Elements of a Successful Project

Science is a process by which we learn about the universe around us. **Engineering** is the application of knowledge toward some useful goal. A good engineer fair project includes the proper use of scientific and engineering ideas, such as the scientific method or the engineering design process. The following steps will help you get started, and hopefully guide you to a well rounded and winning engineering fair project. If you need help, do not be afraid to consult with a scientist or engineer that specializes in your field of study.

STEP 1: Pick a Topic to Study

- Spend some time and give serious consideration to this part of your engineering fair project. Don't settle for a project that has been done before because it is easy. Originality tends to win over judges at BEST Medicine. Pick a topic that grabs your interest and you want to learn more about. The BEST Medicine website (under Resources) lists over 100 potential project ideas.

STEP 2: Do a Background Search

- While not the most exciting part of doing an engineering fair project, you will learn more about the topic. This will provide you with the necessary information needed to come up with a hypothesis or a defined problem, determine appropriate methods to test your hypothesis or design, and allow you to draw conclusions about your results.
- This information will need to be included in your project report and engineering fair display.

STEP 3: Formulate a Hypothesis or Goal

- A hypothesis (for the scientific method) is a sentence or two stating that based on all the information you have to go on this is what you truly believe will be the outcome of what you are going to test.
- A good hypothesis does not necessarily mean that it is a correct hypothesis. Frequently in science, a hypothesis may be disproved by the results of your experiments. This is not a flaw in your engineering fair project.
- Be sure your goal can actually be achieved within the confines of the timing and resources available to you.

STEP 4: Document Your Work (The Laboratory Notebook)

- One of the most important attributes of a good scientist is good record keeping. Doubt is a human trait so you need to be able to prove that what you found is correct and true. Do not rely on your memory.
- The lab notebook should contain all the procedures used in your experiments and all of the data that came from them. Both good results and bad results should be documented. Not every experiment works perfectly.
- Summaries, conclusions for each experiment, and any plans you may have for the next experiment should be written in your notebooks. While it is easy to write too little in your lab notebook, you can never write too much.

STEP 5: Design Experiments to Test Your Prototype (Methods)

- Experiments should test your prototype. Do not be afraid to design more than one experiment to test your idea. Some of the best designs test a prototype device using more than one strategy.
- Be sure to include appropriate comparisons to other design concepts.
- While it may seem labor intensive, test for only one thing in each of your experiments.

STEP 6: Results

- This is the data generated from your experiments. It is best to repeat your experiments more than once to ensure reproducibility.
- SI units (grams, liters, meters, etc.) rather than English units (pounds, gallons, yards, etc.) are typically used in science. These units should be used whenever possible, although it will not count against you at BEST Medicine if you use English units.
- Statistics provide a quick summary of your data. Some commonly used statistics are the number of samples in each group (n); an indicator for the mid-point of your groups (average); the range (minimum and maximum values); and an indication of the variability of the data (standard deviation or standard error of the mean).
- Statistical tests (such as t-tests and ANOVA) can be used to mathematically determine if the differences between your groups are a result of the treatment you imposed rather than if it happened merely due to chance.

STEP 7: Evaluate Your Results and Strengthen Your Project

- Closely examine your data for any inconsistencies to fix, and any interesting findings.
- Take your project a step further. Many times the data you collect generates new questions to be answered. Most judges are impressed by second efforts.
- If your project has any shortcomings in the experimental design, you may want to resolve these problems in a second effort, or at least be ready to discuss them.

STEP 8: Draw Conclusions

- Try to decipher what the information you have obtained from your data actually means. Sometimes there can be more than one answer. If your finding is very specific try to relate it back into the big picture.
- This section is also a good place to describe what future directions you would take your project.

STEP 9: Present Your Findings in a Research Paper

- A research paper is a formal written presentation of your engineering project. Good research papers are well written (using proper sentence structure, correct spelling and punctuation, etc.), well-organized, and contain all of the following items:
  a. Introduction: A paragraph or two that state your topic, your goals, what you hope to achieve, and how you hope to achieve it.
  b. Background: A general introduction to the topic of study, which includes the key findings or factors that lead you to what you decided to study.

c. Hypothesis: A statement or two about what you believe will be the outcome of what you are testing. A hypothesis is necessary for the scientific method, but is not necessary for the engineering design process.
d. Methods: Describe in detail the protocol(s) used to test your design. A person reading your research paper should be able to repeat your experiments completely on the basis of what is written in this section.
e. Results: Describe the data that you obtained from your experiments. In addition to the written text, photos, tables, figures, and graphs are good ways to help present your data to the reader. Do not forget to express your data values using appropriate units of measure (examples: 1.29 cm or 5.8 mL, etc.)
f. Discussion: Explain what your data means. State how your experiments and data support or refute your idea. This section may be the longest and most important section of your paper!
g. Conclusion: Did your idea work? Why or why not? What would you do differently? What would you do next?
h. Acknowledgements and References: List the people and literature sources that assisted you with your project. Don't forget to thank any people or companies who donated time or supplies for your project.

STEP 10: Present Your Findings in a Project Display

- For engineering fairs, you need to construct a display that shows off your project and all the components discussed above. Spend some time on this part of the process. It is your opportunity to showcase your hard work.
- The project display is a visual tool to communicate your project, and should be designed to explain your project in your absence.
- Make your display attractive and eye-catching to draw judges and passersby to your project. Make a good first impression. You may not get a second chance.
- Like a good research paper, a successful project display should have all of the following:
  a. Start with a good title. It may or may not be the same title as your research paper, but it should be displayed prominently.
  b. Have text to summarize your project from start to finish. It is unlikely that you will be able to use all of the written text in your research paper on your display board. Select the most important points from each section to put on the board. You need enough information to convey your points, but do not overdo it. The text should be fairly large and easy to read. If possible, use a printer rather than writing by hand.
  c. Have an organized flow of information. Your display can be organized like your research paper, but make sure the different sections are placed in a logical order around your display board.
  d. Include any necessary display items, especially your laboratory notebook and research paper.

SUMMARY:

- Identify a need. Be sure your idea is something that has a solution and is within your ability to construct.
- Determine limits or other criteria that you must impose on your solution. Cost, materials, and time are all possible limiting criteria.
- Do some preliminary research to see what has already been done to satisfy your need. This process may provide additional ideas.
- Design something that you think will satisfy your need.
- Build and test a prototype, refining or redoing if necessary.