75 centimeters.
   d. The object’s mass and the time taken to lift the object will determine the power achieved (mJ/s).
   e. Teams will be allowed 2 minutes for setup of their device and mass for each attempt.
   f. The mass must be raised above the table in 1 minute or less.
   g. Two attempts will be recorded and the best performance is used in scoring.

15. Wind-to-Vehicle Kinetic Energy Transfer
   a. The team must provide all materials to complete the task, including their vehicle.
   b. The device must accelerate their vehicle from behind the “Start Line” to the “Finish Line”.
   c. The vehicle must have a mass of at least 200 grams.
   d. Teams will be allowed 2 minutes for setup of their device for each attempt.
   e. The vehicle must cross the finish line in 1 minute or less.
   f. The vehicle must remain in contact with the floor throughout the trial from start to finish.
   g. The vehicle mass and speed will be used to determine the kinetic energy of the vehicle (J).
   h. Two attempts will be recorded; the best performance will be used in scoring.

16. HIGH SCHOOL ONLY – Electrical Power and response to change in Wind Direction
   a. The team must configure their device to use the defined generator to deliver the resulting electrical power.
   b. The generator label or marking must be visible or accessible for inspection.
16. (continued) HIGH SCHOOL ONLY – Electrical Power and response to change in Wind Direction
   c. The team must have the generator wires arranged to allow for judge to connect Electrical Load and
      Power Measurement Equipment.
   d. The device must respond to a 60 degree change in wind direction over a 60-second time span.
   e. Average Power measurement will be taken between 10 and 70 seconds from start of fan.
   f. The Electrical Power measurement method will use Vernier equipment and Logger Pro software to
      monitor average power delivered to the load resistor during each trial. Each state, region or
      classroom program may use the alternative method during preparation.
   g. Two attempts will be recorded; the best performance will be used in scoring.

17. Design Efficiency:
   a. The device mass will be measured as a part of the device inspection. All parts used to complete
      the tasks will be included except vehicle mass, lifted masses and tape used to secure device
      during performance.
   b. The Total Performance score from the Mechanical Power, Wind to Vehicle & Electrical Power
      tasks will be divided by the device mass in kilograms to determine Device Efficiency in points
      per kilogram.

Construction and Repair
18. Teams should consider the cost of shipment of device to the local events. It is recommended that
    teams design their device to be disassembled for shipment in a large suitcase(s).
19. Repairs are allowed, replacement parts and materials only, and all repairs must be done in the
    impound area under supervision of a judge. The addition of new or alternate parts not previously
    included is NOT allowed.

Safety
20. Standard safety practices including the use of protective eyewear must be observed.
21. 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.
22. 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
23. The trial order for performance events will be randomly selected.
24. 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.
25. Devices must be in testing condition prior to device inspection. If devices are disqualified during
    inspection check, design changes will not be allowed. Only devices passing inspection will be
    allowed to participate in the performance tasks.
26. All repair materials to be used during the competition must be impounded with the device. Devices
    will be released for trials but will remain impounded between tasks.
27. Each device must be ready for competition when called or forfeit that trial.
28. After teams arrive at task station, Judges will direct them to setup for the task.
29. Trial setup is limited to 2 minutes for each trial.
30. The team member responsible for operation of the device will indicate to the judge that the device is
    in the “ready-to-operate” position.
31. Students may not touch or interfere with the device once a task trial has begun.
32. If during operation a device is found to violate rules those trials will be disqualified.
33. Designs which prevent correct measurement of average power or kinetic energy will be disallowed.
Measurement Equipment

<table>
<thead>
<tr>
<th>Raising a Mass</th>
<th>Wind to Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Meter stick</td>
<td>• Meter stick</td>
</tr>
<tr>
<td>• Stopwatch or video analysis</td>
<td>• Stopwatch or video analysis</td>
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<tr>
<td>• Postal Scale (grams)</td>
<td>• Postal Scale (grams)</td>
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<tr>
<td><strong>Electrical Power &amp; Wind Direction</strong></td>
<td><strong>Electrical Power &amp; Wind Direction</strong></td>
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<tr>
<td><strong>Required</strong></td>
<td><strong>Vernier equipment (stand alone)</strong></td>
</tr>
<tr>
<td>• 10-ohm Resistor 1/8 or 1/4 watt</td>
<td>• Labquest</td>
</tr>
<tr>
<td>• 2 Row Barrier Strip</td>
<td>• Differential Voltage Probe (DVP-BTA)</td>
</tr>
<tr>
<td>• 2 Alligator clip leads</td>
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<tr>
<td><strong>Vernier equipment (PC option)</strong></td>
<td><strong>Vernier equipment (PC option)</strong></td>
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<tr>
<td>• Logger Pro Software</td>
<td>• Logger Pro Software</td>
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<tr>
<td>• Differential Voltage Probe (DVP-BTA)</td>
<td>• Differential Voltage Probe (DVP-BTA)</td>
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<tr>
<td>• GoLink! (GO-LINK)</td>
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**Electrical Power Measurement: Vernier Equipment Setup Details**

Both the Labquest and Logger Pro options allow the user to capture a graph of the power calculated from the voltage output and the value of the resistor (10-ohms) versus time. They also allow the user to determine the Average Power between to times, 10 and 70 seconds for this application. ([http://www.vernier.com/](http://www.vernier.com/))

**Alternative Method:** Averaging the calculated power at multiple positions during the trail. It is recommended that measurements be taken at 10, 40 and 70 seconds. Multiplying the voltage and current readings for each measurement determines the power. Averaging of the three readings determines the team score. The circuit is arranged for one multi-meter to measure current (mA) and the other voltage (V).

- Generator provided by team and connected to their device with label showing
- Alligator clip leads will be used to attach Electrical Load and meters to generator
Wind Direction Platform

Supplies:
- Main Platform – 1 x 12 (3/4”x11”) x 60”
- Main Arc – 1 x 6 (3/4”x5½”) x 40”
- Fan Contour Arc – 1 x 2 (3/4”x2”) x 20”
- Small hinges (optional)
- Screws – 1 ½” sheetrock screws

Instructions
1. The Main Platform remains the same.
2. The Main Arc requires a 100 cm radius arc be cut. This maintains the wind direction toward the Device Area center. Remove the hatched area shown.
3. Align the Main Arc with Main Platform as shown in photo below and secure with screws.
4. Optionally, the final product may be cut in half and hinged on the top surface as shown in photo below.
5. The Fan Contour Arc is attached to the box fan base and also maintains the wind direction toward the Device Area center. Remove the hatched area shown.
6. Remove screws from front of box fan; Align holes on Fan Contour Arc and pre-drill. Assemble Fan Contour Arc to box fan as shown in photo.
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

**Mechanical Power – Raising a mass**

1. Team Power Score \( P_{tm} \) =
   
   \[
   \text{(Trial mass [grams] / Trial time)} \times (9.8 \text{ m/s}^2) \times (0.75 \text{ m}) \text{ [units: mJ/s]}
   \]

2. Task Winner = Greatest team power score \( P_{wm} \) receives maximum points (75 or 50).

3. Task Points = Team Power \( P_{tm} \) divided by \( P_{wm} \), times max points or

   \[
   \text{Task Points} = \frac{P_{tm}}{P_{wm}} \times 75 \quad \text{or} \quad \frac{P_{tm}}{P_{wm}} \times 50
   \]

   **Example**
   - Team 5
     - Trial 1: mass=144g, time=7.25s
     - Trial 2: mass=160g, time=10.16s
     - Team Power \( P_{tm} = 145.9 \text{ mJ/s} \)
     - Task Winner = 156 mJ/s
     - Team 5 Points
       - Middle School Score = \((145.9/156.0) \times 75 = 70.18 \text{ pts}\)
       - High School Score = \((145.9/156.0) \times 50 = 46.76 \text{ pts}\)

**Wind-to-Vehicle Kinetic Energy Transfer Task (Middle and High School)**

1. High School Team Kinetic Energy \( KE_a \) =
   
   \[
   \text{\( KE_a = \frac{1}{2} \times (\text{mass of vehicle [grams]} \times (\text{speed of vehicle})^2 \text{ [units: mJ]} \)}
   \]

   - mass of vehicle = as measured (grams)
   - speed of vehicle = Distance (2.5 meters) / Team Time (seconds)

2. Task winner \( KE_w \) = Greatest kinetic energy achieved by a vehicle.

3. Task Points = Team kinetic energy \( KE_t \) divided by \( KE_w \), times max points or

   \[
   \text{Task Points} = \frac{KE_t}{KE_w} \times 75 \quad \text{or} \quad \frac{KE_t}{KE_w} \times 50
   \]

   **Example**
   - Team 5 – Best Trial
     - Winning Speed & Mass
       - \( 2.5m / 9.54 \text{ s} = 0.262 \text{ m/s} \)
       - 200 grams
     - Winning Energy \( KE_w = 6.87 \text{ mJ} \)
     - Team 5 – Best Trial
       - Best Speed & Mass
         - \( 2.5m / 13.26 \text{ s} = 0.188 \text{ m/s} \)
         - 200 grams
     - Best Kinetic Energy \( KE_a = 3.55 \text{ mJ} \)
     - Team 5 - Points
       - Middle School Score = \(3.55/6.87 \times 75 = 38.75 \text{ pts}\)
       - High School Score = \(3.55/6.87 \times 50 = 25.84 \text{ pts}\)
Assigning Points to Performance - continued

Electrical Power and Change in Wind Direction (High School)
1. High School Team Power ($P_t$)
   Vernier Equipment (Labquest or PC/Logger Pro) Method:
   = Average Power determined by graphing and averaging the delivered power between 10 and 70 seconds, in millijoules/sec or milliwatts (mW).
   - Average ($P_t$) = Direct Measurement
   Alternative Method:
   = Average of Resistor Power measured at three times (10, 40 & 70 seconds) in millijoules/sec or milliwatts (mW).
   - Power ($P$) = Voltage (volts) x Current (milliamps)
   - Average ($P_t$) = ($P_{10} + P_{40} + P_{70})/3$
2. Task winner ($P_w$) = Greatest Average Power delivered to the load resistor.
3. Task Points = Team Power ($P_t$) divided by ($P_w$), times 50 points

$$\text{Task Points} = \frac{P_t}{P_w} \times 50$$

<table>
<thead>
<tr>
<th>Task Winner – Best Trial</th>
<th>Example</th>
<th>Team 5 - Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winning Power ($P_w$) = 31.17 mW</td>
<td>Team 5</td>
<td>High School = (27.63)/(31.17) x 50 = 44.31 pts</td>
</tr>
<tr>
<td>Team Power ($P_t$) = 27.63 mW</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Performance Score:
1. Middle School Performance Score
   = Mechanical Power + Wind to Vehicle
2. High School Performance Score
   = Mechanical Power + Wind to Vehicle + Electrical Power & Wind Direction

Design Efficiency Score:
1. Design Efficiency ($DE_e$) =
   Total Performance Score divided by the designed device mass ($M_d$)
2. Device mass is measured in kilograms, excludes vehicle mass, lifted masses and tape used to secure the device.
3. Design Winner =
   Highest Design Efficiency ($DE_w$) receives 50 pts
4. Design Score =
   Team Performance Efficiency ($DE_e$) divided by ($DE_w$) times 50 pts

Design Score = $\frac{DE_e}{DE_w} \times 50$

**Example**

**Design Efficiency Score:**
Winning Design Efficiency ($DE_w$) based on:
   Team Performance Score = 147.65 pts
   Team Device Mass = 4.32 kg
Winning $DE_w = 147.65 / 4.32 = 34.18$ pts/kg

Team 5 Design Efficiency ($DE_e$) based on:
   Team 5 Performance Score = 133.9 pts
   Team 5 Device mass = 5.73 kg
Team 5 $DE_e = 133.9 / 5.73 = 23.35$ pts/kg
Team 5 DE Score = (23.35/34.18) x 50 = 34.14 pts
Objective
To clearly document their engineering design process, MESA students participating in the MESA USA National Engineering Design Competition will write a technical paper regarding the principles, design, and performance of their device.

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

Electronic Format
Teams are required to save the document in Portable Document Format (PDF) or Microsoft Word format prior to submission. Teams shall also ensure the submitted final product can be read using Adobe Reader (8.0 or newer) or Microsoft Word (2003 or newer) and matches their original document.

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 needed for information or writing assistance, their names should be included in the references.

Deadline
The technical paper must be submitted via e-mail to Washington MESA on or before 5:00 pm local time on Tuesday, June 1, 2011. The papers will be judged and scored prior to the National Competition. Papers shall be e-mailed to: Washington MESA, Head Judge at WAMESA@uw.edu.

Written Presentation
The paper should be typed, double-spaced, and have a cover sheet. Graphics should be computer generated. The font used should be Times New Roman and the font size should be 12. A one-inch margin is required on all sides. Readability will help your paper achieve a higher score in the judging.

The paper should include the following:
A. Title Page
B. Abstract
C. Table of Contents
D. Introduction
E. Discussion
F. Conclusions
G. Recommendations
H. References or bibliography
I. Acknowledgments
J. Appendices (Optional)

Title Page
Title, Authors, State, School and Date need to be included

Abstract
This section is a brief synopsis of your project, 200-250 word. It is the most important part of your paper, stating the purpose and most important features of the report, the main conclusions and recommendations. It should be written in informative, non-technical terms and be interesting so that the reader is drawn to read further.
Table of Contents
Table of contents should correctly identify each required component of the paper.

