Tech Report 2

Research Basics

One of the hardest things about conducting a science fair project is coming up with an idea. To help out with this endeavor, we have compiled a list of projects that you might consider. Remember, for the project to be successful, it must involve a subject you are interested in. You will spend a significant amount of time with this project, so it needs to be something in which you have a genuine interest.

Ninth-grade, high-school students from Peoria, AZ analyze images of Mars. Image credit: NASA/JPL-Caltech/ ASU—Public Domain

What follows are just a few ideas of using rocketry in a science project. Talk to your teacher and/or advisor for more ideas and suggestions. Visit your local library and look through the rocketry section. There are many projects you can do with rocketry. The only limit is your imagination!

Choosing a Topic

This is often the hardest part of the project, and one of the most critical. Without a topic, there is just no way that you can move onto any of the other steps. Often, you may come up with an idea but you are unsure if it is practical. Could it be too expensive, or too complicated? The main thing to remember is to choose a topic involving something that you are truly interested in. You may be involved in this project for many weeks, perhaps months. Some projects go on for years, building upon what has been learned from past projects.

- Once you have a topic, examine the feasibility of your plans. As you try to determine if the project is doable, ask yourself these questions
  Do you have enough time to complete the project?
- Is the information I need readily available and where can I find it?
- Will I need specialty textbooks, and can I borrow them or do I have to buy them?
- What supplies will I need, and how much will this all cost?
- For the younger researchers out there, you have several additional questions you need to ask:
  Will my parents really let me borrow their Gold Card?
- Do my folks understand what I am trying to do and how much it will cost?

Nothing will terminate a science fair project quicker than Mom or Dad getting a bill for $632.57 from Estes for model rocket motors. Lastly, don't just use your folks for your financial backing. Parents can be a great source of direction and help during these types of projects.

If your project is part of a competition, such as a science fair or the NAR R&D event, you need to make sure that the project is acceptable under the rules. For those involved in science fairs, make sure your project complies with the rules of the International Science & Engineering Fair.

Let's Get Organized

Anytime you undertake a long-term project, planing is key to a successful project. Many people tend to leave things to the last minute. When it comes to a research project, last minute projects are easy to spot. By planning your project over a period of time, you avoid the "last minute" syndrome.

One way to keep yourself on track is through the use of a project log. This logbook is an informal record of how you are progressing with your project.

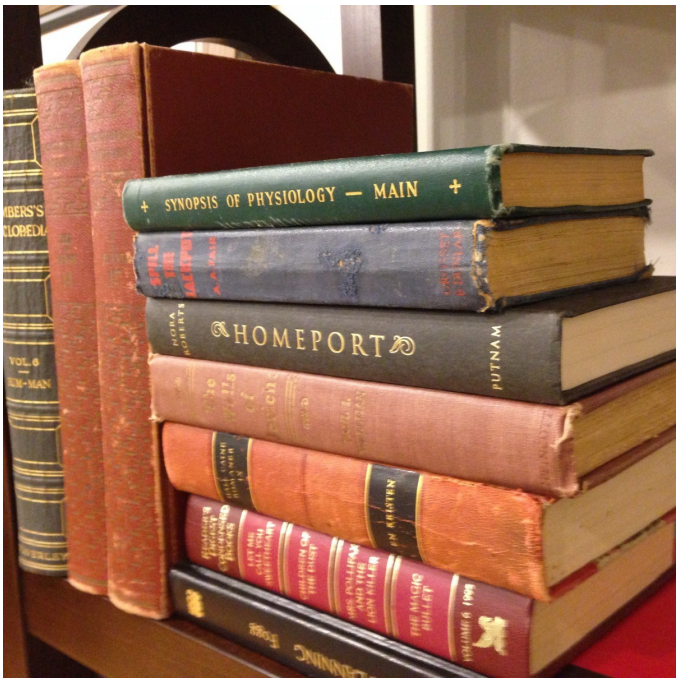
Your log should include the following sections:

- Research
- Purchasing supplies
- Building necessary items
- Setting up the experiment
- Performing the experiment
- Testing
- Observation
- Performing an analysis of the data collected
- Preparing the final report
- Building the display

Background Research

A background research paper is required for most any research project. Many folks dread this part of a research project, and often they wonder why it is even required. Even if it wasn't required, there are some very fundamental reasons why you should perform this background research.

