Elements of a Successful Project

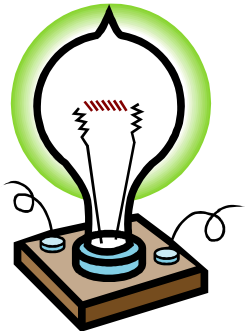
Science is a process by which we learn about the universe around us. Engineering is the application of knowledge toward some useful goal. A good science fair project includes the proper use of scientific and engineering ideas, such as the scientific method. The following steps will help you get started, and hopefully guide you to a well-rounded and winning science fair project. If you need help, don't 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 science fair project. Don't settle for a project that has been done before because it's easy. Originality tends to win over judges at NEOSEF. Pick a topic that grabs your interest and you want to learn more about.

STEP 2: Do a Background Search

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

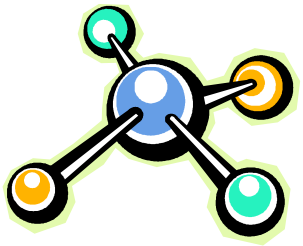


STEP 3: Formulate a Hypothesis or Goal

- A hypothesis 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 science fair project.
- Be sure your hypothesis can actually be tested within the confines of the timing and resources available to you and your science fair project.

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 should be written in your notebooks and any plans you may have for the next experiment. 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 Hypothesis (Methods)

- Experiments should test your hypothesis. Don't be afraid to design more than one experiment to test your hypothesis. Some of the best scientific designs test a hypothesis using more than one strategy.
- Be sure to include appropriate control groups for comparison.
- While it may seem labor intensive, test for only one thing in each of your experiments. For example: Do not change both the temperature and the nutrients for a bacteria culture in the same experiment. If you find a difference in the amount of bacteria produced in the culture, it won't be clear if it is due to the change in temperature or due to the change in the nutrients the culture was grown.

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 NEOSEF 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 is a result of the treatment you imposed rather than it happened merely due to chance.

STEP 7: Evaluate Your Results and Strengthen Your Project

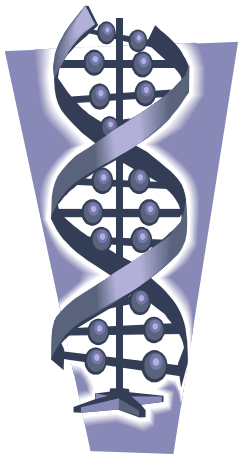
- Closely examine your data for any inconsistencies to fix, and any interesting findings.
- Take your project a step further. Many times the data you collect generates new questions to be answered. Most judges are impressed by second efforts.
- If your project has any short-comings in the experimental 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.

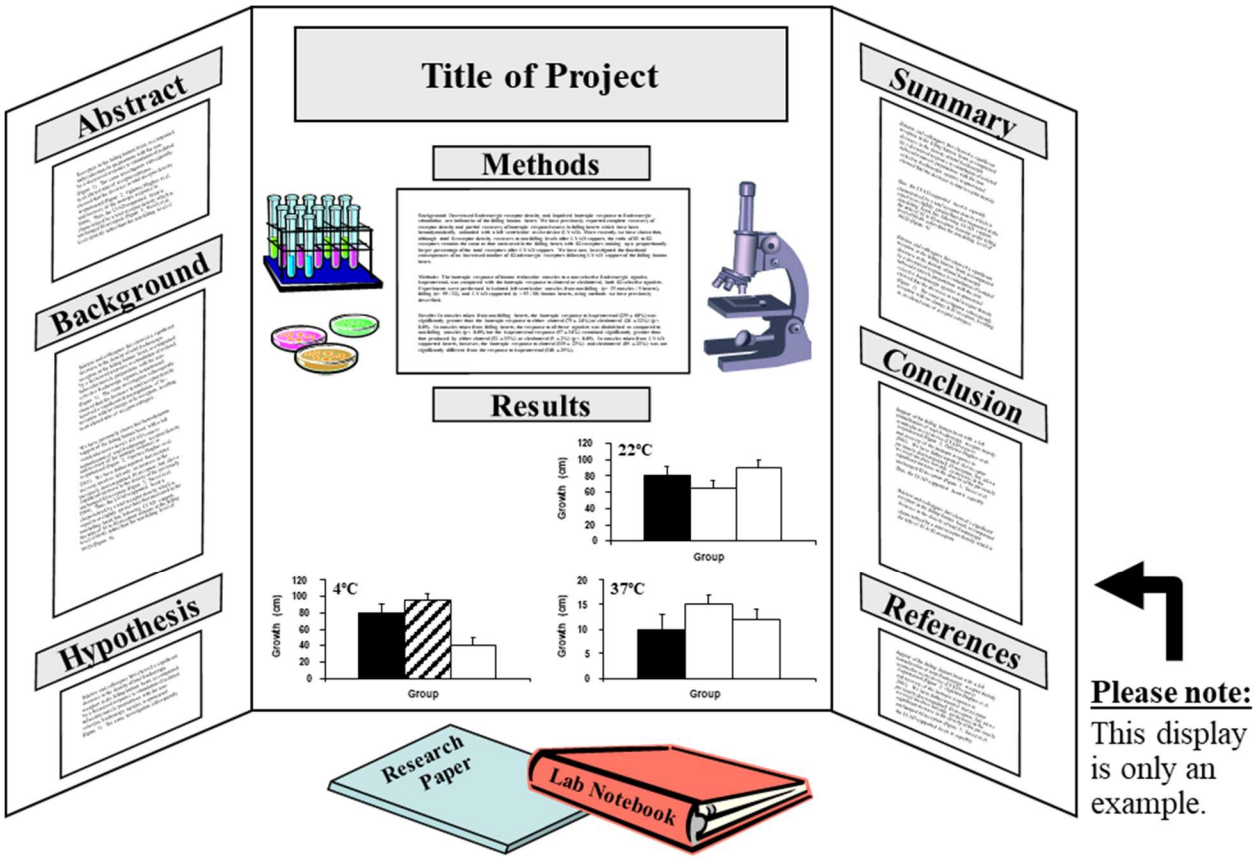
STEP 9: Present Your Findings in a Research Paper

- A research paper is a formal written presentation of your science 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 hypothesis, 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.
    d. Methods: Describe in detail the protocol(s) used to test your hypothesis. 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. Don't 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 hypothesis. This section may be the longest and most important section of your paper!
    g. Conclusion: Was your hypothesis supported? 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 science and 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. **Be sure to follow the NEOSEF Project Guidelines when assembling your virtual display.**



INFORMATION FOR ENGINEERING PROJECTS:

- Engineering projects follow a slightly different process, although it parallels the steps of the scientific method. Read through the steps for science projects, keeping in mind the goals of engineering projects defined below:
  - 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's 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.