Introduction
This is the narrative that prepares readers for the discussion that follows. It provides background for the reader before introducing any technical data. It is broken down into three sections that average one to two paragraphs each:

- Purpose: why the project was initiated and why the report was compiled (e.g., to solve a problem, to evaluate or introduce a new concept, etc.)
- Scope: defines the parameters of your report; outlines methods of investigation and any limiting factors
- Background Information: presents facts the reader should know, conditions or events prior to the project, details of previous reports

Discussion
This is the longest section of the paper. It presents and discusses all evidence (facts, arguments, data, tables, charts, graphs, etc. are referred to and explained here but should be located in the appendix).

1. Summarize the teams’ device development, including a general description of design research, design selection and modifications made to satisfy event rules and task objectives.
2. Discuss physical phenomena related to the device. (e.g. Teams are encouraged to examine and report on potential and kinetic energy, work, aerodynamics, drag, velocity, force acceleration, mechanical advantage and other factors influencing the performance of their device. Newton’s laws of motion may also be addressed in describing the movement of the device using terms such as action/reaction, mass, momentum, inertia, etc.)
3. Use of advanced concepts, techniques, algorithms or other materials that would not normally be included in middle or high school subjects must be explained. The paper must show how the team’s research and work led to their selection and use. Appendices may be used for this purpose.
4. Experimental procedures and test setup (pictures or diagram)
5. Data reduction, analysis tools and models
6. Data (Table, graphs, charts, pictures, diagrams)
7. Results

The discussion section should be imaginative enough to hold the reader's interest and organized logically. Three common ways to organize are shown below:

- Chronological development: present information in order of occurrence, usually the easiest way to organize
- Subject development: present information by subjects, grouped in a predetermined order
- Concept development: arrange information as a series of ideas that reveal the reasoning process used to reach the conclusions; requires more careful organization but allows more creativity and persuasion. Writers should anticipate reader reactions. If presenting a controversial concept, establish a strong case before discussing it in detail. If presenting a popular or familiar concept, briefly and simply establish your case.
Conclusion
In this section, state the major inferences that can be drawn from the discussion. Be sure the evidence was presented in the discussion section. No new evidence should appear in this section.

Recommendations
This section is used to indicate further work to be done or to indicate the best solution when several solutions have been presented. Write recommendations, in strong definitive terms using first person and active verbs.

References
All sources that are consulted should be properly cited. See Resource Materials section for example references and additional information.

Acknowledgments
This section should be used to recognize individuals or groups who have provided support and guidance throughout the design process.

Appendices (optional)
This section contains, in detail, supporting data, charts, tables, photographs, test results, etc.

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 (40 pts)
- Abstract (20 pts)
- Introduction (15 pts)
- Conclusion & Recommendations (15 pts)
- Written Presentation (10 pts)
Objective
The purpose of the display is to provide a visual representation of the engineering design process used to develop the team’s device. Teams will present their device and relevant aspects of the design project from the technical paper. The focus of the display should only be the actual device presented for performance.

Materials Provided
• 30” x 72” x 29” (cafeteria style) table along with skirting

Form, Key Features & Organization
• The maximum display area is equivalent to two 36” x 48” tri-fold presentation boards placed side-by-side on the table.
• The entire display must be on the table and not extend beyond the table top. Displays may be taped to the table for stability.
• Electronic media are not allowed.
• The team state, school and members should be prominently displayed.

Required Elements
• **Abstract** – A brief synopsis of the project, 200-250 words
  ▪ State the purpose and the most important features from the technical paper, the main conclusions and recommendations
  ▪ It should be written in informative, non-technical terms and be interesting to the reader
• **Data and Technical Explanation** – Teams will show their exploration and share explanations of their device and the scientific and engineering ideas involved in the project
  ▪ **Teams should include key physics concepts as well as engineering challenges and solutions**
  ▪ Teams should incorporate text, photographs, drawings, images, tables, charts, graphs, models etc. that share information relevant to the overall project
  ▪ Teams may identify the features of the device using a system of labels or pointers
    ▪ Include modifications made to your device to ensure that it is a top contender.
    ▪ Teams are also encouraged to examine potential and kinetic energy, mechanical advantage, friction, work, Newton’s Laws of Motion, and any other pertinent topics.
• **Scaled Drawing** – A three-view drawing depicting the actual device designed and built.
  ▪ See Resource Materials section for example scaled drawing format
  ▪ Front, side, and top views should be included, see sample page 28
  ▪ All parts of the device should be labeled
  ▪ 3” x 5” Title Card including drawing title, brief description, date completed, and scale used
  ▪ Photographs are not permitted in place of a scaled drawing
  ▪ Scaled drawing may be drawn by hand or computer generated, both methods scored equally.
  ▪ Maximum paper size shall be 11”x17”
**Cost and Labor Summary** – A table summarizing essential cost and labor details of the project.
- Minimum size – 8½” x 11” sheet of paper
- Required Content:
  - Materials – description, source, purchased or donated, actual or estimated cost. Include an estimated total cost.
  - Labor – estimated student hours applied to complete project elements; Device, Technical Paper, Academic Display & Oral Presentation.

**Project Introduction** - Teams must be prepared to introduce themselves to Academic Display Judges and respond to questions about their project and academic display. Time with judges not to exceed 5 minutes.

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

- Technical Explanations & Data Presentation (40 pts)
- Scaled Drawing & Cost-Labor Summary (30 pts)
- Form, Key Features & Organization (10 pts)
- Abstract (10 pts)
- Creativity (10 pts)

**MESA USA Public Viewing of Academic Displays**
The public viewing of the academic displays at the MESA USA event give an opportunity for guests to visit each team display and ask questions.
- At least one team member should be present during the public viewing
Objective
The purpose of the presentation is to provide information about the engineering design project to a panel of judges. Students will organize and deliver a focused, coherent presentation that provides a overview of the development of their design including research, experimentation and conclusions. The judges should understand the speech and become engaged in the presentation. Speeches must be the original work of the team.

Materials Provided
- table
- easel board
- overhead projector
- PC computer with Microsoft PowerPoint 2003 or newer
- LCD projector and screen

Required Elements
- The processes and procedures used in design development.
- Discussion of related physical phenomena.
- Observations and data related to any experiments, testing or research conducted.
- Conclusions derived from the engineering design process.

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. Props, models, charts, graphs or other visual aids should be used.
3. Electronic presentations using Microsoft PowerPoint are allowed but are limited to text and images. Other electronic materials not allowed. Teams should not rely heavily on electronic media.
4. Teams are expected to bring their presentation on either a CD or USB flash drive.
5. Each team may speak for a maximum of 10 minutes. A 5-point deduction will be applied for presentations exceeding 10 minutes. Judges will expect to hear directly from all teams members.
6. Once the presentation begins, audience interruptions will not be permitted.
7. Teams are expected to do research. They may interview and quote experts, associates, or use quotations from written sources. They may provide examples, and/or use illustrations, facts, and figures.
8. All key concepts should be well understood by the team. The use of advanced concepts, techniques, algorithms or other materials that would not normally be included in middle or high school subjects must be explained. Teams must explain how their research and work led to their selection and use.
9. Teams will be randomly selected to determine speaking order.
10. Students must give their presentations in the order drawn. No exceptions or late arrivals are allowed.
11. Judges will provide time signals at 3 mins, 1 min, 30 sec, and 5 sec before time is called.
12. Once the presentation is complete, the judges will conduct a 5-min 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
Shown below are the main areas that will be considered in the evaluation of the Oral Presentation. See the Scoring Materials section for specific details and overall criteria.
- Technical Content (40 pts)
- Overall Presentation (30 pts)
- Oral & Visual Performance (20 pts)
- Question Responses (10 pts)
Inspection and Performance Datasheet

MESA Center: 

MESA School – Level (MS/HS): 

Advisor/Teacher: 

Student Team: 

---

**Inspection**

Sole Energy Source Box Fan ONLY ............................................................................................... Y / N

Vehicle Mass (200 grams or more).................................................................................................. Y / N

Generator: KidWind.org – Wind Turbine Generator, SKU KWM001A or KWM001B................. Y / N

Electrical Load: 10-ohm resistor provided by event host ......................................................... Y / N

Device Mass: All parts excluding vehicle mass, lifted masses & tape… ................. _________________ kg

---

**Performance**

**Mechanical Power**

<table>
<thead>
<tr>
<th>Trial 1</th>
<th>Trial 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>mass (grams)</td>
<td>mass (grams)</td>
</tr>
<tr>
<td>Start: Stop (sec)</td>
<td>Start: Stop (sec)</td>
</tr>
</tbody>
</table>

**Wind-to-Vehicle Kinetic Energy Transfer**

<table>
<thead>
<tr>
<th>Trial 1</th>
<th>Trial 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>vehicle mass (grams)</td>
<td>vehicle mass (grams)</td>
</tr>
<tr>
<td>Start: Stop (sec)</td>
<td>Start: Stop (sec)</td>
</tr>
</tbody>
</table>

**Electrical Power & Wind Direction (high school only)**

<table>
<thead>
<tr>
<th>Trial 1</th>
<th>Trial 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vernier/Logger Pro Method</strong></td>
<td><strong>Vernier/Logger Pro Method</strong></td>
</tr>
<tr>
<td>Average Power: (mW)</td>
<td>Average Power: (mW)</td>
</tr>
<tr>
<td>3-Sample Method</td>
<td>3-Sample Method</td>
</tr>
<tr>
<td>10-second measurements</td>
<td>10-second measurements</td>
</tr>
<tr>
<td>Position 1 Voltage: (volts)</td>
<td>Position 1 Voltage: (volts)</td>
</tr>
<tr>
<td>Position 1 Current: (mA)</td>
<td>Position 1 Current: (mA)</td>
</tr>
<tr>
<td>40-second measurements</td>
<td>40-second measurements</td>
</tr>
<tr>
<td>Position 2 Voltage: (volts)</td>
<td>Position 2 Voltage: (volts)</td>
</tr>
<tr>
<td>Position 2 Current: (mA)</td>
<td>Position 2 Current: (mA)</td>
</tr>
<tr>
<td>70-second measurements</td>
<td>70-second measurements</td>
</tr>
<tr>
<td>Position 3 Voltage: (volts)</td>
<td>Position 3 Voltage: (volts)</td>
</tr>
<tr>
<td>Position 3 Current: (mA)</td>
<td>Position 3 Current: (mA)</td>
</tr>
</tbody>
</table>
# TECHNICAL PAPER SCORING CRITERIA

## TEAM:

2010-2011 MESA USA National Engineering Design Competition

## SCHOOL:

LEVEL: MS or HS

<table>
<thead>
<tr>
<th>Discussion</th>
<th>Abstract</th>
<th>Introduction</th>
<th>Conclusion &amp; Recommendations</th>
<th>Written Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Effective discussion of key concepts, including advanced concepts if used.</td>
<td>a. Purpose</td>
<td>a. Purpose</td>
<td>a. Conclusion</td>
<td>a. Length</td>
</tr>
<tr>
<td>b. Limited discussion of key concepts, including advanced concepts if used.</td>
<td>b. Purpose &amp; Key Features</td>
<td>b. Scope</td>
<td>b. Inferences &amp; Evidence</td>
<td>b. Font</td>
</tr>
<tr>
<td>c. Data analysis not included</td>
<td>c. Good restatement of Conclusions &amp; Recommendations</td>
<td>c. Background Information</td>
<td>b. Further Work &amp; Reasoning</td>
<td>c. Spacing</td>
</tr>
<tr>
<td>d. Data analysis poorly described or not used</td>
<td>d. Well written, but includes some technical terms</td>
<td>d. Key Sections</td>
<td>d. Supporting Sections</td>
<td>d. Key Sections</td>
</tr>
<tr>
<td>e. Graphics not well used to support report</td>
<td>e. Modestly engages and informs reader</td>
<td>e. Grammar, Spelling, etc.</td>
<td>e. Supporting Sections</td>
<td>f. Proper grammar, spelling and sentence structure used throughout the paper.</td>
</tr>
<tr>
<td>f. Little or no discussion of procedures</td>
<td>g. Incomplete statement of purpose for project and report</td>
<td>g. Conclusion</td>
<td>f. References, Acknowledgments, Appendix</td>
<td></td>
</tr>
<tr>
<td>g. Poor restatement of Purpose or Key Features</td>
<td>h. Incomplete statement of scope, multiple items missing or overlooked</td>
<td>h. Inferences follow poorly from discussion evidence</td>
<td>g. Some errors in grammar, spelling, etc.</td>
<td></td>
</tr>
<tr>
<td>h. Poor restatement of Conclusions or Recommendations</td>
<td>i. Limited background information included</td>
<td>i. No new material included</td>
<td>h. Several errors in grammar, spelling, etc.</td>
<td></td>
</tr>
<tr>
<td>i. Uninteresting to reader</td>
<td>j. Unclear to the reader</td>
<td>j. Recommendations: Further work/best solution not well identified</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## LEVEL 4 - 4 points each

a. Very thorough discussion of Physics, Math and/or Engineering concepts, including advance concepts if used.
b. Very clearly states why project undertaken AND why report developed
c. A very thorough description of parameters, methods, limiting factors & technical terms
d. Background: Share key facts, conditions, events prior to project AND previous work on this topic

e. Engages and informs the reader

## LEVEL 3 - 3 points each

a. Effective/complete statement of purpose
b. Effective statement of scope, 1 or 2 items appear missing or overlooked
c. Effective and complete background details, 1 or 2 items appear missing or overlooked
d. Well written, but includes some technical terms
e. Modestly engages and informs reader

