2019 National Engineering Design Challenge Judges Training: Project Report

Thank You!

Thank you for volunteering to score project reports!

We created this slide deck to provide some information about scoring. Thanks for taking the time to review it!

Agenda

- What is MESA?
- Things to keep in mind
- About the competition
- Rubric scale
- Rubric parts
- Logistics of scoring

Pro Tip:
Have a copy of the rubric in front of you while going through slide deck.

Pitch Rubric
Pitch Overview
Entire Competition Rules

What is MESA USA?

- Mathematics Engineering Science Achievement
- Classroom and After School programs
- Human Centered Design & STEM
- 10 States
- Focuses on students underrepresented in STEM
- Over 49,000 K-12 and college students are served annually

Why Training?

1. Inter-rater reliability
   - The degree of agreement among raters.
   - Common understanding of expectation for each part of rubric
2. Consistency among MESA states
3. Context of the Project Report within the scope of the entire National Competition
4. Familiarity with specifications and the rubric
5. Provide information about MESA students. Set expectations

About the Competition

- Teams of 3-4 students
- Device must be designed around the needs of a client.
- An Arduino microcontroller must be part of the solution
- Students will
  - Write a Project Report
  - Give a Product Pitch
  - Give a Technical Presentation and have an Interview
  - Create an Poster

Competition Components

- Project Report - 100 points
- Prototype Pitch - 100 points
- Technical Presentation & Interview-100 points
- Poster Symposium - 50 points

Total: 350 points

Rubric Scale for all items

No half points!

(5)-Exceptional: Exceeds all aspects of the standard when possible.

(4)-Excellent: Meets all aspects of the standard very effectively.

(3)-Met Criteria: Meets all aspects of the standard effectively but no more;

(2)-Fair: Almost meets the standard. May be inaccurate or unclear.

(1)-Poor: Attempts to meet the standard but provides information which is irrelevant or unnecessary.

(0)-Not present: No attempt appears to have been made to meet this standard.

Pro Tip: Judges may not award half points. Whole points only!

The Project Report

Objective

Report will demonstrate the successful development of a prototype through the implementation of the Engineering Design Process. This report should be a summary of the project and lead judges through each stage of the Design Process.

Length

The report must be a minimum of 5 pages and a maximum of 10 pages in length (not including the title page, appendices or bibliography). Thorough but concise papers are encouraged.

See the rules document for a full set of rules and guidelines.

Contents

The Rubric Page 1

Problem Statement The problem is adequately articulated with organized criteria and constraints. The needs of the client have been sufficiently examined to design a solution.
Design Process - Inspiration: Research Prior knowledge, research, and client(s) interviews are adequately articulated and a specific list of needs has been selected.
Design Process–Inspiration: Client's Needs The client's needs are adequately accounted for as initial design choices are analyzed.
Design Process – Inspiration: Client's Needs Client's needs to be addressed are adequately organized and present requirements or limitations
Design Process – Inspiration: Evaluation(x2) The design process is sufficiently iterative and design changes are examined using previously selected criteria and constraints
Design Process – Ideation: Arduino Integration (x2) Integration is appropriately adapted, somewhat innovative, and adequately executed to address criteria and constraints
Design Process – Ideation: Design (x2) Development of prototype is sufficiently connected to knowledge gained and reasoning for design choices is appropriately illustrated.
Design Process – Ideation: Math and Science (x2) Applied math and science concepts are sufficiently suited for design development and analysis of data to inform design choices

Problem Statement

The problem is adequately articulated with organized criteria and constraints. The needs of the client have been sufficiently examined to design a solution.

This should give you a clear picture into the problem that is being addressed, what the client's needs are, and any limitations that the team is working with. To meet the criteria the problem statement should be adequately articulated with organized criteria and constraints. The needs of the client should be sufficiently examined to design a solution.

Example: *Our team is working with an elderly couple who have problems with powering their home. They are on a fixed income but need consistent power for cooling and medicine storage.*

The team has addressed the client and what their needs are. There is the mention of a fixed income, which could be a limitation. However, the statement is not very detailed. This would score a 2. To score a 3, the team would need to more details about what the couple is looking for (criteria) and to state if the fixed income is part of the limitations to the problem.

