MESA USA
National Engineering Design Competition (NEDC)
2017–2018
MESA Arduino STEM Solutions

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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Introduction

There's an old saying that states "Necessity is the mother of invention." Humans have always been most creative, most inventive when they've had a need and lacked a way of resolving it. This idea is the basis for what we know as the field of Engineering.

As a way to find a solution to a need, Engineers implement the Engineering Design Process. This process allows Engineers to systematically identify the need and any obstacles or challenges; draft ideas for a solution using their knowledge of math and science; refine their ideas through testing; and ultimately develop a way to meet the initial need.

Human-Centered Design is an approach in engineering that focuses on people and their specific needs. According to IDEO.org (http://www.designkit.org/human-centered-design), "Human-centered design is all about building deep empathy with the people you're designing for…" IDEO further suggests that Human-Centered Design consists of three phases.

1. **Inspiration**—Engineers learn directly from their client in order to deeply understand their needs.
2. **Ideation**—Analysis of what's learned from the client leads to design ideas and possible prototypes.
3. **Implementation**—Building of the final proposed solution knowing that it meets the needs of your client.

Competition Overview

MESA USA presents the National Engineering Design Competition specifications for 2017–2018. MESA Arduino STEM Solutions asks students to implement the Human-Centered Design approach **to find a client in your community who has a need, design a solution for this need using Arduino, and present your solution and recommendation(s) for next steps** at MESA competitions.

MESA USA has allowed individual states the flexibility to require teams to focus on a particular area of need (i.e., agriculture, physical disabilities) or provide a specific client for teams to focus on at the state competition level. Maryland MESA has decided to allow teams in Maryland some choice when selecting a client for the National Engineering Design Competition.

Maryland MESA encourages teams to identify a client with a need in their community. Maryland MESA recognizes that locating a client to work with adds a layer of complexity to the challenge. Therefore, teams in Maryland also have the **option of choosing to address the needs of one of the sample clients provided by Maryland MESA.** The two (fictitious) clients provided by Maryland MESA are Disaster Action Network, a nonprofit organization looking for solutions to aid those affected by natural disasters, and Device Security Solutions, a small startup interested in solutions to reduce mobile device theft. Please see *Appendix F* for information about Disaster Action Network and Device Security Solutions, as well as descriptions of their design needs.

Design Requirement and Limitations

Your final design must:

- Use Arduino style hardware
- Use at least 3 sensors
- Use at least 2 outputs (motors, servos, LEDs, LCD, etc.)
- Not exceed dimensions of 20 in x 20 in x 20 in (50.8 cm x 50.8 cm x 50.8 cm)
- Not exceed a weight of 20 lbs (9.07 kg)
- Be packaged in an aesthetically pleasing and functional form factor

The components listed below will be used to assess the effective implementation of a Human-Centered Design approach, effective implementation of the Engineering Design Process, and the functionality of the prototype and successful integration of Arduino into the prototype. (See scoring rubrics in *Appendices A* through *E*.)

High school and middle school teams selected to participate at the national event will compete in the four components below:

1. **Technical Interview & Poster**—Students will prepare a short presentation and give a full demonstration of the functionality of the prototype. A poster will provide an overview of their project highlighting key points of the design process including relevant data, and conclusions and recommendations for further development. The purpose is to review and assess the following:
   a. How the prototype meets the client's needs
   b. The use of materials and technologies (Arduino hardware, sensors, etc.)
   c. Originality of the prototype
   d. Usability of the prototype
   e. Design of the prototype
2. **Project Report**
   a. Students will write a 5- to 10-page report that contains the problem statement, summary of the design process, results, conclusion, and the next steps supported by pictures, charts, tables, and/or graphs.
   b. The report should be a journey through the design process, demonstrating key points of the design process and why design choices were made.
   c. The report will have an appendix containing the commented Arduino code and detailed budget.
3. **Prototype Pitch**
   a. Students will prepare a presentation and creatively pitch their prototype to a group of judges, including a demonstration of the prototype.
   b. The presentation should define the problem; provide a detailed description of the client and their needs; discuss current solutions to the problem and their weaknesses; and provide a demonstration of their prototype highlighting its advantages.

Each competing team must consist of two (2) to four (4) students who are active members of a MESA program in a MESA USA state. The first place middle and high school teams from state events will travel to the national competition. These teams must compete in all tasks listed above. This event is scheduled to occur in **June 2018** hosted by Pennsylvania MESA.

Plagiarism Policy

Academic honesty and personal integrity are essential to ensure future success as college students and STEM professionals. As such, MESA USA expects that the work presented as a part of the National Engineering Design Competition will be solely the work of the students. If the work or ideas of another are used to further the students' work, proper credit must be given to the owner (see resource document for information on citing sources). Failure to do so will result in an act of plagiarism. If it is determined that a student committed plagiarism, they will be disqualified from the competition and will be ineligible to receive any awards. They may also risk further sanctions from MESA USA and/or their MESA State.

Scoring Summary

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

Technical Interview & Poster Symposium .....150 points (See *Appendices A*, *B*, and *C*)

Project Report .....100 points (See *Appendix D*)

Prototype Pitch.....100 points (See *Appendix E*)

Resources

As teams work through the Engineering Design Process, some may find the information contained in *Appendix G: Engineering Design Process Overview* helpful. Likewise, some teams may find *Appendix H: Arduino Resources* useful.

Technical Interview & Poster Symposium

(See scoring rubrics in Appendices A, B, and C.)

Overall Objective

The overall objective is to overview the functionality of the team's final device. Teams will use a poster to present their device and relevant aspects of the design process from their technical report. The focus of the display and presentation should only be the final iteration of the prototype. Students will organize and deliver a focused, coherent presentation using the poster to provide an overview of the development of their design—including research, experimentation and conclusions—and demonstrate the functionality of the prototype. The judges should understand the speech and become engaged in the presentation. Judges will then follow up with a Technical Interview. Displays and speeches must be the original work of the team.

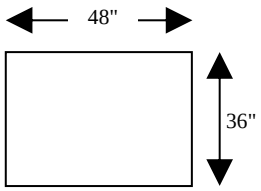
Materials Provided

- Easel or ample wall space for poster or a cafeteria-style table (approximately 30 in x 72 in x 29 in). If a table is provided, teams will need to provide their own poster stand.

Poster Symposium

- Students will be expected to participate in a poster symposium at the national event. Students will display their posters and prototypes and be available to present their designs and answer any questions to those attending the symposium. This event will be open to all event attendees.

Poster Requirements



Poster example only

1. **Size and Type**—Teams must design and print a single poster for the National Event. The maximum size of the poster is 36 in x 48 in. State and local events may opt to allow tri-fold presentation boards with maximum dimensions of 36 in x 48 in. **PLEASE NOTE: Teams in Maryland are REQUIRED to present posters in the form of a 36" x 48" tri-fold presentation board at the regional and state MESA competitions. Middle and high school teams that advance to the national competition will be required to reformat their tri-fold presentation boards to meet the MESA USA National Event requirement (i.e., design and print a single poster with a maximum size of 36"x48").**
2. Teams should include a title at the top of their poster.
3. A team section must be present and should include:
   a. School Name
   b. Grade level representing (middle or high school)
   c. State representing (optional at state and local events)
   d. Names of all team members.
4. An Official MESA logo should be included (contact your state office for a logo).
5. Posters should include the following elements:
   a. **Objective:** This defines the requirement(s) of the design. Could include:
      - Desired attributes of the design—what it will be and what qualities it will have

- Any user requirements that are a mix of project goals and constraints
- Design choices to fulfill the client's needs
- Scope of the project and any priorities in design

b. **Engineering Design Process:** Engineering design is a process for generating the team prototype that meets the specified objective while adhering to specified constraints. The poster could include:

- Specification of team methodology and process
- An analysis of challenges and correlating solutions
- Any evaluation of competing design solutions
- Any relevant research or discovery that led to chosen design solution

c. **Data:** Any visual representation of research, analysis, inspection, and/or testing that led to the prototype design. Can include:

- Charts and/or graphs
- Arduino diagram(s), such as schematics, block-logic diagram, and function block diagram

d. **Conclusions and Recommendations:** Identification of the chosen solution and any recommendations for further progress. Could include:

- Design flaw analysis
- Justification for design choice
- Plans for next steps

e. **Support Materials:** Anything to improve the understanding of the team project and to enhance the visual appeal of the project. Could include:

- Any relevant diagram or layout of the prototype
- Commented Arduino code or logic diagrams
- Any relevant prototype drawing(s)—should include scale and labels
- Relevant photo(s) of prototype, testing conditions/environment, and/or prototype parts—should include scale (if needed) and labels

6. All major sections should be clearly labeled.
7. Your team's Engineering Design Notebook should be available during your presentation so your team, or judges, can refer to it.
8. Electronic media are not allowed. Teams should have the laptop used to program their prototype available to allow judges to review code.
9. No element of your school's previous year's display may be reused. All elements must be original for the current year.

