



Education

“The Power to Hear”
Engineering Design Challenge

Coaches' Guide

Spring 2012

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I. Overview

A. What is the Hall at Patriot Place presented by Raytheon Engineering Design Challenge?

The Hall at Patriot Place presented by Raytheon Engineering Design Challenge (EDC) is a competition that provides middle and high school students, grades 6 to 12, with the opportunity to work on a real world engineering challenge in a collaborative environment. The EDC provides students with opportunities to apply their classroom lessons to a technical problem using the engineering design process. The EDC involves designing a parabolic microphone that is cost effective and yet capable of capturing sounds remotely from the operator on the playing field. The winning team will be invited to use its parabolic microphone on the field during a morning or afternoon practice during training camp.

B. The Vision

One of the clearly defined missions of The Hall at Patriot Place presented by Raytheon and the Kraft family is to develop an ambitious educational program that promotes the development of 21st century skills. The vision is that this program will have national and state approval. The goal of the “Power to Hear” engineering design challenge is to inspire and engage students to employ science, technology, engineering and mathematics (STEM) disciplines to create an efficient and cost effective device which gives the user the ability to listen to and record distance sounds from the playing field.

C. The Competition

This document contains detailed instructions for participation, design requirements, scoring rubric, and guidelines describing the end products that will be submitted for judging. The scoring of the EDC will include the technical quality of the solution, its cost effectiveness and the detailed documentation of the engineering design process used.

II. Competition Rules & Eligibility Requirements

Following are the rules and eligibility requirements for the engineering design challenge participants. In order to participate in the Final Event, each participant and team must meet all criteria and follow all stated rules.

A. Student Eligibility Requirements

1. Participation is limited to students enrolled in schools located in the New England states. Schools are defined to include public, private, or home schools.
2. To be eligible to compete as a student team member, a student must be currently enrolled in grades six, seven, eight, nine, ten, eleven, or twelve. Students enrolled in school environments with alternative grade or level designations must be engaged in a program of study equivalent to the corresponding school grade level.
3. Student team members must have attained the age of 11 as of September 1, 2011.
4. Student team members shall not yet have attained the age of 18 as of September 1, 2011.
5. Teams may be organized around extra-curricular organizations. Girl Scouts, Boy Scouts, science clubs, and museum programs are encouraged to participate.
6. Student team members may only participate on one team.
7. Student team members *may not* transfer from one team to another.

B. Team Composition

1. A team consists of one designated coach and no *fewer than three nor greater than six student* members.
2. Only those team members identified on the official registration form are considered part of the team.

C. Competition Rules

1. One coach may lead multiple teams.
2. A team coach must be at least 21 years of age by October 1, 2011.
3. A coach may be a teacher or other responsible adult.
4. All submissions shall be the original work of the students involved.
5. No team may register after 4:00 PM Eastern Time March 2, 2012.
6. All work must be submitted prior to 4:00 PM Eastern Time April 13, 2012.
7. All submissions must conform to the specifications outlined in the Engineering Design Challenge Guidelines.

III. Coaching a Design Team

A. Roles and Responsibilities

1. *Who can be a coach?*

An EDC coach can be a formal classroom teacher in any school or an adult advisor to an after school or informal learning program. Although having specific expertise in engineering principles or a degree in a STEM-related field may be helpful, coaches are not required to have a technical background to participate. Coaches can be, but are not limited to: technology education teachers, science teachers, math teachers, or someone overseeing a math or science club or museum program.

2. *What role does the coach play on a team?*

The coach should act as a facilitator, advisor, and educator for the team.

3. *What is a coach expected to know?*

A coach may find it necessary to do any or all of the following:

- Provide meeting space
- Create a schedule of meetings
- Attend and supervise all meetings
- Obtain approval from school and permission from parents
- Provide access to resources for students
- Offer guidance, lessons, or suggestions on basic fundamental principles in science, technology, engineering, math and the engineering design process.
- Assist with defining the roles of team members
- Provide suggestions and constructive feedback on strategy and models.
- Register team and assist with final submission
- Assist with final submission criteria: oversee student deadlines and ensure all submissions are made properly and timely.

B. Getting Your Team Started

Team Registration

The team coach can access the EDC application on the Hall website at www.thehallatpatriotplace.com. Only the coach should register your team. Once the coach submits a team registration, he or she will be contacted with an email inviting the team to the judging event.

C. Assembling a Team

As a coach, your role in the EDC is to provide appropriate support that allows the students on the team to work effectively together to develop a solution to the challenge. Although each team will develop its own approach to creating an entry for the challenge, there are some basic steps that you can communicate to your team members.

1. Understand the Problem

Examine the Challenge and identify what needs to be done:

Determine what the goals are and what you will need to do to win. Tip: Look at the scoring guidelines and see what the judges will be looking for and design your solution and documentation so that they conform to the scoring guidelines.

Determine what resources are needed to solve the problem:

You will need to figure out what resources you will need to solve the problem. These will include: (a) human resources (people with expertise needed to do the task you identified); (b) research on what has been done to address the problem by others; and (c) tools needed to do the job.