Design Process - Inspiration: Research

Prior knowledge, research, and client(s) interviews are adequately articulated and a specific list of needs has been selected.

The students are to share what they knew, what they learned from research, and what they learned from the clients. This may be in several places since the Engineering Design Process is iterative.

Example: *We considered various types of alternative energy sources like wind, water, and solar. The clients do not have an accessible water source nearby and winds are intermittent in their area. So we decided Solar was our best options. We started off knowing that solar energy is a way to provide electricity to people in rural areas who do not have access to consistent power. We learned that solar collectors are efficient but only when the sun strikes them at an angle of 90 degrees. Our interviews with the client showed us that we needed a way to capture solar energy as efficiently as possible.*

The team has stated what they knew, what they learned in research, and what they learned from the client. However, it is light on detail. Why did the client need more solar energy? Are there any other factors involved in solar collection? They have adequately stated what they learned but could add more details. This would score a 3. If the team added more details about their research, that would push them into 4 or 5 region.

Design Process -Inspiration: Client's Needs

The client's needs are adequately accounted for as initial design choices are analyzed.

One of the main goals of this project is to meet the needs of a client. It is important for the team to understand the needs of the client to design their solution. Teams need to clearly articulate what those needs are. These will feed into their discussion of their initial design choices.

Example: *Our client told us that they need a way to ensure their house is powered while keeping the energy costs low. We designed our system around this. We wanted to have a way to have solar panels that track the sun.*

The team has talked about the client's needs so it is more than 0. However, the needs are minimally articulated and the answer to them is a system. So the team did account for the needs but we are unsure how. This would score a 2. If they added more detail about how they accounted for the needs with more detail, this would move them to a 3.

Design Process -Inspiration: Client's Needs

Client's needs to be addressed are adequately organized and present requirements or limitations

It is important for the team to understand the various needs of the client to design their solution and understand the limitations for their designs. Teams need to clearly articulate, prioritize, and present requirements and limitations. These will feed into their discussion of their design choices.

Example: *Our client told us that a low-cost system was most important to them. Since our clients are elderly, our team wanted to ensure that the system that we create would require little to no maintenance, which may mean panels would need to be installed on the ground rather than on a roof. Being located in rural southern Arizona the clients have typically over 300 days of sunlight so longer power storage isn't needed.*

The team has talked about the client's needs in good detail with some connection to design requirements and limitations. This would score a 4. If they added more specific detail about power requirements and how they accounted for the needs with more detail, this would move them to a 5.

Design Process – Inspiration: Evaluation

The design process is sufficiently iterative and design changes are examined using previously selected criteria and constraints.

The students need to demonstrate that they have employed the engineering design process multiple times and used their data and research to inform their design decisions..

Example: *Our initial design was solar panels with a tracking system. We discovered that our tracking system was not following the sun to maintain the proper angle. We also address the motor that moves the panel. The motor moved the panels at the proper speed to track the sun but the angle was not maintained to collect the most light. We adjusted the mounts to maintain the angle but it was not consistently keeping the angle.*

The team indicated that they had a prototype that they tested and needed to make adjustments to their project. They have demonstrated at least one iteration so it is at least a 3. If they did not indicate any iteration, it would be at most a 2. The information provided was very minimal. If they addressed the specific angle needed and what was causing the panels to not keep the angle and how they are testing and refining, the score would be higher. This response would be a 3.

Design Process Ideation: Arduino Integration

Integration is appropriately adapted, somewhat innovative, and adequately executed to address criteria and constraints

The students need to explain how they integrated the Arduino microcontroller into their project. They need to explain their reasoning for design choices and how the Arduino is integrated into the system

Example: *We used the Arduino to track the sun using 4 light sensors attached to a "sun wand." The light sensors measure an amount of light lumens, keeping the panel at a 90 degree angle with the sun. The Arduino connects to 2 motors that move horizontally and vertically to adjust the angle the sun is hitting the panels. The Arduino also takes measurements of solar power to ensure it is maximizing sunlight. We decided not to address power collection of panels as we don't have the technology to improve collection.*

The team described their use of Arduino with some innovative tracking of the sun. The explanation of the criteria not addressed is present in a minimal form but doesn't apply to the Arduino. This would score a 4.