First, it is essential to gather as much information as possible. This research should show you previous theories and research that have been performed, as well as discoveries that have already taken place. This will be a great help to you when it comes time to develop your own theories. It may also save you from having to prove that your idea is already fact. Lastly, this research may help you narrow down your project from a general idea to a specific topic.



Second, you will be performing the same type of investigative research that is required of scientists. The ability to hunt down information and use that information to make decisions is a skill you will use long after you graduate high school.

Third (and this is for those of you still in school), during your entire education process you will be required to write papers. These will be of various lengths on a multitude of subjects. These papers require you to know how to plan, organize and write a research paper.

Begin your quest for information with sources that you already have at hand. Use your own

home library, the school library, the public library and the local college library. Don't limit your search to just books. Magazines (often called periodicals) often have some of the latest, up to date information available.

Don't forget to utilize the Internet. Search engines can help you locate an enormous amount of information on just about any subject. Just make sure that the source of the information is reputable. Not every site on the Internet is honest and trust worthy.

Another source of information that many people forget about is the U.S. government and private industries. Many of these organizations are more than willing to pass on information free of charge.

As you gather your information, make sure it is up -to-date. A book on space travel written in 1947 may be interesting, but of little technical value. Make sure you keep a record of where you get your information. You will make this into your bibliography when the project report is written. Code your cards with a letter or number. This will be used to reference parts of your report back to the information source. Make sure that when you write your notes, you do it in your own words. If you quote the information, you must quote it exactly and indicate in your paper that it is a quote.

Once you have your background information collected and it is written on dozens of little cards, you next step is to organize them. Writing an outline is a way of organizing your thoughts before your paper. If you are not familiar with how to write an outline or other parts of a research paper, talk to your teacher or visit these web sites:

Modern Language Association - https://mla.org
Writer's Digest - https://www.writersdigest.com/

When your outline is complete, you can begin to write the background research paper. Be creative. Just because it's a research paper doesn't mean it is simply a string of facts laid out in a hap hazard fashion. Tie your background research into your project. Your teachers (or judges) will look more favorably upon this type of written report. Don't forget to check your spelling and grammar. The majority of you will be using computers to write your reports on. They all come with spell checkers and most have grammar checkers of some sort. Use them. Nothing makes a paper look sloppy like a bunch of misspelled words. And don't forget to give credit to your sources.

When you're done with your initial draft, let some else read the paper. It will be even better if they have no idea what your project is about, as they won't read anything into the paper. They may see things you have overlooked. The more eyes that review the paper, the better. Just remember that it is your paper and you have the final say it what is modified or deleted.

The Hypothesis

Your research project will attempt to solve a very specific problem. Research is really nothing more than problem solving; "How can I do something better, faster, higher, etc.?" Your background research should have helped you zero in on that goal. It is now time to identify exactly what your

experiment will test and what comparisons you intend to make.

Once you make a decision on the question you will attempt to answer (or the problem you will try to solve), you will develop a hypothesis. Your hypothesis is nothing more than an educated guess as to what will happen given a certain set of circumstances. Your background research will be a help to you in this area. By looking at what has been done before and the results of previous experiments, you can make an educated guess as to what will happen in your experiment.

Your experiment will be a test of your hypothesis. When the experiment is concluded, you will have one of three thing conclusions:

- Your hypothesis was correct
- Your hypothesis was incorrect
- The data was inconclusive to prove or disprove your hypothesis

You must identify what you are testing and how you are going to test it. You should also explain why you expect the results of the experiment to prove your hypothesis.

All hypothesis statements begin with "I believe . . . " This shows that the statement is a theory and not a proven fact. Often your hypothesis will include an assumption on why you believe your theory to be true. This may be more of a statement of what you hope to accomplish with your experiment, as opposed to a theory.