## LEVEL 2 - 2 points each

a. Limited discussion of key concepts, including advanced concepts if used.
b. Limited description of procedures, with few diagrams or pictures
c. Limited background information included
d. Many technical terms
e. Uninteresting to reader

## LEVEL 1 - 1 point each

a. Little or no discussion of key concepts, including advanced concepts if used.
b. Little or no description procedures
c. Data analysis not included
d. Graphics do not support report
e. No discussion of finding/results

<table>
<thead>
<tr>
<th>Points</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>16/20 x 40 = 32</td>
<td>/20 x 20 =</td>
</tr>
<tr>
<td>12 x 15 =</td>
<td></td>
</tr>
<tr>
<td>8 x 15 =</td>
<td></td>
</tr>
<tr>
<td>/24 x 10 =</td>
<td></td>
</tr>
</tbody>
</table>

### Total

<table>
<thead>
<tr>
<th>Judge</th>
</tr>
</thead>
</table>

### Judge Feedback:
## ACADEMIC DISPLAY SCORING CRITERIA
### 2010-2011 MESA USA National Engineering Design Competition

<table>
<thead>
<tr>
<th>TEAM:</th>
<th>SCHOOL:</th>
<th>LEVEL: MS or HS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technical Explanations &amp; Data Presentation</strong></td>
<td><strong>Scaled Drawing – Cost &amp; Labor Table</strong></td>
<td><strong>Form, Key Features &amp; Organization</strong></td>
</tr>
<tr>
<td>b. Engineering Ideas</td>
<td>e. Title Card &amp; Labeling</td>
<td>b. Team School &amp; Members</td>
</tr>
<tr>
<td>c. Use of graphics for data</td>
<td>e. Labor</td>
<td>e. Key Features</td>
</tr>
<tr>
<td><strong>Level 4 – 4 points each</strong></td>
<td><strong>Level 4 – 4 points each</strong></td>
<td><strong>Level 4 – 4 points each</strong></td>
</tr>
<tr>
<td>a. Excellent description of 3-4 key Physics concepts</td>
<td>a. Size and Scale very well done -11”x17”</td>
<td>a. Size: 2 tri-folds 36”x48” or equivalent</td>
</tr>
<tr>
<td>b. Excellent description of 3-4 Engineering challenges/solutions</td>
<td>b. Detailed front, side &amp; top views</td>
<td>b. Team School/Members prominently displayed</td>
</tr>
<tr>
<td>c. Tables &amp; graphs provide very relevant information to reviewer</td>
<td>c. Title Card and Labeling very well done</td>
<td>c. Key Features prominently identified</td>
</tr>
<tr>
<td>d. Very effective use of labels/pointers to highlight features of device or data</td>
<td>d. Very detailed list of all materials &amp; costs</td>
<td>d. Excellent Abstract, Data &amp; Technical Information</td>
</tr>
<tr>
<td>e. Display space captures attention of passerby very creatively</td>
<td>e. Detailed list of student time commitment</td>
<td>e. Layout: Very good use of space, neat, uncluttered, very easy to follow</td>
</tr>
<tr>
<td><strong>Level 3 – 3 points each</strong></td>
<td><strong>Level 3 – 3 points each</strong></td>
<td><strong>Level 3 – 3 points each</strong></td>
</tr>
<tr>
<td>b. Good description of 2-3 Engineering challenges/solutions</td>
<td>b. Some errors or omissions in three views</td>
<td>b. Team School/Members well displayed</td>
</tr>
<tr>
<td>c. Tables &amp; graphs used effectively</td>
<td>c. Title Card or labeling elements inaccurate or missing</td>
<td>c. Key Features well identified</td>
</tr>
<tr>
<td>d. Good use of labels/pointers</td>
<td>d. Good list of materials &amp; costs</td>
<td>d. Good Abstract, Data &amp; Technical Information</td>
</tr>
<tr>
<td>e. Good use of labels/pointers</td>
<td>e. Good list of student time commitment</td>
<td>e. Layout: Well presented, 1 or 2 organizational flaws in flow of ideas</td>
</tr>
<tr>
<td><strong>Level 2 – 2 points each</strong></td>
<td><strong>Level 2 – 2 points each</strong></td>
<td><strong>Level 2 – 2 points each</strong></td>
</tr>
<tr>
<td>a. Poor description of Physics concepts</td>
<td>a. Size &amp; Scale wrong size for the display</td>
<td>a. Size: 2 dimension unsatisfactory</td>
</tr>
<tr>
<td>b. Poor description of Engineering ideas</td>
<td>b. 1 or more views missing or poor</td>
<td>b. Team School/Members poorly displayed</td>
</tr>
<tr>
<td>c. Tables &amp; graphs provide little information</td>
<td>c. Title Card or labeling elements missing</td>
<td>c. 1 or 2 Key Features poorly identified</td>
</tr>
<tr>
<td>d. Labels/pointers poorly used</td>
<td>d. Materials List incomplete or missing detail</td>
<td>d. Poor Abstract, Data &amp; Technical Info.</td>
</tr>
<tr>
<td>e. Labor Table incomplete or missing detail</td>
<td>e. Labor Table/Abstract Incomplete or missing detail</td>
<td>e. Layout: poor use of space, some clutter distracts from flow of ideas</td>
</tr>
<tr>
<td>f. Drawing and/or Table lacks neatness or are unclear to reader.</td>
<td>f. Drawing and/or Table/Abstract Incomplete or missing detail</td>
<td>f. Drawing and/or Table not neatly done easily read and interpreted</td>
</tr>
<tr>
<td><strong>Level 1 – 1 point each</strong></td>
<td><strong>Level 1 – 1 point each</strong></td>
<td><strong>Level 1 – 1 point each</strong></td>
</tr>
<tr>
<td>a. Little or no discussion of Physics concepts</td>
<td>a. Size and Scale clearly wrong for display</td>
<td>a. Size: 3 dimensions unsatisfactory</td>
</tr>
<tr>
<td>b. Little or no discussion of Engineering ideas</td>
<td>b. 2 or more views missing or poorly done</td>
<td>b. Team School/Members clearly displayed</td>
</tr>
<tr>
<td>c. Few or no tables &amp; graphs provided</td>
<td>c. Title Card and Labeling poorly done</td>
<td>c. Key Features not identified or not present</td>
</tr>
<tr>
<td>d. Few or no labels/pointers used</td>
<td>d. Missing or poorly done Materials List</td>
<td>d. No Abstract, Data &amp; Technical Info.</td>
</tr>
<tr>
<td>e. Many errors or omissions in three views</td>
<td>e. Missing or poorly done Labor Table</td>
<td>e. Layout: Inadequate use of space, confusing</td>
</tr>
<tr>
<td>f.劳作 Table/Abstract Incomplete or missing detail</td>
<td>f. Lacks neatness &amp; difficult to interpret</td>
<td></td>
</tr>
</tbody>
</table>

### Points Score

<table>
<thead>
<tr>
<th>Points</th>
<th>Score</th>
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<tbody>
<tr>
<td>/16 x 40=</td>
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<tr>
<td>/24 x 30=</td>
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</tr>
<tr>
<td>/20 x 10=</td>
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### Total

**Judge**

### Judge Feedback:

<table>
<thead>
<tr>
<th>Points</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>/20 x 10=</td>
<td></td>
</tr>
<tr>
<td>/20 x 10=</td>
<td></td>
</tr>
<tr>
<td>/12 x 10=</td>
<td></td>
</tr>
</tbody>
</table>
# ORAL PRESENTATION SCORING CRITERIA

## 2010-2011 MESA USA National Engineering Design Competition

**TEAM:**

**SCHOOL:**

**LEVEL: MS or HS**

### Technical Content
- a. Physical Phenomena
- b. Process & Procedures
- c. Data and Explanations
- d. Observations
- e. Conclusions

### Overall Presentation
- a. Introduction
- b. Topic
- c. Flow
- d. Content
- e. Engagement of the Audience

### Oral & Visual Performance
- a. Student Voice
- b. Presence
- c. Eye Contact
- d. Collaboration
- e. Visual Material

### Question Responses
- a. Accurate & Specific
- b. Depth of Knowledge

## Points Score

<table>
<thead>
<tr>
<th>Points</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 x 40</td>
<td></td>
</tr>
</tbody>
</table>

**Judge Attire**
- 5 point deduction MESA USA event shirts required

**Time**
- 5 point deduction for over time limit

### Sample Questions
- What do you think would happen if ...?
- Describe a situation when you resolved a design problem.
- Please elaborate on your description or explanation of...?
- What were the most difficult parts of the paper, performance tasks or academic display? And why?

### Judge Feedback:

- Level 4 - 4 points each
  - a. Several examples of physical phenomena of topic well explained & understood, including advanced concepts if used
  - b. Process & Procedures of development well described
  - c. Data explanations very clear and tied to topic
  - d. Observations follow directly from experiments, testing or research
  - e. Conclusions well thought out and accurate

- Level 3 - 3 points each
  - a. Some examples of physical phenomena of topic explained & understood, including advanced concepts if used
  - b. Some of the design process well described
  - c. Data presented/explained well, not related to topic
  - d. Observations follow from experiences, not clearly from experiments, testing or research
  - e. Conclusions lack detail or include a misconception

- Level 2 - 2 points each
  - a. Very few examples of physical phenomena of topic, including advanced concepts if used
  - b. Very little of design process described
  - c. Unclear data, poorly explained, not related to topic
  - d. Observations do not follow from experiences, limited evidence of experiments, testing or research
  - e. Conclusions unrelated to technical content or includes misconception

- Level 1 - 1 point each
  - a. No discussion of physical phenomena related to topic, including advanced concepts if used
  - b. No discussion of design process
  - c. No data collection or analysis presented
  - d. No Observations made, or do not follow from activities
  - e. No conclusions or recommendations provided

- Level 4 - 4 points each
  - a. Creative introduction of team members & responsibilities
  - b. Very clear description of presentation topic
  - c. Flow – moved very smoothly from point-to-point
  - d. Content – stayed very focused on the topic
  - e. Unique activities & discussion captured and maintained audience & judge attention very well

- Level 3 - 3 points each
  - a. Includes a prepared introduction of team members
  - b. Includes effective topic introduction
  - c. Flow – 1 or 2 poor transitions between points
  - d. Content – strays little from topic unnecessarily
  - e. Activities & discussion engage audience & judges

- Level 2 - 2 points each
  - a. Team introduction poorly done
  - b. Presentation topic not clearly stated
  - c. Flow – several poor transitions between points
  - d. Content – strays unnecessarily from topic repeatedly
  - e. Some activities do not engage audience & judges

- Level 1 - 1 point each
  - a. Lacks team introduction
  - b. Lacks description of presentation topic
  - c. Flow – erratic, no clear point-to-point discussion
  - d. Content – strays from specific topic
  - e. Does not capture audience/judge attention

- Level 4 - 4 points each
  - a. ALL voices heard and understood throughout room
  - b. Student demeanor & appearance well suited for event
  - c. Eye contact is distributed throughout room
  - d. ALL student share equally in presentation
  - e. ALL visual aids contribute audience understanding

- Level 3 - 3 points each
  - a. Few situations with poor voice projection
  - b. 1 or 2 lapses in student demeanor & appearance
  - c. Few situations of poor use of eye contact
  - d. Some lapses in student collaboration & teamwork
  - e. Most visual aids contribute effectively

- Level 2 - 2 points each
  - a. Repeated lapses in voice projection
  - b. Student demeanor & appearance questionable for event
  - c. Quality eye contact sporadic or not used by all members
  - d. One student dominant or excluded from presentation
  - e. Visual aids unclear or cannot be clearly seen by audience

- Level 1 - 1 point each
  - a. Fails to answer questions or ask for clarification
  - b. Students unprepared to respond to questions

- Level 4 - 4 points each
  - a. ALL voices heard and understood throughout room
  - b. Student demeanor & appearance well suited for event
  - c. Eye contact is distributed throughout room
  - d. ALL student share equally in presentation
  - e. ALL visual aids contribute audience understanding

- Level 3 - 3 points each
  - a. 1 or 2 responses inaccurate or lack detail
  - b. Some responses lack thorough knowledge of project

- Level 2 - 2 points each
  - a. 3-4 responses inaccurate or lack detail
  - b. Knowledge of all project elements limited

- Level 1 - 1 point each
  - a. Fails to answer questions or ask for clarification
  - b. Students unprepared to respond to questions

- Level 1 - 1 point each
  - a. Fails to answer questions or ask for clarification
  - b. Students unprepared to respond to questions
Overview
The Wind Energy Challenge competition involves the following performance components with their maximum points in parentheses: Technical Paper (100 pts.), Academic Display (100 pts.), Oral Presentation (100 pts.), Device Performance (150 pts) and Design Efficiency (50 pts). The purpose of these guidelines is to outline the procedures for effectively judging this competition.

Preliminary Assignment
All judges need to read and become familiar with all rules, judging guidelines, and scoring criteria regarding their assignment.

Judging the Technical Paper
1. Read each paper without using the scoring criteria.
2. Using the scoring criteria, revisit each paper and assign a score to each paper.
3. Submit a score sheet for each paper to the lead judge.

Judging the Academic Display
1. View each Academic Display without using the scoring criteria.
2. Listen to team Project Introductions.
3. Using the scoring criteria, revisit each display and assign a score to each display.
4. Submit a score sheet for each display to the lead judge.

