GIFTS: Introduction of the Engineering Design Process in a First Year Multidisciplinary Course though use of Wind Power

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Introduction

First-year engineering students seek hands-on learning experiences to introduce them to the fundamental tools they will use in their future careers. Previous research has also shown that first-year design experiences can help support engineering identity formation and retention [1]. At Kansas State University, the KidWind competition, a popular design challenge for teaching design and critical thinking skills to K-12 students, has been reimagined to enhance the teaching of the engineering design process. In a large-enrollment, first-year design course, the wind turbine project enables students to work in collaborative teams while learning the engineering design process. These teams often consist of students with a wide range of engineering interests, allowing for a multidisciplinary approach.

The objective of this group project is to emphasize and reinforce key aspects such as design criteria, constraints, data verification and validation, end-user experience, cost, and technical communication. Additionally, the project provides significant opportunities for student creativity and exploration of wind power concepts, all without requiring substantial investment in specialized equipment or resources.

Approach

The course begins with five weeks of general instruction on the design process. This includes a discussion of the engineering method and how to effectively communicate the design process to interested parties. Instructors focus on a common design challenge, such as designing a backpack that university students would want and use, to keep the class focused. The course then moves on to understanding how to gather information about the problem. This helps students gain context on what they are designing and ensures they understand the needs of customers, end users, and potential investors. Students interview interested parties and collect professional references that validate the need and value of the project.

Next, students focus on developing design criteria. They will establish numerical constraints that are both comprehensive and meaningful. The objective is for students to understand how these criteria help verify that their design will meet the needs of clients and users. Finally, the concept generation phase begins where students comprehensively address all promising design ideas. The class presents multiple techniques but requires a well-defended decision matrix supported by data and analysis where appropriate.

After completing the general design discussion, week six marks a shift from the general backpack project to the end-of-semester project. The timing of this transition is intentional. There is typically a transient nature to class enrollment in the first five weeks. Forming project teams after this period ensures greater stability and allows students to better manage their schedules and workloads due to having experience with college life.

Following group formation, each team designs, acquires, or purchases all components necessary for their wind turbine prototype. Teams will then construct and test their prototype to ensure adherence to the specifications and objectives outlined in the official Wind Turbine project statement, provided to each team. The final project design must conform to the following constraints:

- Each team receives one KidWind turbine generator (purchased from Vernier [3] at an approximate cost of $6 per unit, acquired in bulk by the instructors).
- Final unassembled projects must fit inside a USPS Medium Flat Rate Priority Mail box (dimensions: 12 in x 14-1/2 in x 3-1/2 in) to facilitate potential global shipment.
- The packaged wind turbine must be capable of assembly by an able-bodied individual aged 16 or older within a 10-minute time limit. This hypothetical "customer," who may reside anywhere globally and may not be proficient in English, will have access solely to the contents of the provided box, including an instruction manual. Teams may assume the availability of standard hand tools (e.g., screwdrivers, wrenches, pliers, hammers) but not specialized equipment.
    - While inclusive design principles are discussed and encouraged through class lectures, it is not a mandatory design constraint within this project. This decision acknowledges the inherent variability in students' technical skills, background knowledge, and the limited time frame of a one-credit-hour course.
- The assembled wind turbine must fit within the dimensions of the KidWind Tunnel [4], a 48” x 48” enclosure equipped with four industrial fans generating an average wind speed of 3.6 m/s at 30 cm from the tunnel opening.
- The wind turbine must be designed to generate power irrespective of its orientation within the wind tunnel.
- Total project cost is limited to $25, including the $6 generator. Free components require instructor approval with the criterion that 90% of the class could obtain the item for free within 24-hours. If 3D printing is used, a setup fee of $3 applies for all 3D printed parts, with individual part costs based on Prusa’s 3D printing price calculator [5].

In addition, the teams must determine two other design criteria with numerical constraints as well as determine ways to verify and validate those constraints.