2. Gather Your Resources

Each team's goal is to create the best solution to the challenge. This will require students to develop a strategy that addresses the following topics: team expertise, coach's expertise and support, differentiated roles, collaboration, budget constraints, and approach.

a. Develop Engineering Design Challenge Team

Team members should be recruited to provide a variety of skills to the team. There should be distinct divisions of labor in the roles and functions of each team member. The exact set of team roles will be determined by the team and may vary based on local expertise and strategy. Note that not every role needs to be filled and some team members may have multiple roles depending on their available expertise and interest.

b. Team Roles

Please see Appendix 5 for some suggested roles that might help your team members understand how they can work together to create a successful design.



3. *Working Together as a Team*

a. Collaborating with Others

There may be multiple teams from one class, multiple classes with teams in one school, or teams created through a non-school organization. You may develop a team that has members from different classes, schools, or organizations within the same state.

b. Researching What Has Been Done and Gathering Information

There are resources provided to you in Appendix 4. These are just suggestions. You should start your research by exploring what others have done with a similar challenge. You may find information on the Web, in libraries, from mentors or other experts. Document all of your information. It is a good way to stay organized and share information with your team. The research you do on what has been done will be the springboard for your work. From that information you will learn what others have tried and get ideas for how you may better develop an approach to solve the EDC.

IV. Team Responsibilities

A. Determine How the Team Will Operate

The nature of each team will determine how it functions. For instance, teams that meet after school will face a different set of needs than teams that function within a classroom. Your coach will help you decide which approach will work best in your community. Often the decision will be made based on how the EDC activities fit within your school's academic program.

B. Operating in Other Venues

Even if your team decides to work outside a formal school setting, it is likely that you will need to have an established educational organization to provide you with access to useful facilities. You may choose to work on the EDC in an after-school program, such as a school club; through Boy or Girl Scouts; at a science or technology center; or through another educational program. Determining the organization with which you will work and the location where you will work needs to be among the first decisions you make.

C. Utilizing the Design Process

Engineers use a specific process to solve problems. The engineering design process provides an effective way to learn how to develop innovative solutions in a systematic way. The process is much like the inquiry process in science. To learn it effectively you need to use it. All team members should learn and participate in the design process. Although the process has been described in a number of different ways, the basic concepts include:

1. Identify the need or problem. We will provide the challenge to you and that will frame the problem. You will need to define how you will solve the problem. This will provide the foundation for organizing your team and developing a work plan.
2. Research and gather important information about the problem. We will provide some reference material, but we encourage you to identify additional material that will help you understand what others have done to address this type of problem. This information will help you develop an approach to the solution.

3. When you start out, you should brainstorm multiple possible solutions to the problem. Through your research you will be able to narrow and refine your potential solutions. When you identify the few you like best, design and test them. Draw on your mathematics and science knowledge.
4. Test, analyze, and gather data on the solutions. Testing the solutions will provide data on how well they worked in addressing the problem. Based on this data you will be able to modify your designs and choose the one that is the most promising.
5. Identify the solution that seems the most promising. Use your test data to create a prototype, modify the design and improve it.
6. Revise or redesign the best solution based on testing and analysis. This step may be done multiple times until you are satisfied with the results.
7. Develop a plan to communicate the results of your work to others. Keep in mind that your reviewers will be looking for a justification of your approach based on test data and your analyses. Also make sure that you include information about how you worked together as a team. Each member of the team should have made a contribution to the solution.

D. Applying the Design Process and Engineering Principles

As you do your work you will be learning the design process and some basic principles of engineering. Learning and demonstrating that you know how to apply the design process and engineering principles will help make your team competitive. You will be asked to make a presentation regarding your team's use of the engineering design process as well as the thinking and learning which took place within the team.

E. Applying Science and Mathematics Principles

It will be necessary to know and apply scientific and mathematical principles to solve the problem. Documentation is extremely important because you must demonstrate that you applied science and math principles within your presentation.

F. Develop a Design Plan and Timeline

1. *Develop a Plan Using the Resources You Have Identified*

In order to be successful you will need to have a plan for your work. This should include: (a) team members with expertise to address the EDC in fields such as science, math, and design; (b) mentors or experts who can supplement the expertise of your team; (c) physical resources such as a place to meet and work, computers, and materials, (d) a strategy for documenting the application of the engineering design process and the mathematical and scientific principles to the EDC; (e) a timeline with milestones; and (f) preparation of your EDC presentation.

2. *Establish a Timeline with Milestones*

A timeline with milestones allows you to determine what needs to be done, when it needs to be done and who needs to do it. You may need to revise this timeline as your work progresses. It is easy for time to rush by so be sure to create a timeline with specific tasks for each team member. The Project Manager should call regular team meetings (at least once a week) to review the progress that everyone has made on their tasks. If problems arise, they should be dealt with efficiently and effectively, and a revised timeline should be created with the plan to resolve the problem. Key events should be noted as milestones. These milestones, such as the date of the competition, should drive the dates for the other tasks.