Presentation and Technical Interview Rules

1. Presentation attire will be the official MESA USA National Engineering Design Competition shirt. A 5-point deduction will be applied for teams not wearing the official t-shirts.
2. Teams will be randomly selected to determine interview order.
3. Students must conduct their interview in the order drawn. No exceptions or late arrivals are allowed.
4. Teams will have 5 minutes to present a summary of their projects, then 3 to 5 minutes to demonstrate their prototype, and finally, there will be 10 to 12 minutes for a technical interview with the judge panel. Total time will not exceed 20 minutes.

a. Judges will notify teams when they have 1 minute remaining in their presentation time, prototype demonstration time, and technical interview time (the remaining available time).
b. Any overage of time will result in a decrease in time for other needed components of the technical interview.

5. Teams are to use their poster for support of their presentation using chosen data and support materials.
   a. Teams may use other materials, such as their engineering notebook or other visual aids, as desired.
6. The presentation will be followed by a demonstration of the team prototype and an interview with the judge panel. Anything not addressed in the presentation can be clarified during the interview process. The interview and presentation are scored together for the presentation section. Total interview time will be used to determine student knowledge of their project, answer questions about design choices, and determine viability of design for the client.
7. Judges will be given a set of prompting questions to use during the technical interview. All questions will relate to clarification of the team's project, follow-up to anything the team presents, or the major content areas: Team Objective, Engineering Design Process, Data, Conclusions and Recommendations, and Support Materials.
8. The presentation is a summary of their project and the interview is a discussion with the judge panel. Together, they should include:
   b. Project Objective
      - Who is the client and what are the client's needs?
      - How does this project fulfill the client's needs?
      - What are the current constraints of your project?
   c. Engineering Design Process
      - What was your team methodology and process?
      - What research did your team do during the project's process?
      - What were other solutions that your team thought of to fill the needs of your client?
      - What were any major challenges and correlating solutions?
   d. Conclusion and Recommendations for the Project
      - What tests were completed on your prototype?
      - What is your final assessment/evaluation of your prototype?
      - What are the next steps for the implementation of your project?
      - Are there any suggestions for improvement and/or redesign?
      - Are there any conclusive findings?
9. During the prototype demonstration:
   a. Prototype should be a working prototype. If not, some areas will not be able to be scored.
   b. Teams should be able to adequately discuss their prototype design, chosen hardware and the logic behind these choices, and the flow of data from input to output.
   c. Teams should be able to discuss how their design differs from other current solutions and any new approaches or design features that are unique to their design.
   d. Teams should demonstrate the usability of the prototype and how it meets the needs of the client.

e. Teams should be able to discuss any testing they did during development and how that testing informed their design choices during the demonstration and/or interview time.

Project Report

(See scoring rubric in Appendix D.)

Objective: Demonstrate the successful implementation of the Engineering Design Process throughout your project. This report should be a summary of your project that leads judges through each stage of the design process. You should identify your client(s) and list the needs that informed your project; describe the problem you are addressing; the process you used to address it; and the progress or results of your work, including key data.

Required Elements: The report should include the following sections.

1. Problem Statement—A detailed description of the client(s) and their needs, an identification of the specific need(s) addressed by the proposed solution, and any limitations that influenced the project
2. Design Process
   a. Key design choices based on prior knowledge, research, and client's needs
   b. Prototype development showing clear links between client's needs, testing conducted, and analysis that lead to each iteration
3. Results—Final iteration of the prototype highlighting strengths
4. Recommendations for further development or next steps for production
5. Data (charts, graphs, tables) and any equations used
6. Appendix
   a. Commented Arduino Code (see examples in the resource document)
   b. Detailed Budget Sheet (see examples in the resource document)
7. Bibliography

Deadline:

- ***Local/State.*** Teams must submit the project report at least 10 calendar days before the regional competition. Please confirm the submission deadline and the submission protocol for your region with your regional coordinator.
  Teams advancing to the State MESA Competition must submit the project report via the Maryland MESA website (https://secwww.jhuapl.edu/MESA/Home/MESADays) at least 10 calendar days before Maryland State MESA Competition. The deadline for submissions for the Maryland State Competition is April 25, 2018. Late papers will be assessed a 25-point deduction from their report score, and no reports will be accepted after April 27, 2018.
- ***National Competition.*** For teams advancing to the national competition, the project report must be submitted via email to Pennsylvania MESA on or before 4:00 pm in your local time zone on **June 4, 2018** (subject to change)**.** Papers should be submitted by a student team member. The papers will be judged and scored prior to the National Competition. Late papers will be assessed a 25-point deduction from their report score, and no reports will be accepted after **June 6, 2018.**
- A PDF version of the final report must be emailed to the Pennsylvania MESA Head Judge at nationalcompetition@mesausa.org. Check the MESA USA national website at mesausa.org for further information. **Please note that the host and Head Judge are not responsible for any internet service delays or misdirected reports. It is the responsibility of the student team**

members to ensure that the report is delivered successfully prior to the deadline. Therefore, submission of materials in advance of the above-listed deadline is highly recommended.

Length: The report should be no less than 5 pages and no more than 10 pages in length. Thorough but concise reports are encouraged.

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

- The report length should be 5 to 10 pages.
- Remember to include the key sections in your report (listed above).
- Your title page should include authors/team members, school, MESA state, and date.
- Be sure to use 1 in margins and double-space your text using 12-pt Times New Roman font.
- Remember to use spelling, sentence, paragraphing, and transition conventions that are appropriate to standard business English throughout the paper.

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

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

Prototype Pitch

(See scoring rubric in Appendix E.)

Objective: Teams will creatively "sell" their solution to a group of "investors." The pitch should introduce the client and their needs, discuss how current solutions do not meet those needs, and present and demonstrate the designed prototype.

Materials Provided

- A projector and laptop with PowerPoint and internet access
- Wireless presentation remote
- Access to electricity for prototypes
- Cafeteria-style table (approximately 30 in x 72 in x 29 in)
- Special Requests for other materials will be considered but are not guaranteed.

Pitch Rules

1. Teams will have 20 minutes to present.
2. Teams will present a prototype pitch to a group of judges, who will act as investors.
3. The pitch will be open to the public. States may opt for private sessions at state and local events.
4. Teams are allowed to bring additional audio and visual aids to enhance their presentation.
5. The pitch must include and will be assessed on the following:
    a. A definition of the problem they are solving
    b. A description of the client base
    c. Any current solutions and their weaknesses
    d. Choices made for the presented prototype
    e. Advantages of the presented prototype
    f. A demonstration of the prototype
    g. Next steps and future potential of the design
6. Teams will also be assessed on the quality of the presentation, including:
    a. The effectiveness of their communication (speaking, eye contact, body language)
    b. The organization of their presentation
    c. The depth and understanding of the content
    d. Quality and creativity of any visual aids
    e. Participation of all team members in the presentation
7. Teams will be randomly selected to determine the order of presentations.
8. Teams must give their pitches in the order drawn. No exceptions or late arrivals.
9. Judges will provide time signals to presenters at 1 minute before the 20-minute limit and every minute thereafter. After +5 minutes (a total of 25 minutes), judges will stop the presentation.