The remaining 10 weeks of the course run in parallel with the design project, introducing key concepts such as codes and standards, verification methodologies, data collection and analysis, and the creation of proper documentation, including instruction manuals and final reports. During this time, students also have opportunities for workdays where they can receive feedback from the instructor and fellow students as well as testing in an official KidWind wind tunnel.

At the end of the semester, students bring their packaged wind turbines to a designated "shipping location," where an instructor takes custody of the package. The project culminates in an expo day, during which volunteer end users open the packaged wind turbines, assemble them under a time constraint, and test in the wind tunnel with turbine generators connected to an energy sensor. In more detail, expo day consists of 30-minute time slots during which:

1. The packaged wind turbine is handed to the “customer” who knows that they “have ordered” a kit and they will be asked to build it but have no further information about the project. A timer begins when they open the box. Penalties apply if the assembly takes over 10 minutes or if instructions are unclear and help is needed.
2. The customer places the assembled wind turbine in the wind tunnel and connects it to the Vernier Go Direct® Energy Sensor [6]. A penalty is assessed if the group needs to modify the turbine assembly for any reason before the test.
3. Testing occurs over three 30-second runs, with energy production measured in Joules over the total time. The average of these three runs becomes the group’s final score. Deductions occur if the group needs to manually start the turbine, modify the turbine during the run, or reassemble it due to failure.

Expo day helps students practice communication with diverse audiences. While the primary objective of the class is to highlight hands-on learning through the design project, the competitive testing motivates them to design for both performance and constraints. Since unknown volunteers build and test the turbines, students must consider user needs, abilities, and experiences when designing.

Results and Discussion

In Fall 2024, the introductory design course was co-taught by seven instructors from seven different engineering departments: Biological and Agricultural, Mechanical, Civil, Electrical, Biomedical, Chemical, and General Engineering. The course had an enrollment of 380 students from 14 different engineering degree programs.

The course offered five different projects, each representing various aspects of the engineering curricula of the enrolled students. Among the students, 159 out of 380 (41.8%) chose the wind turbine project, forming 41 different groups. These groups included members from 12 of the 14 different engineering majors enrolled in the class. The highest concentration of majors within the wind turbine project groups was as follows: 57.2% from Mechanical Engineering, 10.1% from Electrical Engineering, 7.5% from Civil Engineering, and 5.7% from Engineering Undecided.

Of the 41 groups, five were homogeneous in major, all consisting of Mechanical Engineering students. Fifteen groups had members from two different majors, eighteen groups had members from three different majors, and one group included students from four different majors.

Instructor observations suggested a minimal initial benefit of multidisciplinary team structures, due to the composition of the student population, where approximately 90% were first-semester students with diverse backgrounds and limited discipline-specific training. However, teams that included students with concurrent enrollment in discipline-specific courses (e.g., CAD, Circuits, Coding) displayed greater engagement and excitement when project work could leverage their developing expertise.

Because the overall class has five different projects, assessment methods are uniform, rubric based, and tied closely to the learning objectives of the course:

1. Demonstrate how to properly set up, analyze and solve basic engineering problems.
2. Demonstrate formatting guidelines for problem set up and solutions.
3. Utilize engineering tools such as Microsoft Excel and statistics to solve basic engineering problems.
4. Experience engineering design within a team.
5. Establish realistic design criteria for engineering problems.
6. Effectively communicate engineering designs and design process.

The course evaluation was based on 20% attendance and participation, 20% homework, and 60% design project. In the design project category, there were 365 total points, with approximately 200 points allocated to project checkpoints, helping students prepare aspects of the project throughout the semester for the final submission. Group collaboration was self-evaluated by students within their teams throughout the course, a process tracked through weekly billable hour submissions detailing time allocation across project components. The final grade was determined by a final report (100 points), a final presentation/testing component (50 points), and the submission of a final peer evaluation and cumulative billable hours.

The final report aimed to guide the reader through the problem-solving process the group used to create the final project. This report evaluation was based on effective communication, report composition and presentation (title page, table of contents, figures and tables, formatting, and grammar) and on course objectives. Reports had to clearly define design criteria, project development, prototyping analysis, verification of meeting design criteria, data collection, and provide a bill of materials. A report template was provided to students. Evaluation areas were uniform across the five projects using a standard grading rubric (provided in Appendix A).