3. *Strategize How to Present Your EDC Solution*

It is important to have a plan and strategy for preparing your EDC presentation. This should be included in your timeline. Identify roles and responsibilities among the team members for documenting and preparing the presentation. Keep in mind that a quality presentation is likely to require multiple drafts before it is polished and ready to deliver. You need to plan for that part of the process. The presentation should be designed so that reviewers will see that all of the elements of the engineering design process are addressed. Remember the presentation shall be ten to twelve minutes in duration.

4. *Link the Presentation Plan to Your Timeline*

Make sure that you reserve enough time for preparing your presentation. Be sure that key writing tasks and milestones are included in your timeline.

5. *Identify the Presentation Team:*

Each team member should have a role in preparing for the design of the presentation. Assign roles for the documentation, design and preparation of the presentation.

6. *Keep an Engineering Design Diary*

Keeping good records is part of good science and engineering. Each team member should have a project journal in which they record ideas, solution options, plans, sketches of designs, references they collect, actions that need to be taken, notes from meetings, tests and plans. The record archives will be helpful when you begin preparing your EDC presentation and submitting your documentation. Engineering notebooks signed and dated by two witnesses are used in industry as an important part of the documentation used to obtain patents on innovative ideas!

G. Submit Your Challenge Solution

1. *Develop a Plan for the Submission of your Design:*

You need to figure out how to submit your EDC. This should be part of your overall plan. You should identify team member roles and responsibilities for submission. Be sure to be familiar with the guidelines for submission found on page 13. Materials that do not follow the guidelines may not be competitive or, in some cases, may be disqualified.

2. *Meet the Deadline*

Deadlines are very important! EDC projects submitted after the deadline will **NOT** be considered! Plan to have your submission completed well before the due date and time to accommodate any unexpected events.

V. Key Dates and Team Planning Outline

A. Key Dates

Key Dates	
January 20, 2012	New England Design Challenge is Released
March 2, 2012	Last Day for Team Registration
April 13, 2012	Deadline for Submission of EDC presentation and documentation
April 20, 2012	New England Testing Schedule Released
April 28, 2012	New England EDC event at Gillette Stadium

B. Suggested Monthly Planning Outline for New England EDC

	January 20, 2012: New England EDC is released
March	
Coach/Teams	Establish your team and Register your team by March 2, 2012
	Identify roles and team structure
	1. Who is doing what?
	2. Where and when will you meet?
	3. Discuss approach to EDC
	4. Identify potential weak areas and knowledge gaps
	5. Recruit mentors and experts
	6. Identify needed resources and budget restrictions
	March 2, 2012: Last Day for Team Registration
	Work on solving the EDC
	1. Learn what you need to solve EDC
	2. Research to learn topics more in depth
	3. Identify solution options
	4. Begin designing and testing solution options
	5. Identify the best solution option
April	
Coach/Teams	1. Test and refine your best solution
	2. Develop a presentation plan for your EDC
	3. Begin developing your EDC presentation
	4. Refine your presentation
	5. Prepare documents for submission
	6. Submit your EDC documents before the deadline
	April 13, 2012: EDC documents submission due
	Submitted documents are reviewed
	April 20, 2012: New England Teams are notified of testing schedule

VI. The “Power to Hear” Engineering Design Challenge

A. Background and Overview

The “Power to Hear” Engineering Design Challenge is a unique contest that will challenge you to use your science, technology, engineering and math skills, as well as your ability to work collaboratively as part of an engineering design team.

Your student team will build, test and submit a parabolic microphone for use on the sidelines at Gillette Stadium. Your team will document its journey through the steps of the engineering process in a “Power to Hear” engineering design notebook. The notebook will include all of the supporting data describing the solution, the project goal, design phases, and demonstration of understanding of the science and math principals used. This notebook is required of all competing teams. Over time, it becomes the record of your team’s research, design process and iterations, and successes and failures. It describes both the individual and team experiences as your team develops its technical solution. In addition to technical details, this notebook will contain information about the materials used, including detailed costs, receipts or cost estimates of materials borrowed or scavenged. It will also include documentation of your interactions with experts outside of your team. At the time of submittal, your team will review and compile selected materials from your notebook to document the budget and the engineering design solution. You will submit these documents electronically in a preliminary submittal prior to the final competition.

Your teams total score will be based on (a) the documentation and costs associated with the design of the parabolic microphone, (b) the presentation, which will be judged on its completeness in describing the engineering design process and the thinking and learning that took place (10 –12 minutes in duration) and (c) the effectiveness of the parabolic microphone.

The complete description of the “Power to Hear” Engineering Design Challenge is included in Appendix 1. Further information on submission requirements and a scoring outline are included in Appendices 2 and 3.

B. Submission Requirements

1. The **EDC Budget Report** shall include a detailed breakdown of all expenses associated with the construction of the parabolic microphone submitted for testing. The report shall include receipts or cost estimates for each component used in the parabolic microphone being tested. The budget for the materials and parts shall not exceed \$50.00.