Appendix A: Technical Interview (Prototype Demonstration) Rubric

Technical Interview (Prototype Demonstration) Rubric	Exceptional (5 points)	Excellent (4 points)	Good (3 points)	Fair (2 points)	Poor (1 point)	Not present (0 points)	Observation Notes
Design	Design is simple and practical. It exceeds the requirements and the needs of client. All design elements are intentional and well thought out.	Design is simple and practical. It meets all of the requirements and the needs of client. All design elements are intentional and well thought out.	Design is simple and practical. It meets most of the requirements and the needs of client. Most of the design elements are intentional and well thought out.	Design is somewhat simple and/or practical. It meets some requirements and the needs of client. Some of the design elements are intentional and well thought out. Could use some additional design development.	Design is not simple and/or practical. It does not meet most of the requirements and the needs of client. Most of the design elements are not intentional or well thought out. AND/OR Team could not adequately describe or relay most of the design process.	Design was done with little or no thought to the needs of the client. Design elements were used without any hint of design development. AND/OR Team could not adequately describe or relay any part of the design process.	
Originality	Prototype is completely creative, original, and not currently available. Team can clearly describe research done and what makes their prototype innovative and unique.	Prototype is mostly creative, original, and/or significantly modifies an item currently available. Team can clearly describe research done and what makes their prototype mostly innovative and unique.	Prototype is somewhat creative and original and/or modifies an item currently available. Team can adequately describe research done and what makes their prototype somewhat innovative and unique.	Prototype mostly resembles an item currently available. Minimal modifications are made to make item unique. Team can somewhat describe research done and attempts to make their project minimally unique.	Prototype is a near direct copy of a product currently available. Team can minimally describe research done and why they chose to mimic a currently available product.	Prototype is a direct copy of a product currently available. AND/OR Team cannot describe any research done to attempt originality.	
Usability	Prototype is exceedingly intuitive, easy to learn, and easy to use. Team can completely articulate prototype instructions and purpose.	Prototype is entirely intuitive, easy to learn, and easy to use. Team can completely articulate prototype instructions and purpose.	Prototype is mostly intuitive, easy to learn, and easy to use. Team can adequately articulate prototype instructions and purpose.	Prototype is somewhat intuitive, easy to learn, and easy to use. Needs a large amount of instruction and experience to use. Team can somewhat adequately articulate prototype instructions and purpose.	Prototype is not intuitive, not easy to learn, and difficult to use. AND/OR Team has a difficult time articulating prototype instructions and purpose.	Prototype is not intuitive, extremely difficult to learn, and is very difficult to use. AND/OR Team cannot articulate any prototype instructions and purpose.	
Materials and Technology	All materials, equipment, and technologies are exceedingly appropriate for design. Team is extremely logical in material usage and budget consideration. Team can exceedingly articulate and is exceptionally knowledgeable about reasoning and purpose for all materials and technology used.	All materials, equipment, and technologies are appropriate for design. Team is logical in material usage and budget consideration. Team can articulate and is knowledgeable about reasoning and purpose for all materials and technology used.	Most of materials, equipment, and technologies are appropriate for design. Team is logical in material usage and budget consideration. Team can adequately articulate and is adequately knowledgeable about reasoning and purpose for most of materials and technology used.	Some of materials, equipment, and technologies are appropriate for design. Team shows some logic in material usage and budget consideration. Team can somewhat articulate and is minimally knowledgeable about reasoning and purpose for materials and technology used.	Most of materials, equipment, and technologies are not appropriate for design. Team shows little or no logic in material usage and budget consideration. AND/OR Team cannot articulate or show knowledge about reasoning and purpose for most of materials and technology used.	Materials, equipment, and technologies are vague, missing, and/or not appropriate. Team no logic in material usage and budget consideration. AND/OR Team cannot articulate or show knowledge about any of materials and technology used.	

Technical Interview (Prototype Demonstration) Rubric	Exceptional (5 points)	Excellent (4 points)	Good (3 points)	Fair (2 points)	Poor (1 point)	Not present (0 points)	Observation Notes
Arduino Usage (x2)	Selected Arduino Hardware and Use of Sensor(s) are innovative, effective, and relevant to project. Team can exceptionally convey why selections were made or not made. Team is exceptionally knowledgeable about sensor use and programming.	Selected Arduino Hardware and Use of Sensor(s) are innovative, effective, and relevant to project. Team can completely convey why selections were made or not made. Team is completely knowledgeable about sensor use and programming.	Selected Arduino Hardware and Use of Sensor(s) are mostly innovative, effective, and relevant to project. Team can adequately convey why selections were made or not made. Team is adequately knowledgeable about sensor use and programming.	Selected Arduino Hardware and Use of Sensor(s) are somewhat innovative, effective, and/or relevant to project. Team can somewhat convey why selections were made or not made. Team is somewhat knowledgeable about sensor use and programming.	Selected Arduino Hardware and Use of Sensor(s) are poorly innovative, effective, and relevant to project. AND/OR Team can poorly convey why selections were made or not made. Team is not very knowledgeable about sensor use and programming.	Selected Arduino Hardware and Use of Sensor(s) are not innovative, effective, and relevant to project. AND/OR Team cannot convey why selections were made or not made. Team shows no knowledge about sensor use and programming.	
Data Collection: Input	Selected Arduino Hardware and/or Sensor(s) can collect input data exceedingly efficiently and effectively. Prototype is exceedingly able to process input data to result in an actual output data response. Team can exceptionally convey what data they are collecting and/or what variables are occurring to result in an output. This includes superior knowledge of input code and hardware.	Selected Arduino Hardware and/or Sensor(s) can collect input data efficiently and effectively. Prototype is able to process input data to result in an actual output data response. Team can clearly convey what data they are collecting and/or what variables are occurring to result in an output. This includes complete knowledge of input code and hardware.	Selected Arduino Hardware and/or Sensor(s) can collect input data efficiently and effectively. Prototype is able to process input data to result in an actual output data response. Team can adequately convey what data they are collecting and/or what variables are occurring to result in an output. This includes adequate knowledge of input code and hardware.	Selected Arduino Hardware and/or Sensor(s) can collect input data. Prototype is able to process input data to result in an actual or theoretical output data response. Team can somewhat convey what data they are collecting and/or what variables are occurring to result in an output. This includes some knowledge of input code and hardware.	Selected Arduino Hardware and/or Sensor(s) can collect some input data. Prototype is not able to process input data to result in an actual or theoretical output data response. AND/OR Team can poorly convey what data they are collecting and/or what variables are occurring to result in an output. This includes poor knowledge of input code and hardware.	Selected Arduino Hardware and/or Sensor(s) cannot collect input data. Therefore, not able to process input data to result in an actual or theoretical output data response. AND/OR Team cannot convey what data they are collecting and/or what variables are occurring to result in an output. This includes no knowledge of input code and hardware.	
Data Response: Output (x2)	Selected Arduino Hardware and/or Sensor(s) responds to data exceptionally efficiently and effectively. Prototype is able to be demonstrated effectively and with ease. Team can exceptionally convey the output process and what happens during use. This includes superior knowledge of output code and hardware.	Selected Arduino Hardware and/or Sensor(s) responds to data efficiently and effectively. Prototype is able to be demonstrated effectively and with ease. Team can completely convey the output process and what happens during use. This includes complete knowledge of output code and hardware.	Selected Arduino Hardware and/or Sensor(s) responds to data efficiently and effectively. Prototype is able to be demonstrated effectively and mostly with ease. Team can adequately convey the output process and what happens during use. This includes adequate knowledge of output code and hardware.	Selected Arduino Hardware and/or Sensor(s) theoretically can respond to data effectively. Prototype is not able to be demonstrated, but team can effectively relay what should happen. AND/OR Team can somewhat convey the output process and what happens during use. This includes some knowledge of output code and hardware.	Selected Arduino Hardware and/or Sensor(s) theoretically can respond to data effectively. Prototype is not able to be demonstrated and team can vaguely relay what should happen. AND/OR Team can poorly convey the output process and what happens during use. This includes minimal knowledge of output code and hardware.	Selected Arduino Hardware and/or Sensor(s) theoretically cannot respond to data effectively. Prototype is not able to be demonstrated and team cannot relay what should happen. AND/OR Team cannot convey the output process and what happens during use. This includes no knowledge of output code and hardware.	