Design Process - Ideation: Design

Development of prototype is sufficiently connected to knowledge gained and reasoning for design choices is appropriately illustrated.

Teams need to tie their design choices to what they learned through research and client interviews.

Example: *We designed the movement of the solar panels to to try to capture as much energy as possible. We want to be able to capture approximately 4 kWh/m^2 per hour by keeping the panels at a 90^o angle with the sun. Our research shows that this is possible due to the levels of solar radiation over an 8 hour period based on data from PhotoVoltaic Education. We feel that this will allow our system to capture enough energy to power our client's home.*

The team has referenced some research and create a specific design goal from that research. They tie in specific targets based on what they learned. This would receive a 4. To receive a 5, the team would need to reference why the 4 kWh/m^2 is their target.

Design Process - Ideation: Math and Science

Applied math and science concepts are sufficiently suited for design development and analysis of data to inform design choices

Here the students are to tie any mathematical and scientific concepts that are part of their project. The concepts need to be grade appropriate. Please pay attention to whether you are reading a middle school or high school paper as their knowledge will be very different.

Example: *Our solar panels are 5" x 8" and track the sun at a 90 degree angle. The current is a direct current that is stored in a battery.*

The students mentioned some concepts so it is not 0. However, the information is barely articulated. This would score a 1. If the students added more information about electrical storage, wattage, the rate of movement to track the sun, the score would go up.

The Rubric-Page 2

Design Process – Implementation: Testing(x2). Various testing methods were chosen to analyze if design effectively meets established criteria and constraints.
Design Process – Implementation: Data Data analyzed is mostly clear, sufficiently concise, and relevant to project. Data illustrates claims made.
Design Process – Implementation: Data Charts and graphs are suitably chosen, labeled and fairly easy to interpret.
Design Process – Implementation: Data Analysis (x2) Data analysis is used to examine strengths, weaknesses, effectiveness. Results of testing are used to implement design changes.
Spelling & Grammar
Code
Budget
Bibliography
Length

Design Process – Implementation: Testing

Various testing methods were chosen to analyze if design effectively meets established criteria and constraints.

The students need to demonstrate that they performed relevant tests that lead to improving their device per the established criteria and constraints. The tests led to further iterations in the engineering design process.

Example: *Our tests told us that our device had problems tracking the sun. We adjusted the code and the device multiple times to improve the solar tracking.*

The team talks about their testing and results. They do not go into great detail about the results of the tests and how it informed their decisions to improve the device. Nor do they talk about the changes to the code. This would score a 1.

Design Process – Implementation: Data

Data analyzed is mostly clear, sufficiently concise, and relevant to project. Data illustrates claims made.

The students need to talk about their data and how it informed their design choices. They should have charts and graphs to help illustrate the points they make in the body of the paper.

Example: *Our data shows that we were able to collect energy at an average of 12%. Our solar panels are rated to collect 10-20% of the solar energy by the manufacturer. The collection rate ranges between 11-14%.*

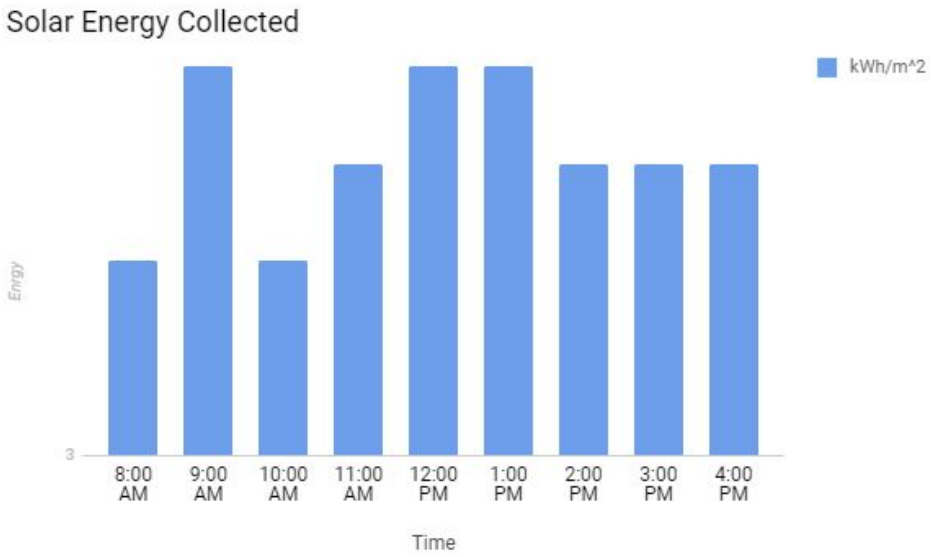
The team is discussing their data and use a range and compare it to the manufacturers specifications. However, they do not provide context for the meaning of the percentage. This would score a 2.