2. **The “Power to Hear” Engineering Design Presentation** should include the design process and results. You will present a PowerPoint presentation (10-12 minutes) at the beginning of the competition. Through the narrative and graphic representations of your presentation your team will communicate that the engineering design process has been followed, that all design variables have been considered, design requirements met, assumptions considered, and calculations correct. Your presentation will include design schematics and specifications, graphic images of the designs you created, costs associated with the design and the thinking and learning that took place.

It should also include information contributing to the technical merit of the proposed solution as well as communicate an understanding of the science and mathematics applied throughout the design process.

Scoring guidelines and scoring rubric for the Engineering Design Presentation can be found in Appendix 3.

3. **The Measurement Playoff** will consist of testing rounds that assess the effectiveness of all parabolic microphones submitted. The first round shall test each microphone’s measured millivolts at 12 yards. During each subsequent round the distance variable will be doubled. Each round will serve as an elimination round, the teams in the top 50% combined scores will move forward to the next round.

C. General Scoring Guidelines

The decisions by the judges are final!

The New England Engineering Design Challenge Scoring Guidelines	
<p>Overall scoring will be based on the following deliverables: Engineering Design Challenge Detail Budget Engineering Design Challenge PowerPoint Presentation Participation in the Measured Play Off</p>	
<p>Scoring Guidelines: EDC Detail Budget - 1000 points – (20*cost) EDC PowerPoint Challenge – 1000 points (see Appendix 3 for scoring rubric) Measurement Play Off [$X_mV@12 \text{ yds} + Y_mV@24 \text{ yds} + W_mV@48 \text{ yds} + Z_mV@72 \text{ yds} + \text{Bonus round}$]</p>	
<p>1. Design solution – To what degree did your team meet all the design requirements?</p>	<p>Design requirements: See Appendix 1</p> <p>Entries must meet all requirements to go on to the Measurement Playoff Round.</p>
<p>2. Engineering Design Presentation –</p>	<p>The presentation shall:</p> <ul style="list-style-type: none"> • Describe in detail the engineering design process as outlined in appendix 1 • Describe the thinking and learning that took place within the team • Demonstrate an understanding of the science and math used to design the parabolic microphone • Provide an overview of the costs associated with the design • Last a minimum of 10 minutes and no more than 12 minutes.

A detailed outline of the Scoring Guidelines can be found in Appendix 3.



VII. Contact Information

Peg Myers
Education and Tours Coordinator
The Hall presented by Raytheon
1 Patriot Place
Phone: 508-549-0553
pegm@patriots.com

Appendix 1: “The Power to Hear” Engineering Design Challenge

Study the basics of sound and the math of conic sections. Calculate the focus of the parabola so you know where to put the microphone to capture sound. Build and test your own parabolic microphone just like they use during the game.

Competition is open to all students in grades 6 – 12. It will take place at Gillette Stadium.

Competition groups:

Group 1: grades 6, 7 and 8

Group 2: grades 9, 10, 11, and 12

Design Requirements:

- REQ101 The parabolic microphone SHALL have no dimension exceeding 48 inches.
- REQ102 The total cost of all components and materials SHALL be less than \$50.01 US dollars
- REQ103 The parabolic microphone SHALL plug into the microphone jack on a laptop or PC. The microphone and the feed to the PC SHALL NOT contain any amplifiers or preamp circuits.
- REQ104 Each entry for **grades 9-12** SHALL be accompanied by a graph plotting distance on the x-axis and your measured output for 6, 12, 24, and 48 yards on the y-axis.
- REQ105 The team SHALL provide a design report and a complete parts list with costs. Documented cost estimates are required for all borrowed or scavenged items. *Provide receipts, pages from a catalog or price lists from online vendors.*
- REQ105 The team SHALL give a 10 to 12 minute¹ PowerPoint presentation explaining the design, costs and building process.
- REQ 106 Each entry SHALL provide a fixture that plugs into the headphone jack on a laptop or PC. The fixture SHALL have leads of at least 12 inches and SHALL have alligator clips attached to one end. This fixture SHALL be passive. ie. no active components like amplifiers.

Entries must meet all requirements to participate in the Measurement Playoff Round.