Technical Interview (Prototype Demonstration) Rubric	Exceptional (5 points)	Excellent (4 points)	Good (3 points)	Fair (2 points)	Poor (1 point)	Not present (0 points)	Observation Notes
Testing	3 or more tests were conducted, documented, and used to improve the design. Team is exceedingly able to convey testing conditions, variables, and results of all tests. Team can convey exceptionally how each test helped to inform design choice(s).	3 or more tests were conducted, documented, and used to improve the design. Team is completely able to convey testing conditions, variables, and results of all tests. Team can convey how each test helped to inform design choice(s).	1 or more tests were conducted, documented, and used to adequately improve the design. Team is adequately able to convey testing conditions, variables, and results of all tests. Team can adequately convey how each test helped to inform design choice(s).	1 or more tests were conducted, documented, and used to minimally improve the somewhat able to convey testing conditions, variables, and results of all tests. Team can somewhat convey how each test helped to inform design choice(s), if at all.	No tests were conducted. Team can somewhat convey what tests should have occurred to help inform design choice(s).	No tests were conducted. Team cannot convey what tests should have occurred to help inform design choice(s). AND/OR If teams conducted a test, team can convey minimally or not at all how each test helped to inform design choice(s), if at all.	
Column Totals							
Total Score:							

Technical Interview Totals

Prototype Demonstration Total: _____

Poster Total: _____

Presentation Total: _____

Shirt Penalty: _____ (-5 points if not wearing official event shirt)

Grand Total: _____

Appendix B: Technical Interview (Poster Rubric)

Technical Interview (Poster Rubric)	Exceptional (5 points)	Excellent (4 points)	Good (3 points)	Fair (2 points)	Poor (1 point)	Not present (0 points)	Observation Notes
Organization	All content areas are included, clearly presented, labeled, and easy to follow even in the absence of the team.	Content areas are found, but the presentation is a bit crowded, not all is labeled, or it is disorganized. Requires the team for full comprehension.	Most of the expected content areas are there, but the presentation is confusing, not all is labeled, and it is difficult to follow in the absence of the team.	Some of the expected content areas are present, but poorly laid out and confusing to follow without the team.	Have at least one content area present, but poorly laid out and entirely confusing to follow without the team.	There is not a clear content area present and unable to follow without the team.	
Coherence	All content is carefully chosen to overview the team's project and present the prototype. There is no extraneous information. Information is succinct and important.	Content is carefully chosen to overview the team's project and present the prototype. There may be a few extraneous points. Information could be more succinct.	Some content is not consistent with the overview of the team's project and presentation of the prototype. There is a moderate amount of extraneous information.	Content appears inconsistent with much of the overview of the team's project and presentation of the prototype and is difficult to follow. There is a moderate amount of extraneous information.	Content appears inconsistent and does present a clean overview of the team's project or presentation of the prototype. It is difficult to follow because of too much extraneous information or too little relevant information.	There is no clear coherence. Content does not relate to project. There is an abundance of extraneous information or not enough information.	
Content Area: Objective	The objective of the project and requirements of the design are all conveyed succinctly, they are articulate, they convey a clear scope of the project, and the quality of background information is exceptional.	The objective of the project and requirements of the design are mostly conveyed succinctly, they are articulate, they convey a good scope of the project, and the quality of background information is above average.	The objective of the project and requirements of the design are mostly conveyed succinctly, they are mostly articulate, they convey a satisfactory scope of the project, and the quality of background information is enough to define basic objective.	The objective of the project and requirements of the design are not conveyed succinctly, they are not articulate, they convey a fair scope of the project, and the quality of background information does not define objective entirely.	The objective of the project and requirements of the design are not conveyed succinctly, they are not articulate, they do not convey a scope of the project, and the quality of background information is poor.	The objective of the project and requirements of the design are not conveyed succinctly or at all, they are not articulate, they are missing or do not convey a clear scope of the project, and the quality of background information is extremely poor or absent.	
Content Area: Engineering Design Process Methodology	There is a clear description and exceptional visual representation of the teams Methodology and Design Process.	There is an above average description and visual representation of the teams Methodology and Design Process.	There is an adequate description and visual representation of the teams Methodology and Design Process.	There is a fair description and minimal visual representation of the teams Methodology and Design Process. Needs some additional information to understand entire process.	There is a poor description and no visual representation of the teams Methodology and Design Process. Needs a fair amount of additional information to understand entire process.	There is no clear description and visual representation of the teams Methodology and Design Process is unclear or absent. Needs a large amount of additional information to understand entire process.	
Content Area: Engineering Design Process Evaluation	There is a complete analysis of project challenges and the correlating solutions; there is a superior evaluation of any competing design solutions; section includes succinct and relevant research and/or background.	There is a good analysis of project challenges and the correlating solutions; there is a good evaluation of any competing design solutions; section includes succinct and relevant research and/or background.	There is an adequate analysis of project challenges and the correlating solutions; there is a fair evaluation of any competing design solutions; section includes succinct and a fair amount of relevant research and/or background.	There is a limited analysis of project challenges and the correlating solutions are not adequate or missing; there is somewhat relevant evaluation of any competing design solutions; section includes a minimal amount of research and/or background.	There is not an adequate analysis of project challenges and the correlating solutions are poor or missing; there is minimal evaluation of any competing design solutions; section does not include succinct or relevant research and/or background.	Project challenges and the correlating solutions are extremely minimal or missing; there is no evaluation of any competing design solutions; section does not include succinct or relevant research and/or background.	

Technical Interview (Poster Rubric)	Exceptional (5 points)	Excellent (4 points)	Good (3 points)	Fair (2 points)	Poor (1 point)	Not present (0 points)	Observation Notes
Content Area: Data	Excellent charts and/or graphs are present that support exemplary research and testing. They are appropriate, clear, and provide a superior perspective to their project. There is logical and clear Arduino Diagram(s) to support programming choice.	Above average charts and/or graphs are present that support complete research and testing. They are appropriate, clear, and provide a complete perspective to their project. There is logical and clear Arduino Diagram(s) to support programming choice.	Charts and/or graphs are present that support adequate research and testing. They are appropriate, clear, and provide a satisfactory perspective to their project. There is an Arduino Diagram(s) to support programming choice that is understandable and satisfactory.	Charts and/or graphs support some amount of research and testing. They are somewhat appropriate, and provide a minimal perspective to their project. There is an Arduino Diagram(s) to support some programming choice(s).	Charts and/or graphs support minimal amount of research and testing. They are somewhat appropriate, and provide a minimal perspective to their project. Arduino Diagram(s) minimally supports any programming choice(s).	Charts and/or graphs are absent or do not support research and testing. They are not appropriate, and provide no perspective to their project. Arduino Diagram(s) do not supports any programming choice(s) or are absent.	
Content Area: Conclusions and Recommendations	Includes a superior design flaw analysis and justification for their design choice. Includes clear and relevant next steps for their project.	Includes an above average design flaw analysis and justification for their design choice. Includes clear and relevant next steps for their project.	Includes a satisfactory design flaw analysis and justification for their design choice. Next steps for their project are satisfactory.	Includes a vague or limited design flaw analysis and justification for their design choice. Includes some next steps for their project, but could use work.	Includes minimal design flaw analysis and poor justification for their design choice. Includes minimal next steps for their project, but could use work.	Includes no design flaw analysis or justification for their design choice. Next steps for their project are missing or entirely inadequate.	
Content Area: Support Concepts	Poster includes quality Math and Science concepts that are relevant and clearly show a superior use of those concepts.	Poster includes quality Math and Science concepts that are relevant and clearly show an above average use of those concepts.	Poster includes quality Math and Science concepts that are relevant and clearly show a satisfactory use of those concepts.	Poster includes Math and/or Science concept(s) that are somewhat relevant and show some use of those concepts.	Poster includes Math and/or Science concept(s) that are minimally relevant and show poor use of those concepts.	Poster does not include any Math and/or Science concept(s) and/or does not show any use of those concepts.	
Content Area: Support Visualization	Excellent use of support materials to include: illustrations, diagrams, sample code, and/or photos. Support materials significantly improve understanding and enhance visual appeal. All items are properly labeled and are completely significant to project.	Above average use of support materials to include: illustrations, diagrams, sample code, and/or photos. Support materials greatly improve understanding and enhance visual appeal. Most of items are properly labeled and are completely significant to project.	Adequate use of support materials to include: illustrations, diagrams, sample code, and/or photos. Support materials improve understanding and enhance visual appeal. Some of items are properly labeled and most are significant to project.	Fair use of support materials to include: illustrations, diagrams, sample code, and/or photos. Support materials somewhat improve understanding and enhance visual appeal. Most or all of items are not properly labeled. Most items are not significant to project.	Poor use of support materials to include: illustrations, diagrams, sample code, and/or photos. Support materials minimally improve understanding and enhance visual appeal. Most or all of items are not properly labeled. Most or all of items are not significant to project.	Support items are completely inadequate or missing sample code. If present, support materials offer no understanding or inadequate significance to project.	
Text Font, Spelling and Grammar	All text is clear and readable at a distance of 3 feet. Contains no errors in spelling or grammar including definition of acronyms at their first use.	All text is clear and readable at a distance of 3 feet. Contains minimal errors in spelling or grammar including definition of acronyms at their first use.	Most of text is clear and readable at a distance of 3 feet. Contains minimal errors in spelling or grammar including definition of acronyms at their first use.	Font is a bit distracting or too small to read at 3 feet. Contains a fair amount of errors in spelling or grammar including definition of acronyms at their first use.	Font is entirely distracting or too small to read at 3 feet. Contains a large amount of errors in spelling or grammar including definition of acronyms at their first use.	Font is entirely distracting or too small to read at 3 feet. Contains an extraordinary amount of errors in spelling or grammar including definition of acronyms at their first use.	
Column Totals							
Total							