Judging the Oral Presentation
1. Judges will assemble all competing students in the room. The rules and judging criteria will be read. Teams will be allowed to ask any questions pertaining to the competition at this time.
2. Judges will excuse all teams from the room.
3. Judges will review rules for audience with all observers. Opposing teams are not allowed to participate as audience members.
4. Once the presentation begins, no one will be allowed to enter or leave the room until the presentation is complete. Audience members are not allowed to disrupt or aid the team (e.g. talking, gesturing, etc.). Any non-complying audience members may be asked to leave.
5. Judges will provide time signals for students at 3 minutes, 1 minute, 30 seconds, and 5 seconds before time is called.
6. Judges will have five minutes to ask questions of the team. To the furthest extent possible, the judges should ask questions that are specific to the team. This includes their technical paper, academic display, oral presentation, and/or device.
7. Using the scoring criteria, assign a score to each presentation.
8. Submit a score sheet for each presentation to the lead judge.

Judging the Device Performance
The device performance is the most valued component of the competition (150 points maximum). In addition to the rules, the judge must be aware of the equipment and track specifics, what specifically is being judged, and how to assign a score to each task.
Preferred Timing & Measurement Method: Video Recorded Analysis

This method provides an effective way to document and measure the times and monitor performance for the tasks. A digital camera or web camera is used to record the performance. These images are inserted into video analysis software. Start and Finish times and other measurements are identified on the video and entered into the scoring tools.

a. Nightlight: inserted in the outlet strip, if it does not have a bright on/off switch or indicator. The outlet strip is placed in the video image for the task. This allows for easy identification of the start of each task. See setup images below. ($1-3 per setup)

b. Digital or Web Camera: placed in a fixed position (tripod) viewing the task area, see setup images below. These cameras usually record 15, 30 or 60 frames per second (fps) providing increasing time resolution of 0.066, 0.033 or 0.017 seconds respectively.

c. PC/Mac and Vernier Logger Pro software: video images are recorded separately and imported or directly recorded into Logger Pro. A scan and marking of the images for times associated “start” and “finish” or voltage readings provide data for scoring. ($180)

d. A demonstration and instructions will be placed on the resource web site (http://sites.google.com/site/MESAUSAWEC).

Electrical Power Measurement: Vernier Equipment Arrangement

Both the Labquest and Logger Pro options allow the user to capture a graph of the power calculated from the voltage output and the value of the resistor (10-ohms) versus time. They also allow the user to determine the Average Power between two times, 10 and 70 seconds for this application. (http://www.vernier.com/)
Device Inspection and Impound (teams called according to drawn competition order)

Measurement Equipment:
- Mechanical Power: Raised Mass - Postal Scale (>200 gram, with +/- 1 gram accuracy)
- Wind to Vehicle: Vehicle Mass - Postal Scale (>200 gram, with +/- 1 gram accuracy)
- Meter sticks
- Example Electrical Generator & Lamp
  a. Generator Part#: SKU KWM001A or KWM001B, KidWind.org
  b. 10-ohm Resistor Part #: RS 272-013 or RS 272-1301, Radioshack

Station 1 - Sign-in, take photo of team with device and sign with school name for visual record

Station 2 - Review device operation to ensure box fan will be sole energy source.

Station 3 - Inspect and Record characteristics materials to be used in the tasks:
1. Mass of object lifted in Mechanical Power task.
2. Mass of vehicle to be moved in Wind-to-Vehicle task.
3. Part # of the lamp used in the Electrical Power and Wind Direction task.
4. Part # of the generator used in the Electrical Power and Wind Direction task.
5. Device Mass: all parts excluding vehicle mass, lifted masses, and tape used to secure device.

Station 4 - Impound device and all materials…guide students to student seating area.

Competition Management (teams called according to drawn competition order)

Team In-the-hole
Team moves from the student seating area and gathers device from impound area.

Team On-deck
Team moves from impound area to On-Deck area and prepares device for next task.

Team Up
Team moves from On-Deck area to the task area and prepares device for task.
1. Judge – DIRECTS team to prepare device for task. (timed)
2. Students – PREPARE device for operation indicate “ready-to-operate” status and WAIT.
3. Judge – ACKNOWLEDGES team “ready status”.
4. Judge – VERIFIES equipment setup
5. Judge – PREPARE timers and/or STARTS recording equipment:
6. Judge – STARTS trial…SWITCHES “ON” outlet strip/fan
7. Judge – MARKS and RECORDS the following:
   a. Violations, as needed
   b. Mechanical Power
      - Total Time (xx.xxx seconds) OR Start/Stop Times on recoding equipment
      - Object Mass (xx.xxx grams)
   c. Wind-to-Vehicle
      - Total Time (xx.xxx seconds) OR Start/Stop Times on recoding equipment
      - Vehicle Mass (xx.xxx grams)
   d. Electrical Power & Wind Direction
      - Total Time (xx.xxx seconds) OR Start/Stop Times on recoding equipment
      - Average Power (xxx.xxx) or Voltage/Current (xx.xxx) reading at 10, 40 & 70 seconds
   e. Performance and Rule Violation Comments
Using the Scoring Criteria

MESA USA recognizes that evaluation of student work can be very subjective. The scoring criteria provided with event materials are intended to guide evaluation and provide a more consistent method for assigning scores to student work. The effective evaluation of their work is important to providing effective feedback for them as they continue their education and postsecondary careers.

Each Scoring Criteria sheet has been arranged as follows (see sample below):
1. Divided into columns – representing key topics of evaluation.
2. Each column or topic title also lists sub-topics for scoring.
3. Within each column, four (4) performance levels are shown.
4. Within each performance level items a-f provide descriptions of varying levels of performance.

Recommended strategy for assigning scores to an evaluation:
1. Review the topic (column) and sub-topics (a-f) within each.
2. Highlight the scoring level description you feel the team has achieved for each sub-topic a-e. NOTE: Each sub-topic a-e should only be highlighted once per topic (column)
3. Repeat this for each topic to complete
4. Each highlighted description earns the assigned points for that scoring level.
5. Use automated scoring or complete included formulas, add all the scores, including deductions, and enter the total score.
6. Written feedback is strongly encouraged. Provide constructive feedback on the strengths and weaknesses of particular topics or sub-topics.

SAMPLE SCORE (Technical Paper – Discussion, shown above)
- a. Physical Phenomena earns 3 points
- b. Experimental Procedures earns 4 points
- c. Data and Analysis earns 2 points
- d. Tables and Charts earns 4 points
- e. Results earns 3 points

DISCUSSION SCORE
16 pts / 20 max pts x 40 topic pts
= 32
National Competition Weekend Order of Events (recommended)
Prior to the Event:
I. Technical Paper Judging

Friday:
II. Rules Review Meeting - The lead judge will review the judging process with team members and their respective advisors.

III. Wind Energy Challenge Practice Testing (at competition site if possible)
   Student teams will be allowed to test their respective devices. Non-competitors will not be allowed in the performance area. Head Judge will be available to assess legality of design according to the rules.

IV. Academic Display Set-Up - Advisors or other family members will not be allowed into the display area. Student teams will be responsible for display set-up.

V. Academic Display Judging - Only judges will be allowed in the display area.

VI. Oral Presentation Judging
   Student teams are responsible for transporting their academic displays and other materials if they elect to use them as part of their oral presentation.

Saturday:
VII. Device Performance Judging
   To allow for full recognition of all teams, tasks will not be performed simultaneously. The following order of tasks will used at the national level:
   A. Electrical Power (HS)
   B. Mechanical Power (MS followed by HS)
   C. Wind to Vehicle (MS followed by HS)

VIII. Public Viewing of Academic Displays

Sunday:
VIII. Awards Ceremony
   Student teams will be recognized in overall and individual categories. See “National Competition Awards Categories” for more details.
Judging Requirements and Assignments
In order to properly and consistently judge all components of the competition, the following judging team should be utilized. Please refer to “Judging Guidelines” for additional details.

Lead Judge Responsibilities:
Oversee all components of the competition and provide final rulings on event related issues.

Judges Needed:

<table>
<thead>
<tr>
<th>Component &amp; Responsibilities</th>
<th>Middle School ²</th>
<th>High School ³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Paper</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Academic Display</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Oral Presentation ¹</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Performance Testing and Impound ³</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

¹ Oral presentation judges are encouraged to participate in technical paper and academic display judging
² Judges should be assigned to either Middle or High School level only
³ Performance Judges must complete the device inspection checks and measurements as well as monitor any potential changes in configuration which may provide an unfair energy advantage during the competition.

Event Area Set-Up
The host center will be responsible for the set-up of the device performance test area. Please refer to the test area illustration for specific requirements. The ideal venue for testing is a school gym or similar facility with a smooth, even floor. The following items should be considered when arranging the event area:

- Crosswinds’ – Position the tables to avoid “crosswinds”, or the wind from one task/table interfering with that of another
- Space – Leave plenty of space between tables, to facilitate foot traffic between them. Also, allow plenty of work or task space in front of the tables
- Electrical Power Availability – The space must have outlets and extension cords necessary to power the following: 1) Test area outlet strip, 2) Optional - A PC used to implement video analysis
- Audience and Competitor viewing
Performance Task Management
All participating teams will be seated in an area separate from the general audience. Under the direction of the lead judge, only one team will be allowed in the testing area at any one time. Team members will be escorted by judges to each of the respective testing areas. The judges and host center staff must ensure that the test area is not disturbed once it is configured.

Based on a pre-determined order, teams will be summoned to the test area in the following order and will be repeated until all tasks are completed:

1) Team Up
2) Team On-Deck
3) Team In-the-hole

“Quiet” time will be requested during the performance of each task.

Safety
In accordance with school safety requirements, all team members will be required to wear safety goggles during all phases of device performance testing. Use of helmets is recommended.

Automated Event Scoring
The 2010-2011 MESA USA Wind Energy Challenge Competition Committee has prepared a Microsoft Excel based scoring tool to simplify the judging portion of the event. All states, regions, centers and teacher/advisors are encouraged to utilize this tool to streamline scoring and event management. The file may be downloaded from http://sites.google.com/site/MESAUSAWEC.

National Competition Awards Categories
The following awards will be presented at the National Competition.

MESA USA Overall Winners
Highest combined score in Device Performance, Academic Display, Technical Paper & Oral Presentation

Component Winners
Device Performance
- Mechanical Power: .................................................................1st, 2nd, & 3rd Place
- Wind-to-Vehicle: .................................................................1st, 2nd, & 3rd Place
- Electrical Power and Wind Direction Response (HS only): 1st, 2nd, & 3rd Place
- Design Efficiency: .................................................................1st, 2nd, & 3rd Place

Academic Display: .................................................................1st, 2nd, & 3rd Place

Technical Paper: .................................................................1st, 2nd, & 3rd Place

Oral Presentation: .................................................................1st, 2nd, & 3rd Place

Award Notes:
Medals or ribbons will be awarded to members in the overall category and individual categories.
Reference Format:
Citing Sources in Technical Writing
If you use books, journals, magazines, and websites to get ideas for your research, it helps you write a better paper. You can quote other people or quote the research that someone else did, and it will support your ideas and theories. When you use another person's idea, words, or research, you need to cite the source.

For every book, website, conversation, interview, article, etc. that you read, listen to, or look at, you need to write down the following information:

- The author of the information (who wrote or spoke the material?)
- The title of the text, website, or article
- The date that the material was first published (for a conversation or interview, use the date that the discussion occurred; for a website, record the date you accessed the website--the date you first looked at the page)
- For journal and magazine articles, the title of periodical and position in a series (e.g. Journal Name, Volume 5, Issue 49) and the pages where the information is located
- The publication information (i.e. city, state, & publisher name)
- For websites, the URL address (e.g. http://www.google.com)

If you're reading an article or a small piece that's part of a bigger book, then you also need:

- The title of the larger collection (if you're reading an encyclopedia article, then this means the name of the encyclopedia)
- The editor of the larger collection (someone that collected all the articles together, whether or not they wrote anything themselves)

At the end of your paper, you will need a Reference page. This page will include entries for all the sources that you used while writing your research paper. For papers in the field of Engineering, researchers often use a citation style developed by the American Psychological Association (APA). This style permits others who read your paper to find the original sources you used--websites, articles, books, etc.--and experience the original document. It includes all the information someone would need to find your source and it organizes the information in a style so that you don't need headings such as "Title," "Author," or "Date of Publication," because it is obvious from the order in which you present these things.

In APA style, books are cited this way:

An article in a periodical (e.g. a journal, magazine, or newspaper):

|---------|-------------------------------------------------------------------------------------------------------------------------------------|
A non-periodical (e.g. book, report, brochure, or audiovisual media):

<table>
<thead>
<tr>
<th>Style</th>
<th>Author, A. A. (Year of publication). <em>Title of work</em>. Location: Publisher.</th>
</tr>
</thead>
</table>

An article in an internet periodical:

|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

A motion picture or video tape:

<table>
<thead>
<tr>
<th>Style</th>
<th>Producer, P. P. (Producer), &amp; Director, D.D. (Director). (Date of publication). <em>Title of motion picture</em> [Motion picture]. Country of origin: Studio or distributor.</th>
</tr>
</thead>
</table>

**Further Information**

For more information about APA style, consult the *Publication Manual of the American Psychological Association* (5th edition) which can be found in most libraries. Also, consider looking at these web resources:

- The APA style website
  http://www.apastyle.org

- The Online Writing Lab (OWL) at Purdue University
  http://owl.english.purdue.edu/handouts/research/r_apa.html
Scale Drawing Sample

Description:
Sample 3-view scale drawing: front view on side, top and fuel view. Identification and use of scale, necessary use of dimension and labeling. Site of hidden line pair required.