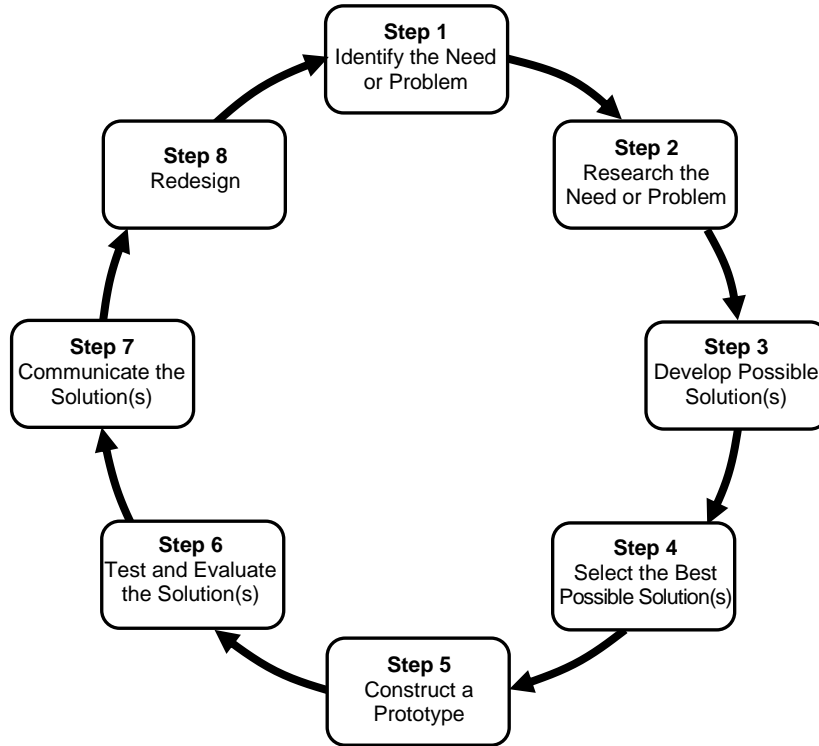
The winning team will be invited to use its parabolic microphone on the field during training camp.

¹ See Appendix 3 for scoring rubric



Appendix 1: “The Power to Hear” Engineering Design Challenge - continued

Steps of the Engineering Design Process¹



1. Identify the need or problem
2. Research the need or problem
 - Examine the current state of the issue and current solutions
 - Explore other options via the Internet, library, interviews, etc.
3. Develop possible solution(s)
 - Brainstorm possible solution(s)
 - Draw on mathematics and science
 - Articulate the possible solution(s) in two and three dimensions
 - Refine the possible solution(s)
4. Select the best possible solution(s)
 - Determine which solution(s) best meet(s) the original need or solve(s) the original problem
5. Construct a prototype
 - Model the selected solution(s) in two and three dimensions
6. Test and evaluate the solution(s)
 - Does it work?
 - Does it meet the original design constraints?
7. Communicate the solution(s)
 - Make an engineering presentation that includes a discussion of how the solution(s) best meet(s) the initial need or the problem
8. Participate in EDC and Redesign
 - Overhaul the solution(s) based on information gathered during the tests and presentation

1 - Massachusetts Department of Elementary and Secondary Education. Science and Technology/Engineering Framework – October 2006 <http://www.doe.mass.edu/frameworks/scitech/2006.doc> page 84



Appendix 2: EDC 2012 Contest Application and Document Submittals

The Hall at Patriot Place Presented by Raytheon
 “Power to Hear” Engineering Design Challenge

Registration Form

Please fill out this form completely. It must be submitted electronically no later than 4:00 p.m. on March 2, 2012. To submit this form electronically, send it as an attachment to education@patriots.com. In the subject line list **Power to Hear**. A hard copy of this registration form, along with parent signature forms, must be received no later than 4:00 p.m. on March 7, 2012. No late registrations will be accepted.

The Engineering Design Challenge will be held on April 28 at Gillette Stadium. Each team will receive an email with instructions and a designated reporting time and location. If the team does not arrive on time, the team will be disqualified. - - - - -

The team members listed below understand and hereby agree to all the requirements stated within the Engineering Design Guidelines.

Team Name _____

School/District/Organization _____

Coaches Name _____

Role in Organization _____

Team Member	Grade	Date of Birth	Email address

A hard copy of this registration form must be submitted and received no later than 4:00 p.m. on March 7, 2012. All parent signature forms must be attached. Incomplete registrations will be disqualified. Send forms to Power to Hear/The Hall at Patriot Place/One Patriot Place/Foxborough, MA 02035



Appendix 2: EDC 2012 Contest Application and Document Submittals - continued

The Hall at Patriot Place Presented by Raytheon
“Power to Hear” Engineering Design Challenge

Parent Signature Form

This form must be completed and received no later than 4:00 p.m. on March 7, 2012. No late registrations will be allowed.

The contest will be held on April 28 at Gillette Stadium. Each team will receive an email with a designated reporting time and location. If the team does not arrive on time the team will be disqualified.

.....
The student listed below has been registered as a team member of the:

Team Name _____

School/District/Organization _____

I hereby grant permission for my student _____ to participate in The Hall at Patriot Place Presented by Raytheon “Power to Hear” Engineering Design Competition. I also verify that my student’s date of birth is

_____.
mm/dd/yyyy

Parent’s Signature: _____ Date: _____

My student may have their picture taken as part of the Engineering Design Challenge experience and the picture may be used in highlights of the event.

Parent Initials

Appendix 2: EDC 2012 Contest Application and Document Submittals - continued

Submittal Requirements for April 13th deadline:

- The PowerPoint presentation must be saved in an Office 2007 PC format and must be submitted on a DVD or flash drive. The PowerPoint presentation must be received at the Hall no later than 4:00 P.M. on April 13th. For **grades 9-12** a drawing of your test setup and a graph plotting distance on the x axis and your measured output for 6, 12, 24, and 48 yards on the y axis must be included.
- Included with the PowerPoint presentation should be a copy of the detailed report of the budget, with accompanying receipts and documentation. Do not send originals.