Implementation: Data

Charts and graphs are suitably chosen, labeled and fairly easy to interpret.

This section is about the data the teams collected and how relevant the data is.

Example



The chart is great and has test data. However, there is little explanation. This would receive a 2. It is relevant to the problem of solar collection and is relevant to the amount of energy the team wishes to collect. While it is graphical, there is only the one data piece. The chart is also missing measurements for the vertical axis so it is hard to understand the data.

This shows our test data for the first test. It was inconsistent

Design Process Implementation: Analysis

Data analysis is used to examine strengths, weaknesses, effectiveness. Results of testing are used to implement design changes.

Teams need to use the data they collected to analyze the strengths and weaknesses of their design. The data should lead back to the Inspiration phase to generate new ideas for their design.

Example: *After looking at our data, we realized that the amount of energy collected was inconsistent and below our targeted goal. We felt this was due to our motor tracking and program failing to keep the right angle. We want a more efficient way to track the sun and keep the angle at 90 degrees.*

The team has used the data to identify a weakness and start thinking about a new idea for their design. While there is a good use of the data, the team only writes about what they want to do. This would score a 3.

Spelling & Grammar

The papers need to have proper spelling and grammar. This is based on your knowledge as professionals.

Scores:

0 - The spelling and grammar mistakes make reading the paper difficult. Mistakes take away from the paper.

1 - Spelling and grammar mistakes are few and do not take away from reading the paper.

2 - No mistakes

Code

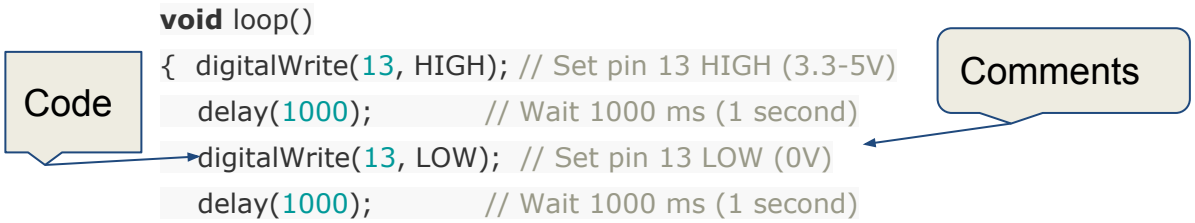
This is part of the appendix. We are looking for the code used in the project and can it be read.

Scores:

0 - No code or minimal code that could not be used for the project to work.

1 - The code is present but unorganized and hard to read. A lot of effort would need to be used to understand the code.

2 - The code is easy to read and the team added some comments that help in the reading.



Budget

The teams need to provide a budget sheet that details what their device costs. They only need to provide the item and its cost.

Score

0 - Less than half of the components needed are listed on the budget sheet

1 - Most of the components needed are listed on the budget sheet

2 - All of the components needed are listed on the budget sheet

A budget receiving a 2 may include the source of the material, unit dimensions, retail price, cost per unit, total cost per item.

Bibliography

The students need to provide reference of their resources for their research. If the team referenced research, they need to cite their source.

Score:

0 - Less than half of the resources are cited

1 - Most of the resources are cited

2 - All resources are cited.

Teams need to use a consistent format. If they do not, the most they can receive is 1.

Length

The paper has a required length of 5-10 pages. This does not include the code, budget or bibliography pages.

Scores:

0: Less than 4 pages or more than 11 pages

1: 4 - 11 pages

2: 5-10 pages

Questions?

If you have any questions while scoring, please look back at these slides or reach out to your point of contact.

Thank you for serving as a judge for the National Engineering Design Competition.

We will see you at MESA Day!

Thank you!