Each of the five projects had a specific testing rubric focusing on project construction and use. While these concepts varied slightly between projects, the larger themes of customer ease of assembly, operation, and project performance were standard. The evaluation rubric for the wind turbine project is provided in Appendix A.

Additionally, instructors assessed projects on ABET outcomes 3 – ability to communicate with a range of audiences, 5 – ability to function effectively on a team, and 7 – ability to acquire and apply new knowledge as needed. These assessments followed standard rubrics to enable comparison between projects. These ABET rubrics appear in Appendix B.

Acknowledgment

The authors would like to thank the contributions of their co-instructors: Dr. Charles Carlson, Dr. Sigifredo Castro Diaz, Dr. Christopher Jones, Dr. Vaishali Sharda, Mr. Chase Harvey, and Ms. Ayumi Amama.

References

[1] D. Knight, J. Sullivan, J., and L. Carlson, “Staying in Engineering: Effects of a Hands On, Team Based, First Year Projects Course on Student Retention,” presented at the 2003 ASEE Annual Conference, Nashville, Tennessee. June 22-25, 2003, 10.18260/1-2—11855.

[2] L. Prendergast, L. and E. Etkina, “Review of a First-Year Engineering Design Course” presented at 2014 ASEE Annual Conference & Exposition, Indianapolis, Indiana. June 15-18, 2014, 10.18260/1-2—22987.

[3] Vernier Science Education. “KidWind Wind Turbine Generator with Wires.” Vernier.com. Accessed: January 13, 2025. [Online] Available: https://www.vernier.com/product/kidwind-wind-turbine-generator-with-wires/

[4] Vernier Science Education. “Wind Tunnel.” Vernier.com. Accessed: January 13, 2025. [Online] Available: https://www.vernier.com/product/wind-tunnel/

[5] Prusa Research. “3D Printing Price Calculator.” Blog.Prusa3d.com. Accessed: January 13, 2025. [Online] Available: https://blog.prusa3d.com/3d-printing-price-calculator_38905/

[6] Vernier Science Education. “Go Direct® Energy Sensor.” Vernier.com. Accessed: January 13, 2025. [Online] Available: https://www.vernier.com/product/go-direct-energy-sensor/