Suggested Format for PowerPoint Presentation

PowerPoint shall include the following:

- Team name, community represented, team members, grades represented
- Description of the need and benefits of solving the problem.
- Project Goals, Objectives, and Constraints
- Approach to solving the problem
- Task assignments
- Results (graphs, data, design sketches etc.)
- Discussion and Conclusions (lessons learned)
- Resources used and budget requirements of final design

Appendix 3: Scoring Guidelines

How Your Team's Total Score Will Be Computed

- 1) **The EDC Budget Report** $1000 - (20 * \text{cost})$ 1000 points maximum

Receipts or cost estimates must be provided for each component
If cost exceeds 50 dollars the entry is not eligible to compete

- 2) **The "Power to Hear" Engineering Design Presentation** 1000 points maximum

Judged on completeness, delivery and staying within allowed time. The presentation should describe the design process as well as the thinking and learning which took place within the team. At a minimum it should cover each step of the design process provided in the team rules.

- 3) **The Measurement Playoff**

Points will be added to your score based on the measured millivolts from each round. The playoff rules and measurement technique will be discussed ahead. The algorithm is given below.

[X mV@12 yds + Y mV@24 yds + W mV@48 yds + Z mV@72 yds + Bonus Round]

Example: $300 \text{ mV} + 150 \text{ mV} + 75 \text{ mV} + 38 \text{ mV} = 563$ points added to the points earned based on the cost algorithm and the presentation round.



Appendix 3: Scoring Guidelines - continued

4) The Challenge Round for Bonus Points

Each team who is still in the competition at 72 yards will have the option of trying for bonus points at 96 yards..

If your microphone produces results greater than 12 mV at 96 yards the number of millivolts we measure at 96 yards will be added to your score.

If your microphone does not exceed 12 mV at 96 yards then **50 mV will be subtracted** from your score.

[XmV@12 yds + YmV@24 yds + WmV@48 yds + ZmV@72 yds + KmV@96 yds]

Example 1: Team chooses to compete at 96 yds and measures 19mV.

$300 \text{ mV} + 150 \text{ mV} + 75 \text{ mV} + 38 \text{ mV} + 19 \text{ mV} = 582$ points added to the points earned based on the cost algorithm and the presentation round.

Example 2: Team chooses to compete at 96 yds and measures 11mV.

$300 \text{ mV} + 150 \text{ mV} + 75 \text{ mV} + 38 \text{ mV} - 50 \text{ mV} = 513$ points added to the points earned based on the cost algorithm and the presentation round.

Appendix 3: Scoring Guidelines - continued

Scoring Rubrics for PowerPoint Presentation

Performance Criteria	100 points each criteria	50 points each criteria	10 points each criteria
Preparation	A copy of PowerPoint handouts provided to judges prior to presentation.	Handouts provided after the presentation.	Handouts were not available.
Organization	Information was presented in a logical, interesting sequence that was easy to follow	Information was somewhat difficult to follow Presenter tended to "jump around" from topic to topic	There did not appear to be any sequence nor order to the information presented.
Technical Specifications	Most slides contained graphics, charts, or photos	Many slides did not contain graphics, charts, or photos	Slides did not contain a graphic, charts or photos
	Appropriate slide animations were used	Used some slide animations, however, more were needed or overused slide animations to the point that they were distracting	No slide animations were used during the presentation
Mechanics	Presentation had no misspellings or grammatical errors	Presentation contained 1-2 spelling or grammatical errors	Presentation contained 3 or more spelling or grammatical errors
Use of Mathematics	Demonstrated a clear understanding of the mathematics used in the design of the parabolic microphone	Demonstrated some understanding of the mathematics used in the design of the parabolic microphone	Demonstrated minimal understanding of the mathematics used in the design of the parabolic microphone

Appendix 3: Scoring Guidelines - continued

Performance Criteria	100 points each criteria	50 points each criteria	10 points each criteria
Use of Science	Demonstrated a clear understanding of the science used in the design of the parabolic microphone	Demonstrated some understanding of the science used in the design of the parabolic microphone	Demonstrated minimal understanding of the science used in the design of the parabolic microphone
Budget Documentation	Detail budget documentation of materials used	Budget presentation was not detailed or well documented	Budget was not included in presentation
Use of Engineering Design Process	Demonstrated and documented the engineering design process	Demonstrated some understanding and documentation of the engineering design process	Demonstrated minimal understanding and documentation of the engineering design process
Overall Presentation	An outstanding presentation. The presentation kept the interest and was among the very best.	A good presentation. The presenter demonstrated the ability to utilize the various features of the program, however, the presentation did not always keep my interest	The presenter displayed little knowledge and/or understanding of the components of assignment, software, computers, etc.