Your hypothesis should mention the following items:

- The subject of your experiment
- The variable to be changed
- The variable to be measured
- The results you expect

The Experiment

When conducting the experiment, you must keep three things in mind. These are the subject, the variable and the control. If you use them properly, your project will be a success. Used improperly, and your project will not do very well.

The subject of an experiment is the item being tested. The variable is the item that is altered or changed. The control is what all of the other results is compared to. The control is one of the most important items in the experiment. If your project was "Effects of Fin Design on Altitude" you might use a rocket kit (such as the Estes Alpha) as the control. The kit would be built according to the instructions, flown and altitudes recorded. Other rockets would be built, based on the control model, with the only change being the design of the fins. These rockets would be flown, altitudes recorded, and these results would be compared to the control model.

Eighth- through 12th-grade students gathered at a U.S. Army Aviation and Missile Research, Development and Engineering Center laboratory to boost their science and math skills. US Army photo—Public Domain

To allow your results to be substantiated, groups are often used. There are generally two groups utilized; A control group and an experimental group. It is important that both groups be identical except for the variable in the

experimental group. Continuing to use our hypothetical "Fin Design" project, if the control group is flown on a calm day, then the experimental group should also be flown on a calm day, preferable the same day, during the same time period. If the experimental group were to be flown on a windy, rainy day, how do you know that the results are due to fin changes and not due to weather changes?

To make your experiment manageable, restrict the number of variations you use. In our hypothetical project, we limited the variable to fin design changes flown on calm days. This is easier to manage than a project that compares different fin designs under different weather conditions.

It is important that the procedures for conducting the experiment be written down and followed each time the experiment is conducted. These procedures may be several pages long and might include not only the experimental flights themselves, but may also include the steps used in the building of the model and the weather conditions necessary to conduct experimental flights.

When conducting the experiment, precise observations and computations are absolutely necessary. Use the metric system, as it shows professionalism in the scientific community (besides, it is easier to use once you get use to it). As you make the observations and measurements, record these results in writing. Do this as it occurs. Any delay may cause you to forget exactly what you saw, and thus your record keeping will not be as accurate. By designing a table or form, you can help keep the information accurate and easy to read.

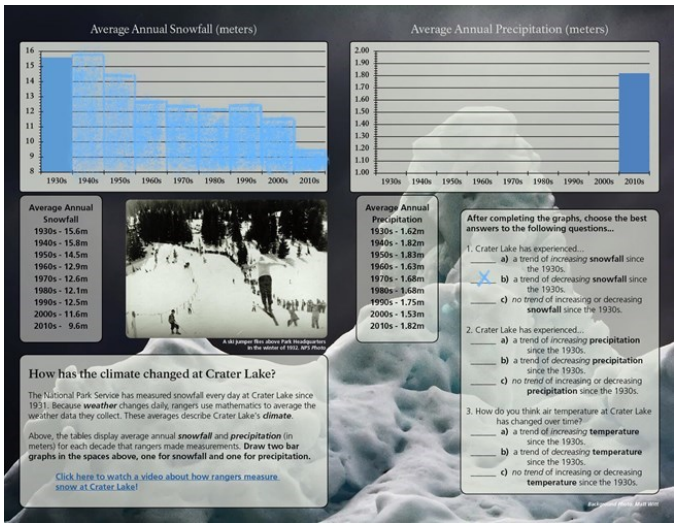
Hopefully, everything will proceed smoothly, and you observations will show some of the effects of the testing. If things are going poorly, you might consider changing your procedures or altering the hypothesis. Before you take any of these steps, however, talk it over with a teacher and/or advisor. They might see something you don't, and may see that the experiment will still result in some useful data. Your experiment may also be disproving you hypothesis, which is just as important as supporting the hypothesis.

Lastly, record your results honestly and truthfully. Avoid the temptation to 'fudge' some of the data to make the results 'look better.' Also, remember that 'nothing happened' is a result. A test that refutes a hypothesis is just as important as proving it.