Appendix A

Final Report Rubric

Criteria		Performance Indicators					Comments
		Below Expectations	Marginal	Minimum Requirements	Meets Expectations	Excellent	
Project Assessment							
		(0 points)	*(1 points)*	*(1.5 points)*	*(2 points)*	*(2.5 points)*	2.5
Title Page		No Title page	Most of the required information is missing	Some of the required information is missing	Includes: Title of project Class Professor Canvas Group ID Due Date First and Last Name of group members	Title page is excellent and includes a detailed image that entices the audience to continue reading.	
Table of Contents	**Example Link**	*(0 point)*	*(1 points)*	*(1.5 points)*	*(2 points)*	*(2.5 points)*	2.5
	https://libroediting.com/2012/12/27/table-of-figures-and-table-of-tables/	No Table of Contents	Table of contents does not have consistent organization and formatting. Or headings/subheadings are missing or have incorrect page numbers.	Table of contents is has consistent organization and formatting. Most headings/subheadings included but some may be missing or have incorrect page numbers.	Table of contents is has consistent organization and formatting. All headings and most subheading are included with correct page numbers.	Table of contents is excellent and has consistent organization and formatting. All headings and subheadings are included with correct page numbers	
Executive Summary	**Example Link**	*(0 point)*	*(1 points)*	*(1.5 points)*	*(2 points)*	*(2.5 points)*	2.5
	https://asana.com/resources/executive-summary-examples	Executive summary is not included in the report	Summary is incomplete, leaving reader puzzled about what the team is providing in its larger report. The problem, solution, value of solution, and final thoughts are unclear or insufficiently described	At least 1 page but no longer than two pages in length. Summary may omit a few facts or provide an incomplete picture of the report or deliverables. Reader may be unclear as to project's problem, solution, value of solution, and final thoughts.	Reasonably summarizes contents of report and deliverables. Presents essential facts about project's problem, solution, value of solution, and final thoughts.	Summary accurately and succinctly summarizes contents of report and deliverables. Presents essential facts about project's problem, solution, value of solution, and final thoughts.	
Table of Figures	**Example Link**	*(0 point)*	*(1 points)*	*(1.5 points)*	*(2 points)*	*(2.5 points)*	2.5
	https://libroediting.com/2012/12/27/table-of-figures-and-table-of-tables/	No Table of Figures	Table of Figures does NOT have consistent organization and formatting. List of figures from the text are included but complete captions are missing/incomplete and/or incorrect page numbers	Table of Figures has consistent organization and formatting. Most of the figures from the text are listed but complete caption are missing/incomplete and/or incorrect page numbers	Table of Figures has consistent organization and formatting. Most figures from the text are listed with complete caption and correct page numbers	Table of Figures is excellent and has consistent organization and formatting. All figures from the text are listed with complete caption and correct page numbers	
Table of Tables	**Example Link**	*(0 point)*	*(1 points)*	*(1.5 points)*	*(2 points)*	*(2.5 points)*	2.5
	https://libroediting.com/2012/12/27/table-of-figures-and-table-of-tables/	No Table of Tables	Table of Tables does NOT have consistent organization and formatting. List of tables from the text is included but complete caption are missing/incomplete and/or incorrect page numbers	Table of Tables has consistent organization and formatting. Most of the tables from the text are listed but complete caption are missing/incomplete and/or incorrect page numbers	Table of Tables has consistent organization and formatting. Most of the tables from the text are listed with complete caption and correct page numbers	Table of Tables is excellent and has consistent organization and formatting. All tables from the text are listed with complete caption and correct page numbers	
Problem Background		*(1-3 points)*	*(4-5 points)*	*(6-7 points)*	*(8-9 points)*	*(10 points)*	10
		The problem isn't clear. Customers, product user, purpose, and justification are not clearly identified.	The problem is stated but purpose and justification is not clear. Customers, product user, and investor are identified but some important characteristics appear to be overlooked.	The problem is introduced but the purpose and justification would benefit from refinement. Customers, product user, and investors are identified but characteristics may be overlooked.	Problem is reasonably introduced and purpose and justification are clear. Customers, product user, and investors have been identified clearly relate to the purpose and justification of the project. At least three references are included	Problem is introduced so that a new reader can clearly understand its value of the product and context of the paper. Customers, product user, and investors have been clearly and concisely identified and clearly relate to the purpose and justification of the project. **At least three professional references (NOT CLASS NOTES OR COMMUNICATIONS) are used to support the need and value of the product**	