Penalty Minutes for Presentation

Rule	Time Range	Penalty
1 minute over/under	9 to 10 or 12 to 13 minutes	50 point deduction
2 minutes over/under	8 to 9 or 13 to 14 minutes	150 point deduction
3 minutes over/under	7 to 8 or 14 to 15 minutes	300 point deduction
Major time violation	Less than 7 or over 15 minutes	600 point deduction
Presentation must stop at 15 minutes even if not finished.		

Appendix 3: Scoring Guidelines - continued

Testing Procedure for Measurement Playoff

A short pre-recorded sound source¹ will be provided for each round.

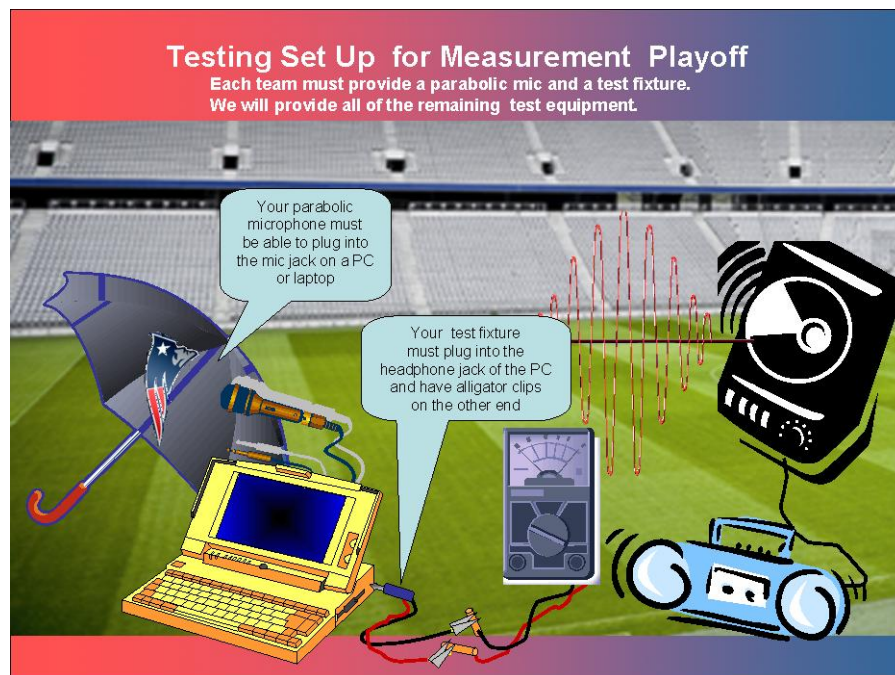
Your microphone will be plugged into the microphone jack on a laptop or PC. The microphone and the feed to the PC SHALL NOT contain any amplifiers or preamp circuits.

The evaluation team will capture the output from your microphone as the track plays. We will record with either the PC's Sound Recorder or Media Player application.

Your output fixture will be plugged into the headphone jack and must be clipped onto the metal leads of our voltmeter.

The recorded output from your microphone will be played back and the output of the PC's headphone jack will be measured by our voltmeter.

Your score will be determined by the maximum reading in millivolts recorded by our voltmeter over the period of the recording.



- ¹ The sound source will be a prerecorded multi-tone source played from an amplifier. It may be a short track from a symphony or pop music selection or a set of tones.

Appendix 3: Scoring Guidelines - continued

Measurement Playoff Elimination

Top 50% in each round will advance to the next round

Score = maximum millivolts in a 30 second sample measured at several ranges

Teams will compete at 12, 24, 48, and 72 yards until their individual reading go below 12 mV at any range. Then they must stop.

Only the top 50% at each measurement range will go on to the next range.

Breakages must be corrected in the round they occur. If a HW failure cannot be corrected the team is eliminated and cannot compete once the measurement table has been moved to the next yard marker.

If a team requires any assistance from the measure team other than collecting the measurements, a penalty of 20 mV will be subtracted from the team's measurement for that round.

Appendix 3: Scoring Guidelines - continued

How A Team's Total Score Will Be Computed

Example:

Budget Team A spent 30 dollars on their design and provided documentation for each part. They get 400 points in the cost part of the competition.
 $1000 - (20 * 30) = 1000 - 600 = 400.$

Team A's design meets all of the requirements.

Presentation The panel of judges ranked the presentation according to a scoring checklist and gave the presentation a score of 800 points.

Team A's presentation took 13.25¹ minutes, which was longer than the allowed time - 150 points will be subtracted from the presentation score.

Team A's total score at this point is: $400 + 800 - 150 = 1050$ points.

Measurement In the measurement round at 12 yards Team A's microphone put out is a maximum of 400 millivolts. This is added to their score: $1050 + 400 = 1450$ points.

At 24 yards Team A's microphone put out a maximum of 200 millivolts. Team A's score is now $1450 + 200 = 1650$ points.

At 48 yards Team A's microphone put out 60 millivolts. Team A's score is now $1650 + 60 = 1710$ points

At 72 yards Team A's microphone put out 20 millivolts. Team A's score is now $1710 + 20 = 1730$

An entry is disqualified if their reading falls below 12 mV at any range because our test setup registers about 11 mV due to ambient noise in the field house.