Scale:
July 19, 2008
1cm = 2cm

Height – 11” –
Width – 17” –
Thank you for taking the time to give the MESA USA Event Committee feedback! Please email comments to your state representative (see list below).

We are very interested in all elements of this event. Please encourage students, teachers/advisors, judges and staff members to share positive experiences and constructive criticism. Please include ideas related to some or all of the following areas:

- Overall Difficulty
- Performance Tasks
- Communication Elements
- Rules
- Judging
- Scoring
- Event Management
- Other ____________________

Please identify the general area and provide detailed comments. Please feel free to include any photos or video from your respective activity.

Arizona.......................................Manny Leon................................... leon@arizona.edu
California ...................................Carlos Gonzalez............................. carlosg@engr.ucr.edu
Colorado.....................................David Ramirez ............................... david.g.ramirez@colorado.edu
Maryland....................................Tom Milnes.................................... Thomas.Milnes@jhuapl.edu
New Mexico...............................Anita Gonzales............................... anita@nmmesa.org
Oregon .......................... Tamara DePue ................................... tdepue@cecs.pdx.edu
Utah............................................Jeffrey Ojeda.................................. jeffrey.ojeda@schools.utah.gov
Washington ..............................Curt Sande ..................................... sande@wsu.edu
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.

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MESA USA
NATIONAL ENGINEERING DESIGN COMPETITION
WIND ENERGY CHALLENGE
2010-2011

Competition Overview
MESA USA presents its national engineering design competition specifications for the 2010-2011 year. The Wind Energy Challenge event involves the transfer of energy from the wind source to the defined tasks. The maximum amount of energy available to complete the tasks will be limited to that provided by the defined commercial fan and the task time constraints. High school and middle school teams selected to participate at the national event will compete in the four components below:

Performance – Teams will research, design, build, test and compete with a windmill device designed to capture and use the available wind energy to complete the tasks. The performance of the devices will be judged in the following tasks:
   a) Mechanical Power: greatest mass raised 75 cm in the least amount of time.
   b) Wind to Vehicle Kinetic Energy Transfer: greatest average kinetic energy achieved by the defined vehicle using average speed over the track distance.
   c) Electrical Power & Wind Direction Response: greatest average power output from the defined generator/electrical load during a 60 degree change in wind direction.
   d) Design Efficiency: greatest ratio of device performance score to device mass.
Middle school teams will compete in tasks a) and b). High school teams will compete in all three tasks.

Technical Paper – Teams will submit a 5-15 page technical paper that details the design, development, experimentation and understanding of their device.

Academic Display – Teams will present the findings of the above-described research in display format. The display should include items such as data (e.g., charts and graphs), photographs, drawings, other ideas, and necessary written explanations.

Oral Presentation – Teams will make an oral presentation based on investigation, experimentation, design, testing, and experiences related to their device. This presentation will be delivered to a panel of judges. After the presentation, teams will be asked questions by the judges.

Each team competing at the state and national level 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 June 23-26, 2011 hosted by Washington MESA. Feedback and comments are welcomed; please see the attached Activity Feedback Form.

Scoring Summary
Final team rankings will be based on the total score derived by adding all of the task scores.

<table>
<thead>
<tr>
<th>Category</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Performance</td>
<td>150</td>
</tr>
<tr>
<td>Device Efficiency</td>
<td>50</td>
</tr>
<tr>
<td>Technical Paper</td>
<td>100</td>
</tr>
<tr>
<td>Academic Display</td>
<td>100</td>
</tr>
<tr>
<td>Oral Presentation</td>
<td>100</td>
</tr>
<tr>
<td>Total Points</td>
<td>500</td>
</tr>
</tbody>
</table>

Automated Event Scoring Software is available
sites.google.com/site/MESAUSAWE
Objective
Students will build a Windmill that meets the criteria outlined in the rules and is designed to perform the following tasks:

Middle School
1. Mechanical Power: greatest mass raised 75 cm in the least amount of time. (2 trials)
2. Wind-to-Vehicle Kinetic Energy Transfer: greatest average kinetic energy achieved by the defined vehicle using average speed over the track distance. (2 trials)

High School
1. Mechanical Power: greatest mass raised 75 cm in the least amount of time. (2 trials)
2. Wind-to-Vehicle Kinetic Energy Transfer: greatest average kinetic energy achieved by the defined vehicle using average speed over the track distance. (2 trials)
3. Electrical Power & Wind Direction Response: greatest average power output from the defined generator/electrical load during a 60 degree change in wind direction. (2 trials)

Design Efficiency – greatest ratio of performance score to device mass

Materials
- Hazardous materials may not be used in the construction or operation of the device, including but not limited to lead.
- All other materials to build the device are legal and optional

Rules
General Rules
1. Teams must design, build and operate their own windmill device. This device will include all parts necessary to capture the wind energy and transfer it to the defined tasks. It may include multiple fan/turbine assemblies.
2. The device must be solely powered by the wind energy available from the defined commercial fan.
3. All designs that conform to the energy rules will be allowed to participate. All teams should carefully review design configuration to ensure that no additional energy is applied to the tasks.
4. Once performance competition begins, student teams may not have contact with non-competitors. Student teams are solely responsible for interaction with judges and addressing problems with their devices.

Test Configurations and Equipment
5. Fan, Device and Working Area: (Fig. 1)
   a. A six foot table will be used. Approximate dimensions of 30”x72”x29”.
   b. All parts of the windmill device must remain behind a line 50 centimeters from the end of the table.
   c. The Device Area shown is intended as a platform for the devices.
   d. The device may extend over the table edges to the sides and into the Working Area to complete the tasks.
   e. Devices may be taped to the table or floor surfaces.
   f. Teams may not touch their device once a task trial has begun.
   g. Teams will be allowed 2 minutes to configure their device before each trial.
Test Configurations and Equipment – continued

6. Mechanical Power – Raising a Mass (Figure 2)
   a. Fan speed will be set to high.
   b. Judge will use outlet strip to start the box fan-wind source and start the timer.
   c. Judge will stop timer when entire mass is above 75 cm, and record time.
   d. Judge will use outlet strip to stop box fan-wind source.
   e. Judges will weigh the detachable object and record the mass.
   f. Objects failing to reach 75 cm receive zero mass for that trial.
   g. Repeat procedure for 2nd trial.

7. Wind-to-Vehicle (Figure 3)
   a. The fan speed will be set to High.
   b. Teams will place the entire vehicle behind the “Start Line”.
   c. Teams will design their device to move the vehicle from behind the Start Line to the “Finish Line” as shown in Figure 3.
   d. Judges will use outlet strip to start box fan-wind source and start the timer.
   e. Judges will stop the timer when any part of the vehicle crosses the “Finish Line” within the boundary.
   f. Vehicles failing to reach the “Finish Line” or leaving the track boundary during a trial will receive zero speed for that trial.
   g. Repeat procedure for 2nd trial.

8. Electrical Power and Wind Direction Response (Figure 4)
   a. Student teams are required to use the specified generator to deliver electricity to the Electrical Load.
   b. Fan speed will be set to High.
   c. Fan motion will begin in Position #1 and rotate clockwise to Position #2.
   d. Judge will simultaneously start the box fan-wind source, and the Stopwatch timer.
   e. Starting at 10 seconds the box fan – wind source will be slid from left-to-right at approximately 10 degrees per 10 second.
   f. Judge will record the Average Power delivered to the load between 10 and 70 seconds.
   g. Repeat procedure for 2nd trial.
Test Configurations and Equipment - continued

Energy Source - Fan
9. Box Fan: Lasko Model 3733 – 20” 3-speed box fan or equivalent. These are 5-blade units that produce the following approximate wind speeds across their cross-sections when on the high setting:

<table>
<thead>
<tr>
<th>Average Wind Speed (meters/second)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lasko 3733</td>
</tr>
<tr>
<td>2.60 @ 75cm</td>
</tr>
</tbody>
</table>

10. No part of the windmill device may be placed farther than 50 centimeters from the end of the table.
11. An outlet strip will be used as the on/off switch for the fan, allowing desired fan speed to be set.

Electrical Load – Electrical Power and Wind Direction Task
12. Generator:
   - KidWind –
   - Wind Turbine Generator, SKU KWM001A
   - or SKU KWM001B
13. Resistor & Base:
   - Radioshack –
   - 10 Ohm Carbon-Film Resistors (5-Pack), Catalog #: 271-013 or 271-1301 and 2-Position Dual-Row Barrier Strips, Catalog 274-656

Task Details -
14. Mechanical Power – Raising a mass
   - The teams will provide all materials necessary to complete the task, including detachable object(s) to be raised during this task.
   - The teams will select the mass and shape for the objects to be raised.
   - The shape and volume of the object(s) and windmill device design must allow the objects to be raised from contact with the ground to a point completely above the target height of 75 centimeters.
   - The object’s mass and the time taken to lift the object will determine the power achieved (mJ/s).
   - Teams will be allowed 2 minutes for setup of their device and mass for each attempt.
   - The mass must be raised above the table in 1 minute or less.
   - Two attempts will be recorded and the best performance is used in scoring.

15. Wind-to-Vehicle Kinetic Energy Transfer
   - The team must provide all materials to complete the task, including their vehicle.
   - The device must accelerate their vehicle from behind the “Start Line” to the “Finish Line”.
   - The vehicle must have a mass of at least 200 grams.
   - Teams will be allowed 2 minutes for setup of their device for each attempt.
   - The vehicle must cross the finish line in 1 minute or less.
   - The vehicle must remain in contact with the floor throughout the trial from start to finish.
   - The vehicle mass and speed will be used to determine the kinetic energy of the vehicle (J).
   - Two attempts will be recorded; the best performance will be used in scoring.

16. HIGH SCHOOL ONLY – Electrical Power and response to change in Wind Direction
   - The team must configure their device to use the defined generator to deliver the resulting electrical power.
   - The generator label or marking must be visible or accessible for inspection.
16. (continued) HIGH SCHOOL ONLY – Electrical Power and response to change in Wind Direction
   c. The team must have the generator wires arranged to allow for judge to connect Electrical Load and Power Measurement Equipment.
   d. The device must respond to a 60 degree change in wind direction over a 60-second time span.
   e. Average Power measurement will be taken between 10 and 70 seconds from start of fan.
   f. The Electrical Power measurement method will use Vernier equipment and Logger Pro software to monitor average power delivered to the load resistor during each trial. Each state, region or classroom program may use the alternative method during preparation.
   g. Two attempts will be recorded; the best performance will be used in scoring.

17. Design Efficiency:
   a. The device mass will be measured as a part of the device inspection. All parts used to complete the tasks will be included except vehicle mass, lifted masses and tape used to secure device during performance.
   b. The Total Performance score from the Mechanical Power, Wind to Vehicle & Electrical Power tasks will be divided by the device mass in kilograms to determine Device Efficiency in points per kilogram.

Construction and Repair
18. Teams should consider the cost of shipment of device to the local events. It is recommended that teams design their device to be disassembled for shipment in a large suitcase(s).
19. Repairs are allowed, replacement parts and materials only, and all repairs must be done in the impound area under supervision of a judge. The addition of new or alternate parts not previously included is NOT allowed.

Safety
20. Standard safety practices including the use of protective eyewear must be observed.
21. 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.
22. 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
23. The trial order for performance events will be randomly selected.
24. 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.
25. Devices must be in testing condition prior to device inspection. If devices are disqualified during inspection check, design changes will not be allowed. Only devices passing inspection will be allowed to participate in the performance tasks.
26. All repair materials to be used during the competition must be impounded with the device. Devices will be released for trials but will remain impounded between tasks.
27. Each device must be ready for competition when called or forfeit that trial.
28. After teams arrive at task station, Judges will direct them to setup for the task.
29. Trial setup is limited to 2 minutes for each trial.
30. The team member responsible for operation of the device will indicate to the judge that the device is in the “ready-to-operate” position.
31. Students may not touch or interfere with the device once a task trial has begun.
32. If during operation a device is found to violate rules those trials will be disqualified.
33. Designs which prevent correct measurement of average power or kinetic energy will be disallowed.
# Measurement Equipment

## Raising a Mass
- Meter stick
- Stopwatch or video analysis
- Postal Scale (grams)

## Wind to Vehicle
- Meter stick
- Stopwatch or video analysis
- Postal Scale (grams)

## Electrical Power & Wind Direction

<table>
<thead>
<tr>
<th>Required</th>
<th>Vernier equipment (stand alone)</th>
<th>Vernier equipment (PC option)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-ohm Resistor 1/8 or 1/4 watt</td>
<td>Labquest</td>
<td>Logger Pro Software</td>
</tr>
<tr>
<td>2 Row Barrier Strip</td>
<td>Differential Voltage Probe (DVP-BTA)</td>
<td>Differential Voltage Probe (DVP-BTA)</td>
</tr>
<tr>
<td>2 Alligator clip leads</td>
<td></td>
<td>GoLink! (GO-LINK)</td>
</tr>
</tbody>
</table>

## Electrical Power Measurement: Vernier Equipment Setup Details

Both the Labquest and Logger Pro options allow the user to capture a graph of the power calculated from the voltage output and the value of the resistor (10-ohms) versus time. They also allow the user to determine the Average Power between to times, 10 and 70 seconds for this application. ([http://www.vernier.com/](http://www.vernier.com/))

Alternative Method: Averaging the calculated power at multiple positions during the trail. It is recommended that measurements be taken at 10, 40 and 70 seconds. Multiplying the voltage and current readings for each measurement determines the power. Averaging of the three readings determines the team score. The circuit is arranged for one multi-meter to measure current (mA) and the other voltage (V).