Criteria		Performance Indicators					
		Below Expectations	**Marginal**	**Minimum Requirements**	**Meets Expectations**	**Excellent**	
Design Criteria		*(1 point)*	*(2 points)*	*(3 points)*	*(4 points)*	*(5 points)*	5
		Design criteria and/or numerical constraints are inadequate.	Some form of design criteria and numerical constraints are presented but they are flawed and lacking sufficient detail.	Design criteria and numerical constraints are specified but not comprehensive. All three required design criteria are included.	Design criteria and numerical constraints are specified and are reasonably complete and clear. All three design criteria are included	Design criteria and numerical constraints are comprehensive and the reader can clearly understand how the criteria will be used to meet the needs of the clients and users, and are supported with **outside references**.	
Project Development (Overview of the process used to create/decide on final design.)		*(1 point)*	*(2 points)*	*(3 points)*	*(4 points)*	*(5 points)*	5
		Information gathering is too limited. Concepts don't span an adequate range. Selected concept does not appear to be the best possible concept.	Several concepts have been generated, but they don't appear to span the full domain of possibilities. Concept selection is applied, but the final selection doesn't appear to be adequately defended.	Concept generation appears reasonable, although further opportunity for information gathering appears to exist. Concept selection appears reasonable, although the process would benefit from data collection and analysis.	Concept generation covers a broad spectrum of possibilities. Concept selection is supported with a sound process (**decision matrix**).	Concept generation comprehensively addresses all promising concepts. Concept selection is supported with a **well defended (detailed explanation of decision matrix)** process (decision matrix) and includes data and analysis wherever appropriate. Final concept appears to be optimal.	
Final Design Description		*(1 point)*	*(2 points)*	*(3 points)*	*(4 points)*	*(5 points)*	5
		The Design Overview does not provide a good understanding of the final product.	Some important aspects of the final product are described, but the reader has difficulty understanding the final product from the material provided.	The Design Overview provides understanding of the final product, although some aspects of it may not be clear. Some figures are provided but more appear warranted.	The final product is presented clearly. The **figures** are sufficient to provide a basic understanding of the final product.	The Design Overview provides a clear and comprehensive understanding of the final product to a new reader. A good number of well-designed figures enhance the text. The text clearly explains the figures.	
		(1 point)	*(2 points)*	*(3 points)*	*(4 points)*	*(5 points)*	5
Prototyping Analysis (Proof that your design works)		Prototypes are only theoretical	Partial prototype was created but unclear if the product is functional	Full prototype was created but additional information or figures are needed to verify product is functional.	Full prototype was created and it is clear the product is functional. Documents **how the team created and modified the prototype** in order to get it to consistently function.	Excellent prototype was created and clearly illustrates the functionality of the product. Clearly documents how the team created and modified the prototype in order to produce a consistently functional prototype.	
		(1 point)	*(2 points)*	*(3 points)*	*(4 points)*	*(5 points)*	5
Verification Methods (HOW YOU ARE COLLECTING DATA)		Process for testing how well the product accomplishes each design criteria is clearly lacking.	Process for testing how well the product accomplished some of the design criteria are stated but lack detail or accuracy.	Process for testing required design criteria is included if methods are modified the quality of the data collection is at least as good as original method. Methods for additional two criteria are stated.	Process for testing how well product accomplished each design criteria is clearly stated, and details for evaluating each criteria are outlined. It is clear that average and standard deviation can be calculated for all criteria except bill of materials.	Process for testing how well the product accomplished each design criteria is clearly stated, and details for evaluating each are clearly outlined. **Product was systematically evaluated for how well it accomplished each design criteria**.	
		(1 point)	*(2 points)*	*(3 points)*	*(4 points)*	*(5 points)*	5
Data Collection (Raw Results of testing)		Data collection is lacking and completion of design criteria are based on assumptions of the group.	Some data was collected through testing and/or feedback.	Data was collected through testing and/or feedback.	Data was collected through testing and/or feedback. Statistical information (average, standard deviations, etc.)	Data was collected through testing and/or feedback from **people outside of the design team**. Statistical information (average, standard deviation, etc.) was presented as justification for effectiveness of the design.	