1 See Appendix 3 for scoring rubric

Appendix 4: Resources

A. Engineering Design Process

Ertas, Atila, and Jone, Jesse C. *The Engineering Design Process*. 1996. Wiley. Engineering is Elementary.

The Engineering Design Process. http://www.mos.org/eie/engineering_design.php

Massachusetts Department of Elementary and Secondary Education.
Science and Technology/Engineering Framework – October 2006
<http://www.doe.mass.edu/frameworks/current.html> page 84

B. Parabolic microphones

<http://www.instructables.com>

<http://mscir.tripod.com/parabola> Parabola Calculator

<http://www.bambooturtle.us/parabolicmicrophone.html>

<http://en.wikipedia.org/wiki/microphone>

<http://frogrecordist.home.mindspring.com/docs/quickparabolic.html>

Frauenfelder, Mark. *Make: Technology on your time Volume 14*. May1, 2008 Make Books

C. Mathematics

<http://math2.org/math/algebra/conics.htm>

<http://www.mathsisfun.com/geometry/conic-sections.html>

Massachusetts Department of Elementary and Secondary Education.
Mathematics Framework – March 2011
<http://www.doe.mass.edu/frameworks/current.html>

NCTM, Principles and standards for School Mathematics
<http://www.nctm.org/standards/default.aspx?id=58>

Appendix 5: Suggested Student Roles

In order to develop a winning strategy, you need to develop a team. Several factors will go into the selection process, including the interest and expertise of individual team members, the expertise of the coach, and the roles that students will adopt. In order to create an effective team, you should set up functionally distinct roles for your members. The precise nature of the roles will be decided by your team and may vary based on local expertise and strategy. Note that not every role needs to be filled and some people may have multiple roles depending on ability and interest. The following are suggested roles that your team may use or modify as you see fit as you develop your strategy for the competition.

Project Manager

The Project Manager will be responsible for recruiting a team and leading the design activity. The Project Manager is responsible for the overall success of the product or program. The Project Manager is the individual responsible for managing the project plan and deliverables, ensuring that all project team members have the necessary resources required to complete the project, and the status for the team, tracking timeline and milestones, and quality. Many times this individual plays additional roles in the project. The Project Manager leads the team and is typically responsible for the development of the overall product, overseeing the budget documents and the Engineering Design documentation and presentation. They often monitor several interrelated sub- project activities engaged in by team members.

Systems Engineer

The Systems Engineer defines the product construction, its components, and the required interfaces. They have ultimate responsibility for ensuring the various parts of the product will work together as a whole when finally assembled. They provide direction to the design team, manage interfaces, and participate in design reviews.

Project Scientist

The Project Scientist should have a strong background and interest in science. This role will be responsible for the scientific integrity of the approach and for translating the scientific principles into the team's engineering design. This role serves as a liaison with a science mentor or expert, assisting the team with the incorporation of scientific advice and evidence.

Appendix 5: Suggested Student Roles - Continued

Project Mathematician

The Project Mathematician should have a strong background and interest in mathematics. This role will be responsible for the mathematical integrity of the approach and for translating the mathematical principles and applications into the team's engineering design and presentation.

Project Communicator (or Communications Specialist)

The Project Communicator integrates the ideas, the approaches, and the solutions from the design team into written documents and the final presentation. This role is responsible for communicating with the EDC representative and representing the team at the competition. This person will communicate with the team apprising them of all event activities.

Procurement Officer

The Procurement Officer will document all materials used, maintain a budget, and prepare final budget document for submittal. This role is responsible for maintaining all documentation including receipts and cost estimates.

Technology Specialist

The technology Specialist should have a background in technology. This role will be responsible for integrity of the PowerPoint presentation, making sure that all requirements for submittal are met. This role will assist with the slide transitions and timing of the presentation.

Appendix 6: Linking the “Power To Hear” Engineering Design Challenge to Curriculum and Standards

Educators in America’s classrooms are accountable for teaching to standards in key areas of the curriculum. Students in America’s classrooms are responsible for meeting the standards identified for their course and grade level. The materials below provide examples of the key curriculum connections between STEM standards and the skills and knowledge you will develop as you work on your engineering design challenge. For the most part, states’ standards are based on national standards reflecting the extensive research done by large professional organizations representing specific academic content areas. Relevant national standards emphasized in the “Power to Hear” Engineering Design Challenge include the following:

National Science Education Standards, National Research Council (1995), found at <http://www.nap.edu>.

Principles and Standards for School Mathematics, National Council of Teachers of Mathematics (2000), found at <http://standards.nctm.org/>

Standards for Technological Literacy: Content for the Study of Technology, International Technology Education Association (2002), found at http://www.iteaconnect.org/TAA/Publications/TAA_Publications.html

Technology Foundation Standards for All Students, ISTE National Educational Technology Standards for Students (2007), found at <http://www.iste.org/standards.aspx>