Appendix C: Technical Interview (Presentation Rubric)

Technical Interview (Presentation Rubric)	Exceptional (5 points)	Excellent (4 points)	Good (3 points)	Fair (2 points)	Poor (1 point)	Not present (0 points)	Observation Notes
Nonverbal Skills	Team holds attention of audiences with the use of direct eye contact; uses poster to guide interview exceedingly well; helps the audience visualize. Team displays relaxed, self-confident nature, and is free of fidgeting and/or nervous movement. Exceptional use of body language.	Team holds attention of audiences with the use of direct eye contact; effectively uses poster to guide interview. Team displays relaxed, self-confident nature, and has minimal use of fidgeting and/or nervous movement. Good use of body language.	Team uses good direct eye contact with audience, but reads some parts from the poster. Movements/gestures enhance articulation. Team somewhat displays relaxed, self-confident nature, and has minimal use of fidgeting and/or nervous movement. Adequate use of body language.	Team uses some direct eye contact with audience, but mostly reads from the poster. Team uses minimal Movements/gestures that enhance articulation. Team mostly displays nervous nature and has a substantial amount of fidgeting and/or nervous movement. Some use of body language.	Team uses minimal eye contact with audience. Mostly reads from and/or has little interaction with poster. Very little movement or descriptive gestures. Team mostly displays nervous nature and shows mostly fidgeting and/or nervous movement. Minimal use of body language.	Team makes no eye contact with audience. Does not interact with poster at all. No movement or descriptive gestures. Obvious tension or nervousness.	
Verbal Skills	Team shows extreme enthusiasm and can verbally convey knowledge about the topic during entire presentation. Uses clear voices and correct usage of technical terms. Can be heard clearly for entire presentation. Entire team shares equally in presentation and all are equally superior in skill.	Team shows mostly enthusiasm and can verbally convey knowledge about the topic during entire presentation. Uses clear voices and correct usage of technical terms. Can be heard clearly for entire presentation. Entire team shares equally in presentation and most team members are above average in skill.	Team occasionally shows positive feelings about the topic, but is adequately knowledgeable. Uses clear voice and most technical terms are used correctly. Can be heard clearly for most of presentation. Entire team shares equally in presentation and all team members show proficiency.	Team occasionally shows positive feelings about the topic and is somewhat knowledgeable. Uses mostly clear voice and some technical terms are used correctly. Can be heard clearly for some of presentation. Entire team shares equally in presentation but some team members are less than proficient.	Team shows only mild interest in the topic during presentation. Uses low voice and/or technical terms incorrectly. Is difficult to hear during presentation. Most of team shares equally in presentation but some team members are less than proficient.	Team shows no interest in the topic presented. Mumbles, uses technical terms incorrectly, or speaks too quietly to hear during presentation. Team does not share equally in presentation and most of team members are less than proficient.	
Project Knowledge	Team demonstrates full knowledge of project. Team presents information in a logical and interesting sequence.	Team answers expected questions and can mostly elaborate. Team presents information in a logical sequence that can be easily followed.	Team answers expected questions and can adequately elaborate. Team presents information in a logical sequence that can be easily followed.	Team answers expected questions but cannot elaborate. Team presents information in a mostly logical sequence.	Team can only answer simple questions. Audience has difficulty following incoherent organization, as team jumps around and does not follow a sequence of information well.	Team does not grasp information and cannot answer questions. Audience cannot understand presentation as there is no clear sequence of information.	
Audience Awareness	Interview significantly increases audience's understanding of importance of project and future impact.	Interview increases audience's understanding of importance of project and future impact.	Interview minimally raises audience's understanding of importance of project and future impact.	Interview minimally raises audience's understanding of importance of topic, shows some development with little future impact.	Interview contributes something, but fails to increase audience's understanding of importance of topic. Lacks development and little future impact.	Presentation fails to increase audience's knowledge of topic and has no future impact.	
Response to Questions	Answers to technical questions demonstrate superior knowledge of the concepts and processes used in project. All members contribute equally to answers and all are equally superior in responses.	Answers to technical questions demonstrate above average knowledge of the concepts & processes used in project. All members contribute equally to answers & most team members are above average in responses.	Answers to technical questions demonstrate a textbook knowledge of concepts and processes used in project. All team members answer questions, but half or less than team can elaborate well.	Answers to technical questions demonstrate some knowledge of concepts and processes used in project. All team members answer questions, but most responses are vague.	Answers to technical questions demonstrate minimal knowledge of concepts and processes used. All team members do not answer questions.	Team is unable to answer technical questions and/or one member of team answers all the questions.	

Technical Interview (Presentation Rubric)	Exceptional (5 points)	Excellent (4 points)	Good (3 points)	Fair (2 points)	Poor (1 point)	Not present (0 points)	Observation Notes
Content Area: Objective	Team states their project objective exceedingly well. Interview stays on topic to address objective to the highest level.	Team clearly states their project objective. Interview stays on topic to properly address objective.	Team clearly states their project objective. Interview stays mostly on topic to properly address objective with some excess information.	Team states their project objective. Interview stays somewhat on topic to properly address objective with a fair amount of excess information.	Team does not state their project objective well. Interview does not stay on topic well to properly address objective with a large amount of excess information.	Team does not state their project objective. Interview does not stay on topic to properly address objective.	
Content Area: Engineering Design Process	Team exceptionally conveys their Methodology and Process; and their project challenges and correlating solutions through presentation or interview. Team is able to incorporate how their research informed their decisions exceedingly well.	Team effectively conveys their Methodology and Process; and their project challenges and correlating solutions through presentation or interview. Team is able to incorporate how their research informed their decisions.	Team effectively conveys their Methodology and Process; and their project challenges and correlating solutions through presentation or interview. Team is able to incorporate how their research informed most of their decisions.	Team mostly conveys their Methodology and Process; and their project challenges and correlating solutions through presentation or interview. Team is able to incorporate how their research informed some of their decisions.	Team inadequately conveys their Methodology and Process; and their project challenges and correlating solutions through presentation or interview. Team is minimally able to incorporate how their research informed any of their decisions.	Team fails to convey their Methodology and Process; and their project challenges and correlating solutions through presentation or interview. Team is unable to incorporate how their research informed any of their decisions.	
Content Area: Data	Team uses and references data to inform and convey their project choice(s) and reasoning through presentation or interview exceedingly well.	Team effectively uses and references data to inform and convey their project choice(s) and reasoning through presentation or interview.	Team mostly uses and references data to inform and convey their project choice(s) and reasoning through presentation or interview.	Team rarely uses and references data to inform and convey their project choice(s) and reasoning through presentation or interview.	Team uses and references data to inform and convey their project choice(s) and reasoning through presentation or interview at minimum of 1 time.	Team does not use and/or reference data to inform and convey their project choice(s) and reasoning through presentation or interview.	
Content Area: Conclusions and Recommendations	Team is able to effectively present to the highest level their final project and discuss conclusive findings, limitations, next steps, and recommendations for further development through presentation or interview. Team is able to incorporate how their tests resulted in their conclusions exceptionally well.	Team is able to effectively present at an above average level their final project and discuss conclusive findings, limitations, next steps, and recommendations for further development through presentation or interview. Team is able to incorporate how their tests resulted in their conclusions well.	Team is able to effectively present their final project and discuss conclusive findings, limitations, next steps, and recommendations for further development through presentation or interview. Team is able to incorporate how their tests resulted in their conclusions adequately.	Team is able to somewhat effectively present their final project and discuss conclusive findings, limitations, next steps, and recommendations for further development through presentation or interview. Team is minimally able to incorporate how their tests resulted in their conclusions.	Team is somewhat unable to present their final project and discuss conclusive findings, limitations, next steps, and recommendations for further development through presentation or interview. Team is unable to incorporate how their tests resulted in their conclusions.	Team is unable to present their final project and discuss conclusive findings, limitations, next steps, and recommendations for further development through presentation or interview. Team is unable to incorporate how their tests resulted in their conclusions.	
Content Area: Support	Team is able to use and reference support materials on poster to enhance interview and convey understanding of project through presentation or interview exceedingly well. Team logically and clearly utilizes other support material to greatly enhance interview.	Team is able to effectively use and reference support materials on poster to enhance interview and convey understanding of project through presentation or interview. Team utilizes other support material to enhance interview.	Team is able to effectively use and reference support materials on poster to enhance interview & convey understanding of project through presentation or interview. Team utilizes other support material to enhance interview, but some material is unused or does not add to the enhancement of the interview.	Team is able to mostly use and reference support materials on poster to enhance interview and convey understanding of project through presentation or interview. Team could use additional material to enhance interview and/or what is available is mostly unused or does not add to the enhancement of the interview.	Team is not adequately able to use and reference support materials on poster to enhance interview and convey understanding of project through presentation or interview. Team could use additional material to enhance interview and/or what is available is mostly unused or does not add to the enhancement of the interview.	Team does not use and/or reference support materials on poster to enhance interview and convey understanding of project through presentation or interview.	
Column Totals							
Total							