Results and Conclusion

The result is nothing more than reporting what happened during the experiment. You should organize and reorganize the data to make the results as clear and meaningful as possible. Do not draw any conclusions from your data at this time. You are simply displaying the data in a meaningful way. The display of data may include bar graphs, charts, etc. It is important that the graphs 'make sense' and are easily understood.
Next comes the conclusion. The difference between the Result and the Conclusion is that the conclusion is a logical interpretation of the results. You will be analyzing what you have learned from the experiment. The conclusion should be about three pages long. Start off by restating your question or hypothesis. The data gleamed from the experiment may prove your hypothesis to be true, false or maybe even inconclusive. As you formulate your conclusion, look for patterns or trends in the data. Look at the charts and graphs to see if a trend clearly emerges. It is extremely important that you review your results critically and without bias in order to reach a definitive conclusion.

A powerful ending to your conclusion is a discussion of any practical value that your experiment may have. This shows your ability not only in the scientific reasoning, but a well-rounded approach relating your work to other fields. This is often looked upon favorably by teachers and judges alike.



National Park Service Photo–Public Domain

Make It Look Good

There is an old expression that says "Clothes don't make the man," but a well-dressed man is sure to be noticed sooner. Unfortunately, this is also true of science projects so here are a few tips to help you get noticed.

Keep a well-written notebook. Use an appropriate cover, usually a three-hole, 8 1/2 by 11 paper, and a folder. Use regular bond paper. Onion paper is too thin and may cause the reader to 'see double.' Always double-space all written work, with the exception of tables, bibliographies, or footnotes. Type or use computer printouts wherever possible. These are usually considered to be 'more professional' and usually receive better marks than those reports that are hand written. I'm not saying that this is right (because I don't believe that it is) but with the low cost of computers and printers it is almost expected to be in a typed format.

Your notebook should include the required forms, a title page, a table of contents, an abstract (an abbreviated version of your background research paper), the background research paper, a bibliography, a statement of the problem or question, the hypothesis, the procedures used, a materials list, the variables and controls, the results, the conclusions, and acknowledgments (a list of people who have helped you with the project).

You may also want to include your project log. Here neatness doesn't count. The log should include your diary, working log, rough notes, and drafts of tables and graphs.

The Display

Your display is an advertisement of your project. It should be designed to attract attention to your work. The purpose of the display is to summarize your project. It should cover the main points and highlights.

President Barack Obama viewed the work of Presidio, Texas, students Janet Nieto and Ana Karen, of Presidio High School's Rocketry Team, and 7th grade student Gwynelle Condino, of Lucy Franco Middle School, in the White House, Feb. 7, 2012. (Official White House Photo by Lawrence Jackson—Public Domain)

Usually the display consists of a folding backboard, 3 to 5 feet high. Check to make sure the fair does not have any restrictions prior to constructing the background. The display must include summaries of the problem, hypothesis, procedures, results and conclusions. You can use flip charts, mini-dioramas etc. Be creative during this part of the project. When using charts and graphs, make them large, visible and attractive. The use of colored tape can create crisp, clear lines on the charts and graphs.

Remember that all of this information must fit onto the backboard you have selected. The best way to accomplish this is to make a blueprint of the project display. Decide now what to put on each of the three panels. Keep a space open to attach your notebook with a string, small chain or other strong material.

The Day of Judgement

Set up your display the day before the judging. Projects in the same category are always grouped together. Places on exhibit tables are usually assigned by alphabetical order.

Rowan Bedesem, a 4th grader at Croton Elementary School, Melbourne, Fla., explains the scientific process to judges from the Air Force Technical Applications Center, Patrick AFB, Fla., during the school's 2016 Science Fair. (U.S. Air Force photo by Susan A. Romano—Public Domain)

When setting up bring extra supplies, such as a hammer, nails, glue, etc. If you use lights in your display, bring some extra bulbs for those that burnout or break.