Criteria		Performance Indicators					
		Below Expectations	Marginal	Minimum Requirements	Meets Expectations	Excellent	
Design Criteria Analysis (Proof of successful design)		*(1-3 points)*	*(4-5 points)*	*(6-7 points)*	*(8-9 points)*	*(10 points)*	10
		Design is not supported with data and success of design is base mostly on groups assumptions and opinions. Clear deficiencies exist. Little correlation is made to illustrate which design features are being used to meet the design criteria and numerical constraints.	Design criteria and numerical constraints are stated and few design features are mentioned but little explanation is given on how they are used to meet the criteria. Tradeoffs between design criteria are not mentioned.	Design criteria and numerical constraints are stated and some design features are mentioned to illustrate how they are being met, but improvements could be made. Tradeoffs between design criteria are stated but lack clarity and understanding.	Clearly illustrates how each design criteria was achieved based on aspects of the design and data analysis. **Tradeoffs between design criteria are clearly stated.**	Excellent illustration of how each of the design criteria was achieved based on aspects of the design and data analysis. Tradeoffs between design criteria are clearly stated, and **justified based on the client needs.**	
Bill of Materials		*(0.5 point)*	*(1 points)*	*(1.5 points)*	*(2 points)*	*(2.5 points)*	2.5
	https://www.wallstreetmojo.com/bill-of-materials/#h-2-detailed-bom-tabular-format	The budget information is inadequate.	Some form of a budget is present but the information is flawed and lacking sufficient detail.	The budget is specified but not comprehensive. Only one source of information was used to establish the budget.	The budget is specified for the project. The budgets are reasonably complete and clear. More than one source was used to establish the budget.	The budget is complete and clear. Cost of different aspects of the design are clearly discussed and tradeoffs between cost and other design criteria are clearly explained. Multiple sources were utilized to create the most accurate and up to date budget possible.	
Conclusions (SELL YOUR DESIGN)		*(1 point)*	*(2 points)*	*(3 points)*	*(4 points)*	*(5 points)*	5
		The reader cannot deduce the essential project results by reading the Conclusion. The strengths and limitations of the design aren't clear. Little reflection on the design process is provided.	The essential results are not clearly stated. The discussion of strengths and limitations should be expanded. Little reflection on the design process is provided.	Conclusions are largely qualitative rather than quantitative. The discussion of strengths and limitations would benefit from further expansion. More could be said about the design process.	Most important results are addressed and some quantitative results are included. Strengths and limitations of the final design are discussed. Some cost information is included. Reflections on the design process are included.	Conclusions provide a **succinct summary of all essential results**. Results are summarized **quantitatively** as well as qualitatively. The discussion of strengths and limitations is insightful and objective. Useful final cost information is provided. A succinct evaluation of the design process is provided.	
Writing Assessment							
Formatting		*(1 point)*	*(2 points)*	*(3 points)*	*(4 points)*	*(5 points)*	5
		Formatting requirements are not shown. Sections formatted poorly and don't include headings.	Formatting not consistent or doesn't follow requirements.	Provided template was used or replicated, but small inconsistences occur.	Provided template was used or accurately replicated.	Formatting is excellent and follows requirements. Section headings easily allow reader to find important information. **Formatting tools demonstrated in lecture were utilized.**	
Quality/Quantity of Figures and Tables		*(1 point)*	*(2 points)*	*(3 points)*	*(4 points)*	*(5 points)*	5
		The figures and tables seem unprofessional. Many figures or tables are hard to understand, or many more figures are needed. They are not be properly referenced in the text.	Several figures or tables are hard to understand, or more figures are needed. Many tables and figures are not be referenced from the text.	A few figures are difficult to understand, or a few more figures may be needed. A few figures may not be referenced from the text.	Content is supported with a good number of figures and tables. Figures and tables are generally clear and well designed. Most tables and figures are properly referenced in the text.	The number of figures and tables is appropriate to the project. Figures and tables are meaningful and easy to understand. **The text references all figures and tables.**	