Appendix D: Project Report Rubric

Project Report Rubric	Exceptional (5 points)	Excellent (4 points)	Good (3 points)	Fair (2 points)	Poor (1 point)	Not present (0 points)	Observation Notes
Problem Statement	The problem is clearly articulated with well-defined parameters. The needs of the client have been carefully weighed to design a solution. All limitations are clearly identified.	The problem is adequately articulated with some parameters. The needs of the client are evident but not fully demonstrated. Most limitations are identified.	The problem is articulated with some parameters. The needs of the client are evident but leave some questions. Some limitations are identified.	The problem is poorly articulated with little to no parameters. The needs of the client are barely evident. A few limitations are evident.	The problem is barely articulated. The needs of the client are not evident. No limitations are evident.	The problem statement is not present or not understandable.	
Design Process—Inspiration: Research	The prior knowledge, research, and interviews with client(s) is clearly articulated	The prior knowledge, research, and interviews with client(s) is adequately articulated.	The prior knowledge, research, and interviews with client(s) is articulated but leaves some questions.	The prior knowledge, research, and interviews with client(s) is poorly articulated.	The prior knowledge, research, and interview with client(s) is minimal.	The prior knowledge, research, and interview with client(s) is not present	
Design Process—Inspiration: Client's Needs (x2)	The client's needs are clearly accounted for during the Inspiration process	The client's needs are accounted for during the Inspiration process.	The client's needs are adequately accounted for during the Inspiration process.	The client's needs are poorly accounted for during the Inspiration process.	The client's needs are mentioned but not accounted for during the Inspiration process.	The client's needs are not accounted for during the Inspiration process.	
Design Process—Inspiration: Repeatability (x2)	The design process is clearly iterative and clearly shown to have been repeated with multiple iterations.	The design process is iterative and adequately shown to have been repeated at least one time.	The design process is iterative and is minimally shown to have been repeated at least one time.	The design process is not iterative **or** not adequately shown to have not have been repeated.	The design process is not iterative **and** is not adequately shown to have been repeated.	There is no evidence of repeatability in the Inspiration phase.	
Design Process—Ideation: Link to Inspiration (x2)	A clear path leads from Inspiration to Ideation.	A path leads from Inspiration to Ideation.	A path leads from Inspiration to Ideation but has some holes.	A path leads from Inspiration to Ideation that is minimal.	Little evidence of a path from Inspiration to Ideation.	No evidence of a path from Inspiration to Ideation.	
Design Process—Ideation: Design (x2)	Designs are clearly articulated with reference to knowledge gained.	Designs adequately reference the knowledge gained.	Designs minimally reference the knowledge gained.	Designs poorly reference the knowledge gained.	Designs barely reference the knowledge gained.	Designs do not reference knowledge gained.	
Design Process—Ideation: Math and Science (x2)	Math and Science concepts are clearly articulated as part of the design.	Math and Science concepts are articulated as part of the design.	Math and Science concepts are adequately articulated as part of the design.	Math and Science concepts are poorly articulated as part of the design.	Math and Science concepts are barely articulated as part of the design.	No Math and Science concepts are present.	
Design Process—Implementation: Data (x2)	Data is recorded and shown as part of tests in graphical form. The data is relevant and useful.	Data is recorded and shown as part of tests. The data is mostly relevant and useful.	Some data is recorded and shown as part of tests The data is partly relevant and useful.	Minimal data is recorded. Data is mostly irrelevant.	Little data is recorded. Data is mostly irrelevant	No data is recorded.	
Design Process—Implementation: Analysis (x2)	Data is clearly used to determine strengths and/or weaknesses. Data is used to inspire new ideas.	Data is used to determine strengths and/or weaknesses. Data may or may not be used to inspire new ideas.	Data is adequately used to determine strengths and/or weaknesses. Data is adequately used to inspire new ideas.	Data is minimally used to determine strengths and/or weaknesses. Data is minimally used to inspire new ideas.	Data is barely used to determine strengths and/or weaknesses. Data is barely used to inspire new ideas.	Data analysis is not present.	
Design Process—Implementation: Process (x2)	Data is clearly used to return to the Inspiration phase to improve the design.	Data is used to return to the Inspiration phase to improve the design.	Data is adequately used to return to the Inspiration phase to improve the design.	Data is minimally used to return to the Inspiration phase to improve the design.	Data is barely used to return to the Inspiration phase to improve the design.	Data is not used to return to the Inspiration phase to improve the design.	

Project Report Rubric	Exceptional (5 points)	Excellent (4 points)	Good (3 points)	Fair (2 points)	Poor (1 point)	Not present (0 points)	Observation Notes
Spelling & Grammar				No errors in spelling and grammar.	Minor errors in spelling and grammar.	Numerous errors in spelling and grammar.	
Code				Code is easy to read with some comments	Code is difficult to read.	Code is minimal or non-existent.	
Budget				All items are clearly accounted for.	The majority of items are accounted for.	Less than half of the items are accounted for.	
Bibliography				All research is accounted for using a consistent format.	Most research is accounted for using a consistent format.	Less than half of the research is accounted for.	
Length				The report is 5 to 10 pages in length.	The report is 4 to 11 pages in length.	The report is less than 4 or more than 11 pages in length.	
Column Totals							
Total							

Appendix E: Pitch Presentation Rubric

Pitch Presentation	Exceptional (5 points)	Excellent (4 points)	Good (3 points)	Fair (2 points)	Poor/Lacking (1 point)	Not present (0 points)	Observation Notes
Problem Definition (Total 20 Points)							
Client description • Market size (no. of people) • Impact on client • Market area (where are the clients located)	Client base is clearly identified and a complete profile, including information on population size and location, is provided so that observers have no questions about the client base.	Client base is clearly identified and a profile is provided but may be missing a few minor details leaving observes with less than 100% clarity about the client base.	Client base is identified and the profile includes the essential details, but observers need some crucial information for full clarity about the client base.	Client base is mostly identified, but the profile is incomplete and observers need a significant amount of information to be clear about the client base.	Client base is minimally identified and a profile, if included, provides little useful information about the client base.	It is unclear who the client base is and a profile, if included, does not provide any useful information about the client base.	
Client Impact • How is the client affected by the problem? • Did they talk to actual clients?	Articulately explains how the client is affected by the problem and includes all necessary data gathered from research and anecdotal information from clients to provide a complete picture.	Explains how the client is affected and includes significant data gathered from research and anecdotal information from clients to provide a clear picture.	Explains how the client is affected and includes essential data gathered from research and anecdotal information from clients to provide a mostly clear picture.	Explains how the client is affected and includes somewhat useful data gathered from research and anecdotal information from clients to provide a less than adequate picture.	Somewhat explains how the client is affected and includes inconsequential data gathered from research and anecdotal information from clients to provide a unclear picture.	Does not explain how the client is affected and data included, if any, is not useful. Anecdotal information from clients is random.	
Problem Description • Must outline what the problem is that they are trying to solve.	A clear and complete description is provided, and includes all significant variables or aspects of the problem that need to be addressed.	A clear and almost complete description is provided, and includes most variables of the problem that need to be addressed.	An adequate description is provided, and includes enough variables of the problem that need to be addressed.	A inadequate description is provided, and is missing crucial variables of the problem that need to be addressed.	A description is provided, but lacks enough variables of the problem that need to be addressed to understand the problem.	Little to no description is provided. Variables, if included are illogical.	
Current Solutions • How is the problem currently being solved and what are the weaknesses of these solutions?	All current solutions are listed and a complete breakdown of their weaknesses is provided.	Most of the current solutions are listed and a breakdown of most of their weaknesses is provided.	The essential current solutions are listed and an adequate breakdown of their weaknesses is provided.	A few of the current solutions are listed and an incomplete breakdown of their weaknesses is provided.	Little to none of the current solutions are listed and very little breakdown of their weaknesses is provided.	Current solution are glossed over or left out completely. There is no breakdown of weaknesses or breakdown is illogical.	
Product (Total: 10 points)							
Why did they choose this solution? • How has their research and design process led to this prototype?	Team clearly articulates research, design, and testing that led to the prototype.	Team adequately articulates research, design, and testing that led to the prototype.	Team articulates research, design, and testing that led to the prototype but leaves out a key component.	Team somewhat adequately articulates research, design, and testing that led to prototype but leaves out key components.	Team barely articulates research, design, and testing that led to prototype. Information is sparse.	Team does not discuss research, design, and testing.	
Advantages • What makes their solution better than others and best for client?	Team clearly describes advantages of prototype over other solutions for client citing multiple reasons.	Team clearly describes advantages of prototype over other solutions for client citing one reason.	Team describes advantages of prototype over other solutions with some degree of clarity.	Team describes advantages of prototype over other solutions with no clear reason as to why.	Team description of advantages of prototype over other solutions is unclear.	No mention of advantages over other solutions.	