- Generator provided by team and connected to their device with label showing
- Alligator clip leads will be used to attach Electrical Load and meters to generator
Wind Direction Platform

Supplies:
- Main Platform – 1 x 12 (3/4”x11”) x 60”
- Main Arc – 1 x 6 (3/4”x5½”) x 40”
- Fan Contour Arc – 1 x 2 (3/4”x2”) x 20”
- Small hinges (optional)
- Screws – 1 ½” sheetrock screws

Instructions
1. The Main Platform remains the same.
2. The Main Arc requires a 100 cm radius arc be cut. This maintains the wind direction toward the Device Area center. Remove the hatched area shown.
3. Align the Main Arc with Main Platform as shown in photo below and secure with screws.
4. Optionally, the final product may be cut in half and hinged on the top surface as shown in photo below.
5. The Fan Contour Arc is attached to the box fan base and also maintains the wind direction toward the Device Area center. Remove the hatched area shown.
6. Remove screws from front of box fan; Align holes on Fan Contour Arc and pre-drill. Assemble Fan Contour Arc to box fan as shown in photo.
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

**Mechanical Power – Raising a mass**

1. Team Power Score \( P_{tm} = \frac{(\text{Trial mass}[\text{grams}] / \text{Trial time}) \times (9.8 \text{ m/s}^2) \times (0.75 \text{ m})}{} \) [units: mJ/s]
2. Task Winner = Greatest team power score \( P_{wm} \) receives maximum points (75 or 50).
3. Task Points = Team Power \( P_{tm} \) divided by \( P_{wm} \), times max points or

\[
\text{Task Points} = \frac{P_{tm}}{P_{wm}} \times 75 \quad \text{or} \quad \frac{P_{tm}}{P_{wm}} \times 50
\]

**Example**

<table>
<thead>
<tr>
<th>Task Winner</th>
<th>Example</th>
<th>Team 5 Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winning Power ( P_{wm} ) = 156 mJ/s</td>
<td>Team 5</td>
<td>Middle School Score = (145.9/156.0) x 75 = 70.18 pts</td>
</tr>
<tr>
<td></td>
<td>Trial 1: mass=144g, time=7.25s</td>
<td>High School Score = (145.9/156.0) x 50 = 46.76 pts</td>
</tr>
<tr>
<td></td>
<td>Trial 2: mass=160g, time=10.16s</td>
<td></td>
</tr>
<tr>
<td>Team Power ( P_{tm} ) = 145.9 mJ/s</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Wind-to-Vehicle Kinetic Energy Transfer Task (Middle and High School)**

1. High School Team Kinetic Energy \( KE_a \) = \( \frac{1}{2} \times (\text{mass of vehicle}[\text{grams}] \times (\text{speed of vehicle})^2 \) [units: mJ]
   - mass of vehicle = as measured (grams)
   - speed of vehicle = Distance (2.5 meters) / Team Time (seconds)
2. Task winner \( KE_a \) = Greatest kinetic energy achieved by a vehicle.
3. Task Points = Team kinetic energy \( KE_t \) divided by \( KE_a \), times max points or

\[
\text{Task Points} = \frac{KE_t}{KE_a} \times 75 \quad \text{or} \quad \frac{KE_t}{KE_a} \times 50
\]

**Example**

<table>
<thead>
<tr>
<th>Task Winner – Best Trial</th>
<th>Example</th>
<th>Team 5 - Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winning Speed &amp; Mass = 2.5m / 9.54 s = 0.262 m/s = 200 grams</td>
<td>Team 5 – Best Trial</td>
<td>Middle School Score = 3.55/6.87 x 75 = 38.75 pts</td>
</tr>
<tr>
<td>Winning Energy ( KE_a ) = 6.87 mJ</td>
<td>Best Speed &amp; Mass ( = 2.5m / 13.26 s = 0.188 m/s = 200 grams )</td>
<td>High School Score = 3.55/6.87 x 50 = 25.84 pts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Assigning Points to Performance - continued

Electrical Power and Change in Wind Direction (High School)

1. High School Team Power (\(P_t\))
   Vernier Equipment (Labquest or PC/Logger Pro) Method:
   = Average Power determined by graphing and averaging the delivered power between 10 and 70 seconds, in millijoules/sec or milliwatts (mW).
   - Average (\(P_t\)) = Direct Measurement
   Alternative Method:
   = Average of Resistor Power measured at three times (10, 40 & 70 seconds) in millijoules/sec or milliwatts (mW).
   - Power (P) = Voltage (volts) x Current (milliamps)
   - Average (\(P_t\)) = \((P_{10} + P_{40} + P_{70})/3\)

2. Task winner (\(P_w\)) = Greatest Average Power delivered to the load resistor.

3. Task Points = Team Power (\(P_t\)) divided by (\(P_w\)), times 50 points

\[
\text{Task Points} = \frac{P_t}{P_w} \times 50
\]

<table>
<thead>
<tr>
<th>Task Winner – Best Trial</th>
<th>Example</th>
<th>Team 5 - Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winning Power ((P_w)) = 31.17 mW</td>
<td>Team 5</td>
<td>High School =</td>
</tr>
<tr>
<td>Team Power ((P_t)) = 27.63 mW</td>
<td></td>
<td>((27.63)/(31.17) \times 50 = 44.31 \text{ pts})</td>
</tr>
</tbody>
</table>

Total Performance Score:
1. Middle School Performance Score
   = Mechanical Power + Wind to Vehicle
2. High School Performance Score
   = Mechanical Power + Wind to Vehicle + Electrical Power & Wind Direction

Design Efficiency Score:
1. Design Efficiency (DE) =
   Total Performance Score divided by the designed device mass (\(M_d\))
2. Device mass is measured in kilograms, excludes vehicle mass, lifted masses and tape used to secure the device.
3. Design Winner =
   Highest Design Efficiency (\(DE_w\)) receives 50 pts
4. Design Score =
   Team Performance Efficiency (\(DE_t\)) divided by (\(DE_w\)) times 50 pts

\[
\text{Design Score} = \frac{DE_t}{DE_w} \times 50
\]

Example

**Design Efficiency Score:**
Winning Design Efficiency (\(DE_w\)) based on:
- Team Performance Score = 147.65 pts
- Team Device Mass = 4.32 kg
Winning \(DE_w = 147.65 / 4.32 = 34.18 \text{ pts/kg}\)

Team 5 Design Efficiency (\(DE_t\)) based on:
- Team 5 Performance Score = 133.9 pts
- Team 5 Device mass = 5.73 kg
Team 5 \(DE_t = 133.9 / 5.73 = 23.35 \text{ pts/kg}\)
Team 5 DE Score = \((23.35/34.18) \times 50 = 34.14 \text{ pts}\)
Objective
To clearly document their engineering design process, MESA students participating in the MESA USA National Engineering Design Competition will write a technical paper regarding the principles, design, and performance of their device.

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

Electronic Format
Teams are required to save the document in Portable Document Format (PDF) or Microsoft Word format prior to submission. Teams shall also ensure the submitted final product can be read using Adobe Reader (8.0 or newer) or Microsoft Word (2003 or newer) and matches their original document.

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 needed for information or writing assistance, their names should be included in the references.

Deadline
The technical paper must be submitted via e-mail to Washington MESA on or before 5:00 pm local time on Tuesday, June 1, 2011. The papers will be judged and scored prior to the National Competition. Papers shall be e-mailed to: Washington MESA, Head Judge at WAMESA@uw.edu.

Written Presentation
The paper should be typed, double-spaced, and have a cover sheet. Graphics should be computer generated. The font used should be Times New Roman and the font size should be 12. A one-inch margin is required on all sides. Readability will help your paper achieve a higher score in the judging.

The paper should include the following:
A. Title Page
B. Abstract
C. Table of Contents
D. Introduction
E. Discussion
F. Conclusions
G. Recommendations
H. References or bibliography
I. Acknowledgments
J. Appendices (Optional)

Title Page
Title, Authors, State, School and Date need to be included

Abstract
This section is a brief synopsis of your project, 200-250 word. It is the most important part of your paper, stating the purpose and most important features of the report, the main conclusions and recommendations. It should be written in informative, non-technical terms and be interesting so that the reader is drawn to read further.
Table of Contents
Table of contents should correctly identify each required component of the paper.

Introduction
This is the narrative that prepares readers for the discussion that follows. It provides background for the reader before introducing any technical data. It is broken down into three sections that average one to two paragraphs each:
- Purpose: why the project was initiated and why the report was compiled (e.g., to solve a problem, to evaluate or introduce a new concept, etc.)
- Scope: defines the parameters of your report; outlines methods of investigation and any limiting factors
- Background Information: presents facts the reader should know, conditions or events prior to the project, details of previous reports

Discussion
This is the longest section of the paper. It presents and discusses all evidence (facts, arguments, data, tables, charts, graphs, etc. are referred to and explained here but should be located in the appendix).
1. Summarize the teams’ device development, including a general description of design research, design selection and modifications made to satisfy event rules and task objectives.
2. Discuss physical phenomena related to the device. (e.g. Teams are encouraged to examine and report on potential and kinetic energy, work, aerodynamics, drag, velocity, force acceleration, mechanical advantage and other factors influencing the performance of their device. Newton’s laws of motion may also be addressed in describing the movement of the device using terms such as action/reaction, mass, momentum, inertia, etc.)
3. Use of advanced concepts, techniques, algorithms or other materials that would not normally be included in middle or high school subjects must be explained. The paper must show how the team’s research and work led to their selection and use. Appendices may be used for this purpose.
4. Experimental procedures and test setup (pictures or diagram)
5. Data reduction, analysis tools and models
6. Data (Table, graphs, charts, pictures, diagrams)
7. Results

The discussion section should be imaginative enough to hold the reader's interest and organized logically. Three common ways to organize are shown below:
- Chronological development: present information in order of occurrence, usually the easiest way to organize
- Subject development: present information by subjects, grouped in a predetermined order
- Concept development: arrange information as a series of ideas that reveal the reasoning process used to reach the conclusions; requires more careful organization but allows more creativity and persuasion. Writers should anticipate reader reactions. If presenting a controversial concept, establish a strong case before discussing it in detail. If presenting a popular or familiar concept, briefly and simply establish your case.
Conclusion
In this section, state the major inferences that can be drawn from the discussion. Be sure the evidence was presented in the discussion section. No new evidence should appear in this section.

Recommendations
This section is used to indicate further work to be done or to indicate the best solution when several solutions have been presented. Write recommendations, in strong definitive terms using first person and active verbs.

References
All sources that are consulted should be properly cited. See Resource Materials section for example references and additional information.

Acknowledgments
This section should be used to recognize individuals or groups who have provided support and guidance throughout the design process.

Appendices (optional)
This section contains, in detail, supporting data, charts, tables, photographs, test results, etc.

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 (40 pts)
• Abstract (20 pts)
• Introduction (15 pts)
• Conclusion & Recommendations (15 pts)
• Written Presentation (10 pts)
Objective
The purpose of the display is to provide a visual representation of the engineering design process used to develop the team’s device. Teams will present their device and relevant aspects of the design project from the technical paper. The focus of the display should only be the actual device presented for performance.

Materials Provided
- 30” x 72” x 29” (cafeteria style) table along with skirting

Form, Key Features & Organization
- The maximum display area is equivalent to two 36” x 48” tri-fold presentation boards placed side-by-side on the table.
- The entire display must be on the table and not extend beyond the table top. Displays may be taped to the table for stability.
- Electronic media are not allowed.
- The team state, school and members should be prominently displayed.

Required Elements
- **Abstract** – A brief synopsis of the project, 200-250 words
  ▪  State the purpose and the most important features from the technical paper, the main conclusions and recommendations
  ▪  It should be written in informative, non-technical terms and be interesting to the reader
- **Data and Technical Explanation** – Teams will show their exploration and share explanations of their device and the scientific and engineering ideas involved in the project
  ▪  **Teams should include key physics concepts as well as engineering challenges and solutions**
  ▪  Teams should incorporate text, photographs, drawings, images, tables, charts, graphs, models etc. that share information relevant to the overall project
  ▪  Teams may identify the features of the device using a system of labels or pointers
    ▪  Include modifications made to your device to ensure that it is a top contender.
    ▪  Teams are also encouraged to examine potential and kinetic energy, mechanical advantage, friction, work, Newton’s Laws of Motion, and any other pertinent topics.
- **Scaled Drawing** – A three-view drawing depicting the actual device designed and built.
  ▪  See Resource Materials section for example scaled drawing format
  ▪  Front, side, and top views should be included, see sample page 28
  ▪  All parts of the device should be labeled
  ▪  3” x 5” Title Card including drawing title, brief description, date completed, and scale used
  ▪  Photographs are not permitted in place of a scaled drawing
  ▪  Scaled drawing may be drawn by hand or computer generated, both methods scored equally.
  ▪  Maximum paper size shall be 11”x17”
• **Cost and Labor Summary** – A table summarizing essential cost and labor details of the project.
  - Minimum size – 8 ½” x 11” sheet of paper
  - Required Content:
    - Materials – description, source, purchased or donated, actual or estimated cost. Include an estimated total cost.
    - Labor – estimated student hours applied to complete project elements; Device, Technical Paper, Academic Display & Oral Presentation.