The AEDC Commander, Col. Rodney Todaro, met with the Lebanon High School rocketry team to congratulate the students on making it to the 14th annual national Team America Rocketry Challenge in Virginia. (U.S. Air Force photo/Holly Peterson-Public Domain)

The night before the fair, get a good nights sleep. Wear neat, conservative clothes (like what you would wear to church). Don't eat, chew gum, slouch or clutch a soft drink when the judges are walking the exhibit area. Smile and speak politely when questioned or addressed. Be ready to discuss your work. Each entrant is expected to give a short oral presentation about his or her project. When asked, don't say "It's all here on the board!"

Here are a few hints to giving a good oral presentation:

- During your discussion, be friendly and polite.
- Maintain good eye contact and don't stare at the floor or ceiling
- Be ready to introduce yourself and your project
- State your purpose and hypothesis clearly, followed by a brief description of your procedures.

- List your results. Point out graphs, charts, or tables that are in your notebook or on your backboard.
- Discuss your conclusions.

The judges will no doubt have questions, such as
How did you get interested in the topic?
Do you intend to continue work in this area?
What practical applications does your work have?

When the question and answer session is over, shake hands and thank the judge. Now breathe a sigh of relief, for it's all over until a winner is announced.

You're a Winner!
The fact is, if you never get a ribbon, trophy or any other type of reward, you are still a winner. You have shown perseverance in completing your project, and you've gained a working knowledge of the scientific method and an insight into an area of science.

Lastly, don't give up . . . There's always next year!

Topics
One of the hardest things about conducting a science fair project is coming up with an idea. To help out with this endeavor, we have compiled a list of projects that you might consider. Remember, for the project to be successful, it must involve a subject you are interested in. You will spend a significant amount of time with this project, so it needs to be something in which you have a genuine interest.

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Rocketry and Computers
Rockets and computers just seem to naturally go together. Here are a few ideas where you can combine the two into a single project.

- Design a computer program to aid in the design of a model rocket.
- Design a computer program to predict the performance of a model rocket.
- Design a computer program that will determine the altitude of a rocket.(You can use single station tracking, two station in-line tracking, or elevation/azimuth tracking).

U.S. Air Force photo by Garry Guthrie-Public Domain

Rocketry and Engineering
The design of rocketry air frames and components can be challenging, whether on the large scale in a NASA research lab or on a smaller scale in the workroom of the model rocketeer. Here are several projects that can offer a challenge, or start you thinking towards other engineering avenues.

- Different parachute designs and their effect on rate of descent and/or drifting.
- The effect of canard fins on reducing weather cocking during flight
- How does fin design and number effect the altitude of a rocket?
- How does clustering versus staging affect the altitude achieved by a rocket?
- How does the shape of the nose cone effect the drag and performance of a rocket?

- How does rotation of "spin stabilization" effect the stability and performance of a rocket?
- How does temperature effect the performance of a solid fuel model rocket motor?
- What is required to launch a model rocket under water?
- Is there a performance benefit to using a closed breech launching system?

Rocketry and Aerial Photography

Aerial photography and model rocketry make a great combination. To have a successful photography project, you must be able to have a consistent launch system, including launch vehicle, camera, and recovery system. Here are a few suggestions on how to use photography in a model rocketry project.

- Is it possible to determine cloud and smog patterns using aerial photography?
- What interpretation techniques are necessary in aerial photography?
- Is it possible to aerial mapping using rocket photography?
- Can erosion rates be determined based on aerial photography?

If You Enjoy Rocketry, Consider Joining the NAR

If you enjoy model rocketry and projects such as the Arduino Launch Control System, Project:Icarus, The Dyna-Soar and others, then consider joining the National Association of Rocketry (NAR). The NAR is all about having fun and learning more with and about model rockets. It is the oldest and largest sport rocketry organization in the world. Since 1957, over 80,000 serious sport rocket modelers have joined the NAR to take advantage of the fun and excitement of organized rocketry.

The NAR is your gateway to rocket launches, clubs, contests, and more. Members receive the bi-monthly magazine “Sport Rocketry” and the digital NAR Member Guidebook—a 290 page how-to book on all aspects of rocketry. Members are granted access to the “Member Resources” website which includes NAR technical reports, high-power certification, and more. Finally each member of the NAR is cover by $5 million rocket flight liability insurance.

For more information, visit their web site at https://www.nar.org/