Pitch Presentation	Exceptional (5 points)	Excellent (4 points)	Good (3 points)	Fair (2 points)	Poor/Lacking (1 point)	Not present (0 points)	Observation Notes
Prototype Demo (Total: 25 points)							
Demonstration • Shows how client will use it	Demonstrates that easily used by client and is intuitive. Explains all of the features and functions of the prototype.	Demonstrates that easily used by client and is mostly intuitive. Explains most of the features and functions.	Demonstration shows that minimal training is needed for client to use. Explains the essential features and functions.	Demonstration shows that some training is needed for client to use. Explains some of the features and functions.	Demonstration was not clear and concise on how to use. Vague explanation of features and functions.	Not easy to use. Client would need significant training. No explanation of features and functions provided.	
Functionality (as proclaimed by students)	Fully functional, smooth no pauses or bugs.	Fully functional with one pause or bug.	Mostly functional with several pauses or bugs.	Somewhat functional with many pauses or bugs.	Barely functional. Numerous pauses or bugs.	Does not function.	
Ease of use (Someone else tries to use the device)	Client was able to use it with no assistance from team.	Client was able to use it with minimal assistance from team.	Client was able to use it with some assistance from team.	Client was able to use it with a lot of assistance from team.	Client could use it with total assistance from team.	Client could not use it at all.	
Next Steps • What happens next in order to bring to the client? • Scalability	Team clearly describes the next steps they need to undertake to bring prototype to the client.	Team adequately describes the next steps they need to undertake to bring prototype to the client.	Team somewhat adequately describes the next steps they need to undertake to bring prototype to the client.	Team, with some degree of clarity, describes the next steps they need to undertake to bring prototype to the client	Team minimally describes the next steps they need to undertake to bring prototype to the client.	Team does not describe the next steps they need to undertake to bring prototype to the client.	
Potential of Design • What would the next iteration look like?	The team clearly identifies what steps they will take to create the next iteration of the prototype.	The team adequately identifies what steps they will take to create the next iteration of the prototype.	The team somewhat adequately identifies what steps they will take to create the next iteration of the prototype.	The team inadequately identifies what steps they will take to create the next iteration of the prototype.	The team minimally identifies what steps they will take to create the next iteration of the prototype.	The team does not identify identifies what steps they will take to create the next iteration of the prototype.	
Presentation (Total: 45 points)							
Communication	• Speech flows nicely with no pauses • Speaks clearly • Speaks loudly enough for everyone to hear; changes tone and pace to maintain interest • Does not use filler words	• Speech includes 1–2 distracting pauses • Speaks clearly; not too quickly or slowly • Speaks loudly enough for everyone to hear; changes tone and pace to maintain interest • Rarely uses filler words (< 3)	• Speech includes some distracting pauses • Speaks clearly most of the time • Speaks loudly enough for the audience to hear most of the time, but may speak in a monotone • Occasionally uses filler words (3–5)	• Speech includes several distracting pauses • Mumbles or speaks too quickly or slowly • Speaks too softly to be understood • Frequently uses filler words (e.g., uh, um, so, and like—more than 5 times)	N/A	Did not present speech.	
Speech Organization	Presents ideas and information with excellent effectiveness. Introduction is strong and inviting, body is focused and clearly manipulated, and closing is effective in unifying entire presentation.	Presents ideas and information with competent effectiveness. Introduction is clear and effective, body is focused, and closing assists in unity.	Presents ideas and information with acceptable effectiveness. Presentation has generally effective introduction, organization for body and closing.	Presents ideas and information with passable effectiveness. Organization is only partly effective and transitions are rough.	Presents ideas and information with insufficient effectiveness. Organization is lacking.	Did not present speech.	

Pitch Presentation	Exceptional (5 points)	Excellent (4 points)	Good (3 points)	Fair (2 points)	Poor/Lacking (1 point)	Not present (0 points)	Observation Notes
Content	Shows an excellent degree of understanding of ideas, concepts, themes, and information.	Shows a competent degree of understanding of ideas, concepts, themes, and information.	Shows an acceptable degree of understanding of ideas, concepts, themes, and information.	Shows a passable degree of understanding of ideas, concepts, themes, and information.	Shows an unsatisfactory degree of understanding of ideas, concepts, themes, and information.	Did not present speech.	
Visual Aids/Creativity	Overall presentation shows excellent evidence of creativity, leading to a masterful, compelling, and provocative presentation.	Overall presentation shows a strong evidence of creativity, leading to an interesting presentation that affects the audience.	Overall presentation shows an acceptable level of creativity, leading to a satisfactory and general presentation.	Overall presentation shows some evidence of creativity, leading to a passable presentation that falls somewhat short on detail.	Overall presentation shows little or no evidence of creativity, leading to a dull and prosaic presentation that is lacking in detail.	Did not present speech.	
Eye Contact	Keeps eye contact with audience most of the time; does not use notes or slides.	Sometimes makes eye contact; only glances at notes or slides.	Makes infrequent eye contact; reads notes or slides most of the time.	Does not look at the audience; reads notes or slides.	N/A	Did not present speech.	
Body Language	• Uses natural movements and gestures • Looks poised and confident	• Uses a few movements appearing natural • Shows some poise and confidence (only a little fidgeting or nervous movement)	• Uses a few gestures or movements but they do not look natural • Shows some poise and confidence (only a little fidgeting or nervous movement)	• Does not use gestures or movements • Lacks poise and confidence (fidgets, slouches, appears nervous)	N/A	Did not present speech.	
Intro of team members	All team members are introduced.	N/A	Some team members are introduced	N/A	N/A	No team members were introduced.	
Participation	All team members participate for about the same length of time.	N/A	All team members participate, but not equally.	N/A	Not all team members participate; only one or two speak.	Did not present.	
Time	Presentation finishes within time.	Presentation finishes within + 1 minute of time limit.	Presentation finishes within + 2 minute of time limit.	Presentation finishes within +3 minute of time limit.	Presentation finishes greater than 4 minute of time limit.	Did not present or goes more than 5 minutes over time limit.	
Column Totals							
Total							

Appendix F: Sample Clients

Client #1: Disaster Action Network
Industry: Natural Disaster Relief

Like many youth, Marcus Smith liked to spend a lot of time on social media connecting with friends, following celebrities, and checking out the latest filters. But every now and then, a different kind of post would catch his attention. Marcus soon realized that social media could be used not only to connect with friends but also to follow what was happening in the world. Over time, Marcus began using social media more and more as a way to keep up with news and current events. In particular, posts, snaps, and tweets about natural disasters across our country and around the world always seemed to captivate him.

The images of endless rubble from earthquakes, entire islands devastated by hurricanes, people trapped by encroaching forest fires, neighborhoods flattened by tornados, cities swallowed by floodwaters, and schools left without power or water stuck with him. He couldn't shake the thought of all of those people in trouble.

Marcus admired the people and organizations that worked to help those affected by natural disasters. But he had this nagging sense that more could be done. He knew that there must be more effective and efficient ways to help save and rebuild lives—not only in the height of the event but also during the ongoing efforts to provide aid for recovery.

As Marcus grew older, these destructive natural events and the subsequent relief efforts stuck in his mind and eventually became a driving force in his career choices. Now as a young entrepreneur, Mr. Smith heads the growing non-profit organization Disaster Action Network, which focuses on providing solutions for those affected by natural disasters.

As the CEO of Disaster Action Network, Mr. Smith is interested in how to better use technology to effectively aid those affected by natural disasters. He has engaged The Johns Hopkins University Applied Physics Laboratory (JHU/APL) to provide insight into the most effective use of readily available hardware and software to aid those affected by natural disasters. Disaster Action Network is looking to invest in effective methods to employ before, during, and after natural disasters strike. **As a team of junior engineers associated with JHU/APL, you are tasked with developing an Arduino-based device that will be used to effectively and efficiently aid those affected by natural disasters.** You will be pitching your idea to a team of Mr. Smith's representatives.