• **Project Introduction** - Teams must be prepared to introduce themselves to Academic Display Judges and respond to questions about their project and academic display. Time with judges not to exceed 5 minutes.

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

• Technical Explanations & Data Presentation (40 pts)
• Scaled Drawing & Cost-Labor Summary (30 pts)
• Form, Key Features & Organization (10 pts)
• Abstract (10 pts)
• Creativity (10 pts)

**MESA USA Public Viewing of Academic Displays**
The public viewing of the academic displays at the MESA USA event give an opportunity for guests to visit each team display and ask questions.

• At least one team member should be present during the public viewing
Objective
The purpose of the presentation is to provide information about the engineering design project to a panel of judges. 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. Speeches must be the original work of the team.

Materials Provided
- table
- easel board
- overhead projector
- PC computer with Microsoft PowerPoint 2003 or newer
- LCD projector and screen

Required Elements
- The processes and procedures used in design development.
- Discussion of related physical phenomena.
- Observations and data related to any experiments, testing or research conducted.
- Conclusions derived from the engineering design process.

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. Props, models, charts, graphs or other visual aids should be used.
3. Electronic presentations using Microsoft PowerPoint are allowed but are limited to text and images. Other electronic materials not allowed. Teams should not rely heavily on electronic media.
4. Teams are expected to bring their presentation on either a CD or USB flash drive.
5. Each team may speak for a maximum of 10 minutes. A 5-point deduction will be applied for presentations exceeding 10 minutes. Judges will expect to hear directly from all team members.
6. Once the presentation begins, audience interruptions will not be permitted.
7. Teams are expected to do research. They may interview and quote experts, associates, or use quotations from written sources. They may provide examples, and/or use illustrations, facts, and figures.
8. All key concepts should be well understood by the team. The use of advanced concepts, techniques, algorithms or other materials that would not normally be included in middle or high school subjects must be explained. Teams must explain how their research and work led to their selection and use.
9. Teams will be randomly selected to determine speaking order.
10. Students must give their presentations in the order drawn. No exceptions or late arrivals are allowed.
11. Judges will provide time signals at 3 mins, 1 min, 30 sec, and 5 sec before time is called.
12. Once the presentation is complete, the judges will conduct a 5-min 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
Shown below are the main areas that will be considered in the evaluation of the Oral Presentation. See the Scoring Materials section for specific details and overall criteria.
- Technical Content (40 pts)
- Overall Presentation (30 pts)
- Oral & Visual Performance (20 pts)
- Question Responses (10 pts)
## Inspection and Performance Datasheet

**MESA Center:______________________________**

**MESA School – Level (MS/HS):______________________________**

**Advisor/Teacher:______________________________**

**Student Team:______________________________**

### Inspection

Sole Energy Source Box Fan ONLY ................................................................. Y / N
Vehicle Mass (200 grams or more) ........................................................................ Y / N
Generator: KidWind.org – Wind Turbine Generator, SKU KWM001A or KWM001B ......... Y / N
Electrical Load: 10-ohm resistor provided by event host ........................................ Y / N

**Device Mass:** All parts excluding vehicle mass, lifted masses & tape… ................. __________ kg

### Performance

**Mechanical Power**

<table>
<thead>
<tr>
<th>Trial 1</th>
<th>Trial 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>mass (grams)</td>
<td>mass (grams)</td>
</tr>
<tr>
<td>Start: __________</td>
<td>Stop __________ (sec)</td>
</tr>
</tbody>
</table>

**Wind-to-Vehicle Kinetic Energy Transfer**

<table>
<thead>
<tr>
<th>Trial 1</th>
<th>Trial 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>vehicle mass (grams)</td>
<td>vehicle mass (grams)</td>
</tr>
<tr>
<td>Start: __________</td>
<td>Stop __________ (sec)</td>
</tr>
</tbody>
</table>

**Electrical Power & Wind Direction (high school only)**

<table>
<thead>
<tr>
<th>Trial 1</th>
<th>Trial 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vernier/Logger Pro Method</td>
<td>Vernier/Logger Pro Method</td>
</tr>
<tr>
<td>Average Power: ______________ (mW)</td>
<td>Average Power: ______________ (mW)</td>
</tr>
</tbody>
</table>

3-Sample Method

- 10-second measurements
  - Position 1 Voltage: ______________ (volts)
  - Position 1 Current: ______________ (mA)
- 40-second measurements
  - Position 2 Voltage: ______________ (volts)
  - Position 2 Current: ______________ (mA)
- 70-second measurements
  - Position 3 Voltage: ______________ (volts)
  - Position 3 Current: ______________ (mA)
## TECHNICAL PAPER SCORING CRITERIA

### 2010-2011 MESA USA National Engineering Design Competition

**TEAM:**

**SCHOOL:**

**LEVEL: MS or HS**

### Discussion

- **a.** Very thorough discussion of Physics, Math and/or Engineering concepts, including advance concepts if used.
- **b.** Very complete description of experimental/testing procedures including diagrams or pictures.
- **c.** Thorough description of data analysis, any subsequent calculations performed or other operations to explore the data.
- **d.** High level of detail, tables, graphs, charts, etc. useful to report.
- **e.** Clearly engages and informs the reader.

### Abstract

- **a.** Effective discussion of key concepts, including advanced concepts if used.
- **b.** Effective description of procedures including diagrams or pictures.
- **c.** Good description of data analysis.
- **d.** Very well written, includes some technical terms.
- **e.** Modestly engages and informs reader.

### Introduction

- **a.** Very good restatement of Purpose & Key Features.
- **b.** Very clear restatement of Conclusions & Recommendations.
- **c.** Well written, but includes some technical terms.
- **d.** Well restated the reader.

### Conclusion & Recommendations

- **a.** Conclusion: Inferences follow very logically from discussion evidence.
- **b.** No new material included.
- **c.** Further work/best solution well identified.
- **d.** Written in first person with active verbs.

### Written Presentation

- **a.** Effective restatement of Purpose/Key Features.
- **b.** Good restatement of Conclusion or Recommendations.
- **c.** Engages and informs the reader.

### Points Score

<table>
<thead>
<tr>
<th>Points</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>16/20</td>
<td>40=32</td>
</tr>
<tr>
<td>/20 x 20=</td>
<td></td>
</tr>
</tbody>
</table>

### Judge Feedback:

Release Date: August 26, 2010

---

**Judge:**

**Score:**

**Total:**
# ACADEMIC DISPLAY SCORING CRITERIA

**TEAM:**

<table>
<thead>
<tr>
<th>Technical Explanations &amp; Data Presentation</th>
<th>Scaled Drawing – Cost &amp; Labor Table</th>
<th>Form, Key Features &amp; Organization</th>
<th>SCHOOL:</th>
</tr>
</thead>
<tbody>
<tr>
<td>b. Engineering Ideas</td>
<td>e. Title Card &amp; Labeling</td>
<td>b. Team School &amp; Members</td>
<td>a. Length,</td>
</tr>
<tr>
<td></td>
<td>e. Labor</td>
<td>c. Key Features</td>
<td>b. Purpose &amp; Key Features</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e. Layout</td>
<td>c. Conclusions &amp; Recommendations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>d. Non-technical</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>e. Informative &amp; Interesting</td>
</tr>
<tr>
<td>a. Use of graphics for data</td>
<td></td>
<td></td>
<td>Creativity</td>
</tr>
<tr>
<td>b. Use of labels/pointers</td>
<td></td>
<td></td>
<td>a. Visual Appeal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Holding Interest</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c. Use of models</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Level 4 – 4 points each**
  a. Excellent description of 3-4 key Physics concepts
  b. Excellent description of 3-4 Engineering challenges/solutions
  c. Tables & graphs provide very relevant information to reviewer
  d. Very effective use of labels/pointers to highlight features of device or data

- **Level 3 – 3 points each**
  a. Good description of 2-3 key Physics concepts
  b. Good description of 2-3 Engineering challenges/solutions
  c. Tables & graphs used effectively
  d. Good use of labels/pointers

- **Level 2 – 2 points each**
  a. Poor description of Physics concepts
  b. Poor description of Engineering ideas
  c. Tables & graphs provide little information
  d. Labels/pointers poorly used

- **Level 1 – 1 point each**
  a. Little or no discussion of Physics concepts
  b. Little or no discussion of Engineering ideas
  c. Few or no tables & graphs provided
  d. Few or no labels/pointers used

---

### Points Score

- **/16 x 40 = Total**
- **/24 x 30 = Judge**
- **/20 x 10 =**

---

**Judge Feedback:**
## ORAL PRESENTATION SCORING CRITERIA

### 2010-2011 MESA USA National Engineering Design Competition

**TEAM:**
**SCHOOL:**
**LEVEL: MS or HS**

### Technical Content
- a. Physical Phenomena
- b. Process & Procedures
- c. Data and Explanations
- d. Observations
- e. Conclusions

### Overall Presentation
- a. Introduction
- b. Topic
- c. Flow
- d. Content
- e. Engagement of the Audience

### Oral & Visual Performance
- a. Student Voice
- b. Presence
- c. Eye Contact
- d. Collaboration
- e. Visual Material

### Question Responses
- a. Accurate & Specific
- b. Depth of Knowledge

### Level 4 - 4 points each
- a. Several examples of physical phenomena of topic well explained & understood, including advanced concepts if used
- b. Process & Procedures of development well described
- c. Data explanations very clear and tied to topic
- d. Observations direct from experiments, testing or research
- e. Conclusions well thought out and accurate

### Level 3 - 3 points each
- a. Some examples of physical phenomena of topic explained & understood, including advanced concepts if used
- b. Some of the design process well described
- c. Data presented/explained well, not related to topic
- d. Observations follow from experiences, not clearly from experiments, testing or research
- e. Conclusions lack detail or include a misconception

### Level 2 - 2 points each
- a. Very few examples of physical phenomena of topic, including advanced concepts if used
- b. Very little of design process described
- c. Unclear data, poorly explained, not related to topic
- d. Observations do not follow from experiences, limited evidence of experiments, testing or research
- e. Conclusions unrelated to technical content or includes misconception

### Level 1 - 1 point each
- a. No discussion of physical phenomena related to topic, including advanced concepts if used
- b. No discussion of design process
- c. No data collection or analysis presented
- d. No Observations made, or do not follow from activities
- e. No conclusions or recommendations provided

<table>
<thead>
<tr>
<th>Technical Content</th>
<th>Overall Presentation</th>
<th>Oral &amp; Visual Performance</th>
<th>Question Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>a, b, c, d, e</td>
<td>a, b, c, d, e</td>
<td>a, b, c, d</td>
<td>a, b</td>
</tr>
</tbody>
</table>

### Points
- /20 x 40=
- /20 x 30=
- /20 x 20=
- /8 x 10=

### Judge Feedback:
- What do you think would happen if ...?
- Describe a situation when you resolved a design problem.

### Sample Questions
- Please elaborate on your description or explanation of...?
- What were the most difficult parts of the paper, performance tasks or academic display? And why?

### Judge Attire
- 5 point deduction MESA USA event shirts required

### Time
- 5 point deduction for over time limit

### Total
Overview
The Wind Energy Challenge competition involves the following performance components with their maximum points in parentheses: Technical Paper (100 pts.), Academic Display (100 pts.), Oral Presentation (100 pts.), Device Performance (150 pts) and Design Efficiency (50 pts). The purpose of these guidelines is to outline the procedures for effectively judging this competition.

Preliminary Assignment
All judges need to read and become familiar with all rules, judging guidelines, and scoring criteria regarding their assignment.

Judging the Technical Paper
1. Read each paper without using the scoring criteria.
2. Using the scoring criteria, revisit each paper and assign a score to each paper.
3. Submit a score sheet for each paper to the lead judge.

Judging the Academic Display
1. View each Academic Display without using the scoring criteria.
2. Listen to team Project Introductions.
3. Using the scoring criteria, revisit each display and assign a score to each display.
4. Submit a score sheet for each display to the lead judge.

Judging the Oral Presentation
1. Judges will assemble all competing students in the room. The rules and judging criteria will be read. Teams will be allowed to ask any questions pertaining to the competition at this time.
2. Judges will excuse all teams from the room.
3. Judges will review rules for audience with all observers. Opposing teams are not allowed to participate as audience members.
4. Once the presentation begins, no one will be allowed to enter or leave the room until the presentation is complete. Audience members are not allowed to disrupt or aid the team (e.g. talking, gesturing, etc.). Any non-complying audience members may be asked to leave.
5. Judges will provide time signals for students at 3 minutes, 1 minute, 30 seconds, and 5 seconds before time is called.
6. Judges will have five minutes to ask questions of the team. To the furthest extent possible, the judges should ask questions that are specific to the team. This includes their technical paper, academic display, oral presentation, and/or device.
7. Using the scoring criteria, assign a score to each presentation.
8. Submit a score sheet for each presentation to the lead judge.