Criteria		Performance Indicators					
		Below Expectations	**Marginal**	**Minimum Requirements**	**Meets Expectations**	**Excellent**	
Grammar & Style		*(1 point)*	*(2 points)*	*(3 points)*	*(4 points)*	*(5 points)*	5
		Writing style is unprofessional. Poor organization with obvious missing material or redundancies. Many missing definitions. Poor sentence and paragraph structure. Excessive grammatical errors. Or exceeds 15 pages not including tables and figures.	Writing is in need of significant editing. Inadequate organization is evident in missing material or redundancies. Several important terms are undefined. Many overly complicated sentences. Sentences aren't thoughtfully organized into paragraphs. A significant number of grammar or spelling errors exist.	Writing is acceptable but not entirely clear. Weaknesses in organization are reflected in some missing material or redundancies. Portions are unnecessarily wordy. A few important terms are undefined. Some sentences or paragraphs are overly long or complicated. A few too many grammar or spelling errors.	Writing is overall clear. Good organization. Most important terms are defined upon first usage. Most sentences and paragraphs are well structured. Few grammar or spelling errors.	Writing is easy to read. Excellent organization. Writing is concise yet all necessary content is included. All important terms are defined upon first usage. Sentences and paragraphs are well structured throughout. Almost no grammar or spelling errors.	
References	**Example Link**	*(1 point)*	*(2 points)*	*(3 points)*	*(4 points)*	*(5 points)*	5
	https://owl.purdue.edu/owl/research_and_citation/apa_style/apa_formatting_and_style_guide/reference_list_basic_rules.html	The list of references is clearly inadequate.	The list of reference should be expanded. Limited in text citations.	The list of references appears limited for the project scope, or several references seem unnecessarily obscure. Most of the **references are cited in the text.**	A reasonable list of references is cited using a APA format. Majority of the references are correctly cited in the text.	A comprehensive list of references is cited using a APA format. All references listed are correctly cited in the text.	
Overall		*(1-3 points)*	*(4-5 points)*	*(6-7 points)*	*(8-9 points)*	*(10 points)*	10
		The report provides poor documentation of the final product. The purpose and audience are lacking or inappropriate. The scope is inadequate relative to the difficulty of the project and the team's available resources.	The report does not adequately document all aspects of the final product. The purpose and audience are lacking or inappropriate. The scope seems too limited relative to the difficulty of the project and the team's available resources.	The report documents most aspects of the final product. The purpose and audience are appropriate. The scope is adequate in relation to the project difficulty and the team's available resources.	The report documents all important aspects of the final product. The purpose and audience are appropriate. The scope is appropriate to the project difficulty and the team's available resources. A follow-up team could clearly understand the project by reading this report.	The report is comprehensive yet concise. The purpose and audience are appropriate. The scope is commendable considering the project difficulty and the team's available resources. The project is documented in a way that a follow-up team could efficiently re-construct this team's important results.	
Total Points Possible: 100							100

Expo Presentation Rubric

Criteria	Ratings						Pts
Device can be constructed in 10 minutes	**10 pts**	**9 pts**	**8 pts**	**6 pts**	**4 pts**	**0 pts**	**/10 pts**
TIME:	Constructed in time limit	Construction time 10:01 - 11:00 minutes	Construction time 11:01 - 12:00 minutes	Construction time 12:01 - 13:00 minutes	Item was able to be constructed but exceeded reasonable time OR no construction was required	Unable to construct product	
Customer needs no assistance from the group to build the device	**10 pts**	**8 pts**	**6 pts**	**4 pts**	**2 pts**	**0 pts**	**/10 pts**
	Clearly understand instruction manual	Ask one question to build device	Customer had to ask two questions to build device	Ask three questions to build device	Ask four questions to build device	Device was unable to be built without 5 or more questions by the customer	
Device does not need modification from the group before testing	**5 pts**			**3 pts**		**0 pts**	**/5 pts**
	No modification needed			No more than two parts of the device needed group intervention AND modification took less than 1 minutes		Three or more parts of the device needed group modification OR time to modify was greater than 1 minutes.	
Customer can run the device without group help	**5 pts**			**3 pts**	**1 pts**	**0 pts**	**/5 pts**
	Customer understood how to run the device			Customer had to ask one question to run device	Customer had to ask two questions to run the device	Customer had to ask three or more questions to run the device	
Testing	**5 pts**			**3 pts**		**0 pts**	**/5 pts**
Prototype can be successfully tested in the wind tunnel: Record energy producing runs in Joules (30 second Runs). Average of 3 runs will be used in scoring. Producing some energy is all that is required.	Energy was produced without any team modifications during testing			Modifications we needed during testing to produce energy		No energy was produced	
Restart Testing The exception to this rule is if your motor fails. A replacement motor will be provided and you can test again with no deduction.	**5 pts**			**3 pts**		**0 pts**	**/5 pts**
	Testing worked in first attempt			Testing worked at second attempt		Unable to test prototype	
All parts and instruction manual were included in the box	**0-10 Points (Depending on missing items)**						**/10 pts**

Appendix B

Outcome: 3 – An ability to communicate effectively with a range of audiences.