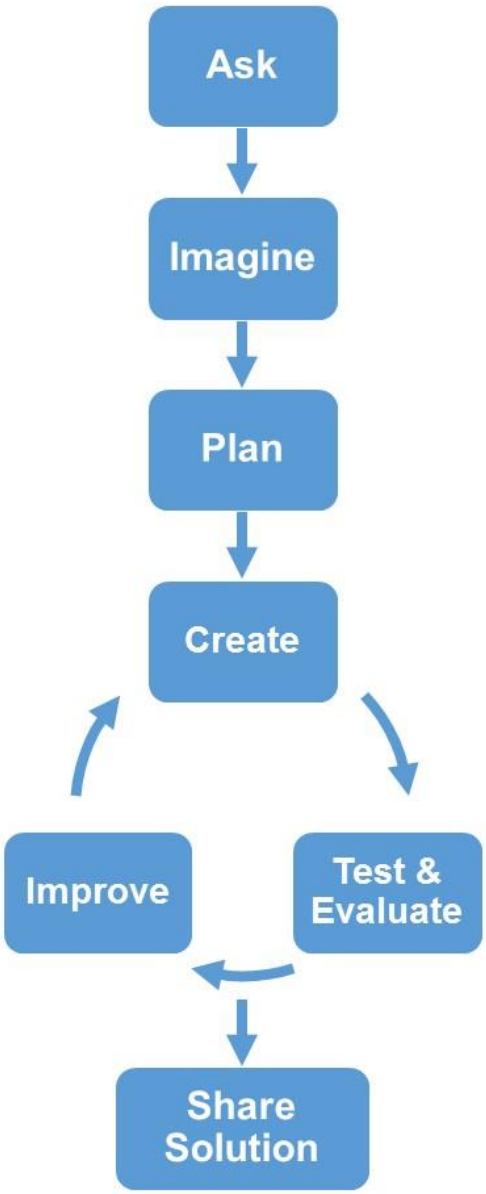
Client #2: Device Security Solutions
Industry: Mobile Device Theft Prevention

Can you imagine how upset your parents would be if your cell phone was stolen? Can you imagine how upset *you* would be? Maybe you, or one of your friends, know what it's like to have a phone or tablet stolen. It's a quick way to ruin your day.

Your parents probably say you should keep your phone on you at all times, but what if you're at the pool? Or the basketball court? Sometimes you just can't have it in your pocket. Sometimes you just have to set it down.

Device Security Solutions, a small Maryland-based startup, has approached The Johns Hopkins University Applied Physics Laboratory (JHU/APL) to provide insight into possible ways to reduce cell phone theft. Device Security Solutions is looking to invest in solutions that most effectively use readily available hardware and software to reduce device theft. **As a team of junior engineers associated with JHU/APL, you are tasked with developing an Arduino-based device to help reduce cell phone theft.** You will be pitching your design to the founders of Device Security Solutions.

Appendix G: Engineering Design Process Overview



Source: Based on graphic produced by NASA Jet Propulsion Laboratory, California Institute of Technology
https://www.jpl.nasa.gov/edu/pdfs/engineering_design_process_light.pdf

Ask

In this phase, you will determine the specific problem you are trying to solve.

- Spend time thinking about the main problem in the situation. What problem(s) or challenge(s) is the end user facing? Think about the people who are facing the problem that needs to be solved. Try to put yourself in their shoes. Get your ideas down on paper.
- Focus on identifying the *specific* problem in the situation. Think about how the main issue can be broken down to identify a specific problem to address. Get as specific as possible. Sometimes the specific problem is presented to you by the client or end user. Other times you need to work to identify the specific problem that needs to be addressed.
- Think about the limitations and requirements that are involved with the problem.
- Research the problem. Search the internet for information. Interview someone with knowledge about the problem. Visit the library. Think about similar problems and how they were solved.

Imagine

In this phase of the process, you will think about as many potential solutions as possible and start deciding which one(s) may work best.

- Brainstorm, Brainstorm, Brainstorm! Don't spend time wondering if the ideas are possible or not. Work fast! The goal is to get as many ideas down on paper as quickly as possible. You can do this as a group or work individually and then share the ideas with your team.
- Start thinking about the ideas you generated. Which ideas seem like they might be the most promising? Ask yourself questions like:
  - Can this idea actually be made?
  - Do we have the skills to make it? Can we learn the skills needed to make it?
  - What materials are needed? Can we get those materials?
  - Can we produce this idea in the amount of time we have?
  - Does the idea actually address the specific problem? Does it fit within the constraints of the problem?

  Thinking in these terms will help you figure out which idea to develop.

Plan

In this phase, you will make all of the plans necessary to build your idea.

- Draw quick sketches and diagrams. Make notes about how to construct your idea. Think about all the things you will need to know before you start building.
- Make lists. What materials will you need? How can you get them? What Arduino code will you need? How much time is going to be needed to build your product? What should go on your to-do lists?
- Identify the skills each team member possesses. What skills need to be learned?
- Determine roles and responsibilities of team members. What will each team member do?

Create

Now you are ready to build a prototype!

- One of the key ideas here is *rapid prototyping*. How can you build a working prototype as quickly as possible? Don't worry about making everything perfect. Don't worry about the little details. The idea is to make a prototype of your idea to test as quickly as possible. Cardboard and duct tape are great at this phase!
- It might be good to take photos of your prototype to refer to later in the process.

Test & Evaluate

In this phase, you will see how well your solution works.

- Try it out! Make sure to record data, observations, and notes. Data and observations will help you determine how well your design works now and how much better (or worse) later versions of your design work.
- Evaluate how well the design works. Which part(s) of the design work well? Which don't work well?
- Remember to think about the end user. How well does the design solve the problem from the user's perspective?

Improve

Now it's time to make your design better!

- Spend time really thinking about what you discovered in the Test & Evaluate phase. Think about how the good things about your design can be made even better. Think about changes that can be made to the parts of the design that didn't work well.
- When you have decided how your design can be best improved, go back to the Create phase and modify your design. Create, Test & Evaluate, Improve… Create, Test & Evaluate, Improve… Repeat, Repeat, Repeat. Keep repeating this cycle until you have a design that is the best solution possible to the specific problem you identified in the Ask phase.

Share Solution

Pull it all together and share your idea!

- Build the final version of the design.
- Prepare the:
  - Written Project Report
  - Technical Presentation (including a Prototype Demonstration)
  - Poster
  - Prototype Pitch

  Remember to refer to the scoring Rubrics in Appendices A through E.
- Proudly present your design to the judges at the MESA competition.

Appendix H: Arduino Resources

Sparkfun

Sparkfun provides tutorials specific to the Sparkfun MESA kit. Tutorials start with setting up your Sparkfun Redboard. Additional tutorials provide hook-up diagrams and sample code for LEDs, switches, photoresisters, potentiometers, motors, and servos. This is a great place for beginners to start.

https://learn.sparkfun.com/MESA2015

Elegoo

Elegoo provides tutorials for each of the sensors in the kit. Each tutorial focuses on a single sensor and includes basic information about the sensor, hook-up diagrams, and pictures. Sample code is also provided for each sensor. The tutorials and sample code can be downloaded from the Elegoo website under the Download section. (Be sure to download the resources for Elegoo Upgraded 37-in-1 Sensor Kit V2.0.)

https://www.elegoo.com/download/

ArduinoModules.info

This site provides background information, hook-up diagrams, and sample code for many sensors.

http://arduinomodules.info/

Make: Getting Started with Arduino (3rd Edition)

by Massimo Banzi and Michael Shiloh
Available at Amazon.com and some public libraries.

This book provides some general background information about Arduino, as well as some examples of more complex projects.

https://www.amazon.com/Getting-Started-Arduino-Electronics-Prototyping/dp/1449363334/ref=sr_1_1?ie=UTF8&qid=1505150311&sr=8-1&keywords=make+getting+started+with+arduino%0c

Arduino Project Handbook: 25 Projects to Get You Started

by Mark Geddes
Available at Amazon.com and some public libraries.

This book provides examples of projects ranging from simple to complex projects.

https://www.amazon.com/Arduino-Project-Handbook-Practical-Projects/dp/1593276907/ref=sr_1_fkmr0_1?s=books&ie=UTF8&qid=1505151425&sr=1-1-fkmr0&keywords=rduino+Project+Handbook%3A+25+Projects+to+Get+You+Started