Judging the Device Performance
The device performance is the most valued component of the competition (150 points maximum). In addition to the rules, the judge must be aware of the equipment and track specifics, what specifically is being judged, and how to assign a score to each task.
Preferred Timing & Measurement Method: Video Recorded Analysis
This method provides an effective way to document and measure the times and monitor performance for the tasks. A digital camera or web camera is used to record the performance. These images are inserted into video analysis software. Start and Finish times and other measurements are identified on the video and entered into the scoring tools.

a. Nightlight: inserted in the outlet strip, if it does not have a bright on/off switch or indicator. The outlet strip is placed in the video image for the task. This allows for easy identification of the start of each task. See setup images below. ($1-3 per setup)

b. Digital or Web Camera: placed in a fixed position (tripod) viewing the task area, see setup images below. These cameras usually record 15, 30 or 60 frames per second (fps) providing increasing time resolution of 0.066, 0.033 or 0.017 seconds respectively.

c. PC/Mac and Vernier Logger Pro software: video images are recorded separately and imported or directly recorded into Logger Pro. A scan and marking of the images for times associated “start” and “finish” or voltage readings provide data for scoring. ($180)

d. A demonstration and instructions will be placed on the resource web site (http://sites.google.com/site/MESAUSAWEC).

Electrical Power Measurement: Vernier Equipment Arrangement
Both the Labquest and Logger Pro options allow the user to capture a graph of the power calculated from the voltage output and the value of the resistor (10-ohms) versus time. They also allow the user to determine the Average Power between two times, 10 and 70 seconds for this application. (http://www.vernier.com/)
Device Inspection and Impound (teams called according to drawn competition order)

Measurement Equipment:
- Mechanical Power: Raised Mass - Postal Scale ( >200 gram , with +/- 1 gram accuracy)
- Wind to Vehicle: Vehicle Mass - Postal Scale ( >200 gram , with +/- 1 gram accuracy)
- Meter sticks
- Example Electrical Generator & Lamp
  a. Generator Part#: SKU KWM001A or KWM001B, KidWind.org
  b. 10-ohm Resistor Part #: RS 272-013 or RS 272-1301, Radioshack

Station 1 - Sign-in, take photo of team with device and sign with school name for visual record
Station 2 - Review device operation to ensure box fan will be sole energy source.
Station 3 - Inspect and Record characteristics materials to be used in the tasks:
  1. Mass of object lifted in Mechanical Power task.
  2. Mass of vehicle to be moved in Wind-to-Vehicle task.
  3. Part # of the lamp used in the Electrical Power and Wind Direction task.
  4. Part # of the generator used in the Electrical Power and Wind Direction task.
  5. Device Mass: all parts excluding vehicle mass, lifted masses, and tape used to secure device.
Station 4 - Impound device and all materials…guide students to student seating area.

Competition Management (teams called according to drawn competition order)

Team In-the-hole
Team moves from the student seating area and gathers device from impound area.

Team On-deck
Team moves from impound area to On-Deck area and prepares device for next task.

Team Up
Team moves from On-Deck area to the task area and prepares device for task.
1. Judge – DIRECTS team to prepare device for task. (timed)
2. Students – PREPARE device for operation indicate “ready-to-operate” status and WAIT.
3. Judge – ACKNOWLEDGES team “ready status”.
4. Judge – VERIFIES equipment setup
5. Judge – PREPARE timers and/or STARTS recording equipment:
6. Judge – STARTS trial…SWITCHES “ON” outlet strip/fan
7. Judge – MARKS and RECORDS the following:
   a. Violations, as needed
   b. Mechanical Power
      - Total Time (xx.xxx seconds) OR Start/Stop Times on recoding equipment
      - Object Mass (xx.xxx grams)
   c. Wind-to-Vehicle
      - Total Time (xx.xxx seconds) OR Start/Stop Times on recoding equipment
      - Vehicle Mass (xx.xxx grams)
   d. Electrical Power & Wind Direction
      - Total Time (xx.xxx seconds) OR Start/Stop Times on recoding equipment
      - Average Power (xxx.xxx) or Voltage/Current (xx.xxx) reading at 10, 40 & 70 seconds
   e. Performance and Rule Violation Comments
Using the Scoring Criteria

MESA USA recognizes that evaluation of student work can be very subjective. The scoring criteria provided with event materials are intended to guide evaluation and provide a more consistent method for assigning scores to student work. The effective evaluation of their work is important to providing effective feedback for them as they continue their education and postsecondary careers.

Each Scoring Criteria sheet has been arranged as follows (see sample below):
1. Divided into columns – representing key topics of evaluation.
2. Each column or topic title also lists sub-topics for scoring.
3. Within each column, four (4) performance levels are shown.
4. Within each performance level items a-f provide descriptions of varying levels of performance.

Recommended strategy for assigning scores to an evaluation:
1. Review the topic (column) and sub-topics (a-f) within each.
2. Highlight the scoring level description you feel the team has achieved for each sub-topic a-e.
   NOTE: Each sub-topic a-e should only be highlighted once per topic (column)
3. Repeat this for each topic to complete
4. Each highlighted description earns the assigned points for that scoring level.
5. Use automated scoring or complete included formulas, add all the scores, including deductions, and enter the total score.
6. Written feedback is strongly encouraged. Provide constructive feedback on the strengths and weaknesses of particular topics or sub-topics.

### SAMPLE SCORE (Technical Paper – Discussion, shown above)

a. Physical Phenomena earns 3 points
b. Experimental Procedures earns 4 points
c. Data and Analysis earns 2 points
d. Tables and Charts earns 4 points
e. Results earns 3 points

**DISCUSSION SCORE**

16 pts / 20 max pts x 40 topic pts = 32
National Competition Weekend Order of Events (recommended)

Prior to the Event:
I. Technical Paper Judging

Friday:
II. Rules Review Meeting - The lead judge will review the judging process with team members and their respective advisors.

III. Wind Energy Challenge Practice Testing (at competition site if possible)
Student teams will be allowed to test their respective devices. Non-competitors will not be allowed in the performance area. Head Judge will be available to assess legality of design according to the rules.

IV. Academic Display Set-Up - Advisors or other family members will not be allowed into the display area. Student teams will be responsible for display set-up.

V. Academic Display Judging - Only judges will be allowed in the display area.

VI. Oral Presentation Judging
Student teams are responsible for transporting their academic displays and other materials if they elect to use them as part of their oral presentation.

Saturday:
VII. Device Performance Judging
To allow for full recognition of all teams, tasks will not be performed simultaneously. The following order of tasks will used at the national level:
A. Electrical Power (HS)
B. Mechanical Power (MS followed by HS)
C. Wind to Vehicle (MS followed by HS)

VIII. Public Viewing of Academic Displays

Sunday:
VIII. Awards Ceremony
Student teams will be recognized in overall and individual categories. See “National Competition Awards Categories” for more details.
Judging Requirements and Assignments
In order to properly and consistently judge all components of the competition, the following judging team should be utilized. Please refer to “Judging Guidelines” for additional details.

Lead Judge Responsibilities:
Oversee all components of the competition and provide final rulings on event related issues.

Judges Needed:

<table>
<thead>
<tr>
<th>Component &amp; Responsibilities</th>
<th>Middle School ¹</th>
<th>High School ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Paper</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Academic Display</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Oral Presentation ³</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Performance Testing and Impound ³</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

¹ Oral presentation judges are encouraged to participate in technical paper and academic display judging
² Judges should be assigned to either Middle or High School level only
³ Performance Judges must complete the device inspection checks and measurements as well as monitor any potential changes in configuration which may provide an unfair energy advantage during the competition.

Event Area Set-Up
The host center will be responsible for the set-up of the device performance test area. Please refer to the test area illustration for specific requirements. The ideal venue for testing is a school gym or similar facility with a smooth, even floor. The following items should be considered when arranging the event area:

- Crosswinds’ – Position the tables to avoid “crosswinds”, or the wind from one task/table interfering with that of another
- Space – Leave plenty of space between tables, to facilitate foot traffic between them. Also, allow plenty of work or task space in front of the tables
- Electrical Power Availability – The space must have outlets and extension cords necessary to power the following: 1) Test area outlet strip, 2) Optional - A PC used to implement video analysis
- Audience and Competitor viewing

![Event Area Diagram]
Performance Task Management
All participating teams will be seated in an area separate from the general audience. Under the direction of the lead judge, only one team will be allowed in the testing area at any one time. Team members will be escorted by judges to each of the respective testing areas. The judges and host center staff must ensure that the test area is not disturbed once it is configured.

Based on a pre-determined order, teams will be summoned to the test area in the following order and will be repeated until all tasks are completed:
1) Team Up
2) Team On-Deck
3) Team In-the-hole

“Quiet” time will be requested during the performance of each task.

Safety
In accordance with school safety requirements, all team members will be required to wear safety goggles during all phases of device performance testing. Use of helmets is recommended.

Automated Event Scoring
The 2010-2011 MESA USA Wind Energy Challenge Competition Committee has prepared a Microsoft Excel based scoring tool to simplify the judging portion of the event. All states, regions, centers and teacher/advisors are encouraged to utilize this tool to streamline scoring and event management. The file may be downloaded from http://sites.google.com/site/MESAUSAWEC.

National Competition Awards Categories
The following awards will be presented at the National Competition.

MESA USA Overall Winners
Highest combined score in Device Performance, Academic Display, Technical Paper & Oral Presentation

Component Winners
Device Performance
Mechanical Power: .................................................................1st, 2nd, & 3rd Place
Wind-to-Vehicle: .................................................................1st, 2nd, & 3rd Place
Electrical Power and Wind Direction Response (HS only): .................................1st, 2nd, & 3rd Place
Design Efficiency: .................................................................1st, 2nd, & 3rd Place

Academic Display: .................................................................................1st, 2nd, & 3rd Place

Technical Paper: ..................................................................................1st, 2nd, & 3rd Place

Oral Presentation: ..................................................................................1st, 2nd, & 3rd Place

Award Notes:
Medals or ribbons will be awarded to members in the overall category and individual categories.
Reference Format:
Citing Sources in Technical Writing

If you use books, journals, magazines, and websites to get ideas for your research, it helps you write a better paper. You can quote other people or quote the research that someone else did, and it will support your ideas and theories. When you use another person's idea, words, or research, you need to cite the source.

For every book, website, conversation, interview, article, etc. that you read, listen to, or look at, you need to write down the following information:

- **The author** of the information (who wrote or spoke the material?)
- **The title** of the text, website, or article
- **The date** that the material was first published (for a conversation or interview, use the date that the discussion occurred; for a website, record the date you accessed the website--the date you first looked at the page)
- For journal and magazine articles, the **title of periodical and position** in a series (e.g. *Journal Name, Volume 5, Issue 49*) and the **pages** where the information is located
- **The publication information** (i.e. city, state, & publisher name)
- For websites, the **URL address** (e.g. http://www.google.com)

If you're reading an article or a small piece that's part of a bigger book, then you also need:

- **The title of the larger collection** (if you're reading an encyclopedia article, then this means the name of the encyclopedia)
- **The editor** of the larger collection (someone that collected all the articles together, whether or not they wrote anything themselves)

At the end of your paper, you will need a **Reference page**. This page will include entries for all the sources that you used while writing your research paper. For papers in the field of Engineering, researchers often use a citation style developed by the American Psychological Association (APA). This style permits others who read your paper to find the original sources you used--websites, articles, books, etc.--and experience the original document. It includes all the information someone would need to find your source and it organizes the information in a style so that you don't need headings such as "Title," "Author," or "Date of Publication," because it is obvious from the order in which you present these things.

In APA style, books are cited this way:

An article in a periodical (e.g. a journal, magazine, or newspaper):

<table>
<thead>
<tr>
<th>Style</th>
<th>Author, A. A., Author, B. B., &amp; Author, C. C. (Date of Publication). Title of article.</th>
</tr>
</thead>
</table>
A non-periodical (e.g. book, report, brochure, or audiovisual media):

<table>
<thead>
<tr>
<th>Style</th>
<th>Author, A. A. (Year of publication). <em>Title of work</em>. Location: Publisher.</th>
</tr>
</thead>
</table>

An article in an internet periodical:

|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

A motion picture or video tape:

<table>
<thead>
<tr>
<th>Style</th>
<th>Producer, P. P. (Producer), &amp; Director, D.D. (Director). (Date of publication). <em>Title of motion picture</em> [Motion picture]. Country of origin: Studio or distributor.</th>
</tr>
</thead>
</table>

Further Information

For more information about APA style, consult the *Publication Manual of the American Psychological Association* (5th edition) which can be found in most libraries. Also, consider looking at these web resources:

- The APA style website
  http://www.apastyle.org

- The Online Writing Lab (OWL) at Purdue University
  http://owl.english.purdue.edu/handouts/research/r_apa.html
Thank you for taking the time to give the MESA USA Event Committee feedback! Please email comments to your state representative (see list below).

We are very interested in all elements of this event. Please encourage students, teachers/advisors, judges and staff members to share positive experiences and constructive criticism. Please include ideas related to some or all of the following areas:

- Overall Difficulty
- Performance Tasks
- Communication Elements
- Rules
- Judging
- Scoring
- Event Management
- Other ___________________

Please identify the general area and provide detailed comments. Please feel free to include any photos or video from your respective activity.

Arizona.......................................Manny Leon................................... leon@arizona.edu
California ..................................Carlos Gonzalez............................. carlosg@engr.ucr.edu
Colorado.....................................David Ramirez ............................... david.g.ramirez@colorado.edu
Maryland....................................Tom Milnes.................................... Thomas.Milnes@jhuapl.edu
New Mexico..................................Anita Gonzales ............................ anita@nmmesa.org
Oregon ...................................... Tamara DePue ............................. tdepue@cecs.pdx.edu
Utah...........................................Jeffrey Ojeda............................... jeffrey.ojeda@schools.utah.gov
Washington .................................Curt Sande ................................. sande@wsu.edu