Outcome 3				
Performance Indicators	**Poor (1)**	**Inadequate (2)**	**Adequate (3)**	**Exemplary (4)**
3.1 Use of Proper and Effective Language and Organization	Serious issues with focus, clarity, grammar, spelling, and information accuracy.	Communication is unclear, disjointed, and difficult to follow.	Persuasive, clear, and straightforward communication with a logical sequence.	Highly professional, succinct, clear, and coherent presentation.
3.2 Use of Visual Aids	Inadequate or irrelevant visual aids.	Limited visual aids that partially cover the concepts.	Visual aids that adequately cover important concepts and are clearly relevant.	Varied and effective visual aids that maximize communication.
3.3 Technical Depth	Fails to persuade; minimal use of skills; proposed goals are not addressed.	Focuses on others' work; lacks sufficient detail to support ideas.	Uses relevant skills; proposed goals are complete.	Advanced insight; exceeds goals; focuses on new understandings.
3.4 Use of External References and Resources	No external information, irrelevant sources, plagiarism, or dishonesty.	Inadequate research, limited sources, lacks variety.	Identifies and presents useful sources correctly formatted and referenced.	Collects extensive, relevant information from a wide range of sources, validating findings.

****Modified from ASEE Paper "**Assessment of Communication and Teamwork Skills in Engineering Technology Programs" by Dr. Daniel Jones

Outcome: 5 - An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

Outcome 5				
Performance Indicators	**Poor (1)**	**Inadequate (2)**	**Adequate (3)**	**Exemplary (4)**
5.1 Timeliness	Often late, misses deadlines, and meetings.	Equally on time and late for deadlines and meetings.	Reliable but occasionally misses deadlines or meetings.	Always on time, meets deadlines, and attends all meetings.
5.2 Establish Goals and Plan Tasks	Requires others to create the plan and direction.	Contributes to goal setting and planning only if insisted upon; often defers to others.	Provides input in establishing goals and planning tasks.	Actively seeks leadership opportunities in establishing goals and tasks.
5.3 Meet Team Objectives	Always relies on others to meet team objectives. Rarely follows through.	Sometimes meets objectives - often needs reminding.	Usually meets objectives - rarely needs reminding.	Consistently meets objectives without needing to be reminded.
5.4 Create a Collaborative and Inclusive Environment	Dominates. Rarely allows anyone else to express their own opinions and points of view.	Listens but is focused on own ideas. Will work with others' ideas if in the minority.	Usually listens, interacts, discusses, and contributes to the group, helping to achieve consensus.	Consistently and respectfully listens, interacts, discusses, and contributes to the group helping to achieve consensus.

Outcome: 7 – An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Outcome 7				
Performance Indicators	**Poor (1)**	**Inadequate (2)**	**Adequate (3)**	**Exemplary (4)**
7.1 Research and Gather Information	Collects no information or collects irrelevant information.	Collects little information with little relevance.	Collects some information with some relevance.	Collects a great deal of information most of which is relevant.
7.2 Give Proper Citations	Provides no citations or improperly cites sources.	Provides few citations with frequent errors in format or completeness.	Provides citations that are mostly correct but may have minor errors or omissions.	Provides thorough and accurate citations in the correct format with no errors.
7.3 Determine Quality Resources	Fails to evaluate the quality of resources; relies on unreliable or inappropriate sources.	Occasionally identifies quality resources but often uses unreliable sources.	Generally identifies quality resources, though may occasionally rely on less credible sources.	Consistently identifies and uses high-quality, credible resources.
7.4 Obtain Input from Customers and Suppliers	Fails to seek or utilize input from customers and suppliers.	Occasionally seeks input but with limited engagement or usefulness.	Seeks and uses input from customers and suppliers with moderate success.	Actively seeks and effectively uses input from customers and suppliers to improve outcomes.