SACRAMENTO REGIONAL STEM FAIR
STUDENT HANDBOOK

Northern California
STEM
Education Foundation
Science • Technology • Engineering • Math

TABLE OF CONTENTS

Research and the Process of STEM

The Intel International Science & Engineering Fair (ISEF) and it's Affiliated Fairs are research (data) driven. Research is a process by which people discover or create new knowledge about the world in which they live. Students may design research projects that provide quantitative data through experimentation, followed by analysis and application of that data for their Sacramento Regional STEM Fair Project.

Note: Projects that are demonstrations, 'library' research or informational projects, 'explanation' models or kit building are not appropriate for research based science fairs.

Project Plan Information

We've mapped out good Project Plans dependent on your type of scientific, technological, engineering or mathematical (STEM) experiment below. Take a look!

Theoretical Projects:

These projects may involve a thought experiment, development of new theories and explanations, concept formation or designing a mathematical model.

Note: *This type of project may not be used in research based science fairs.*

Science Projects:

Good scientists question what they know! Use the 'Scientific Process', also known as the 'Inquiry Cycle', simplified in a list below to conduct your Scientific Research:

1) Ask a question
   Be curious, but choose a limited subject that you want to know more about. Identify a testable problem and move on to step 2!

2) Perform background research
   Hit the books! (To ensure that your project will be approved by the Scientific Review Committee, remember to read the Rules & Guidelines first here)

3) Hypothesize
   Take an educated guess at what will happen & record it

4) Design your experiment
   Make sure your experiment is "controlled" – meaning

only one thing changes at a time so you can measure exactly what happens. Record development in your experiment – it will be in handy for your research paper

5) Experiment & Analyze results
Once you have your data from your experiment, we suggest graphing the results – not only can you use this on your project board, but you can also visualize what happened more easily!

6) Conclude
Tell us what happened. Is it what you thought? Why or why not?

7) Report & Exhibit
Make the report and exhibit informative and detailed, but memorable as well

8) Review & Discuss
Create and memorize a 2-3 minute long presentation for your family and friends. Let them ask you questions in order to prepare yourself for judging at the Fair. *Remember, it's always better to be able to converse during judging than to read off note cards!*

9) Perform another Research Project!
You can continue your research project, revamping it for next year or you can start with a new question. The possibilities are endless!

Inquiry & Non-Inquiry Based Research

Engineers, inventors, mathematicians, theoretical physicists, and computer programmers have different objectives than those of other scientists - they follow a different process in their work that depends on their area of study.

Engineering Projects:

"Scientists try to understand how nature works; engineers create things that never were." A good way to plan out your Engineering Project is to follow the list below:

1) Ask - "How can I make this better?" or "who needs what, because of why?"

   Create a prototype to improve items we already have

2) Develop a few designs
   The more designs you have, the more your prototype becomes perfected

3) Perform background research
   Find out if anything has already been done or developed to answer your question. What makes them strong or weak solutions?

4) Make a materials list with your preliminary designs
   Consider costs, manufacturing and user requirements

5) Build and test a prototype!
   Consider reliability, repair and servicing. Take note of these things for your data book

6) Retest and redesign
   If you need to!

7) Review & Discuss
   Create and memorize a 2-3 minute long presentation for your family and friends. Let them ask you questions in

Getting Started

I. Pick your topic:

An idea of what you want to study or learn about should come from your areas of interest. (A hobby might lead you to a good topic.) What is going on in the world that you would like to know more about? Important: pick a question or problem that is not too broad and that can be answered through scientific investigation.

II. Research the Topic:

Use all available resources – such as professionals, the library and the internet!

III. Organize:

Narrow your thinking by focusing on a particular idea with organization.

IV. Make a Time Table:

Make sure you can accomplish your experiment in time! Develop a time line to manage your time efficiently. Your application is very important make sure you check what exactly you need to fill out. Allow plenty of time to experiment and collect data. Leave yourself time to write your paper and put together your display board.

V. Plan the Experiment:

Write a research plan that explains how you will do your experiments and exactly what will be involved. The experimental design should also include a list of materials. Remember: you must design your experiment so that it is a 'controlled' experiment. (When you finish designing your research plan, fill out the appropriate forms for the application)

VI. **Register for the STEM Fair online!**

VII. Consult with Your Adult Sponsor and Get Approvals:
You are required to discuss your research plan with an Adult Sponsor and obtain a signature of approval. In reviewing your research plan, you should determine if additional forms and prior approval are needed.

VIII. Conduct Your Experiment:
During experimentation, keep detailed notes of each and every experiment, measurement and observation in a log book. Do not rely on memory. Besides, judges love logbooks! Use data tables or charts to record your quantitative data.

IX. Analyze Your Results:
Use appropriate graphs to make 'pictures' of your data and identify patterns from the graphs. Use statistics to give your results meaning. Did your experiments give you the expected results? Why or why not? Are there other explanations that you had not considered or observed? Were there experimental errors in your data taking, experimental design or observations? Remember, that even errors or unchanged results are as much a 'discovery' as if there was a change!

X. Draw Conclusions:
Keep an open mind — never alter results to fit your theory. If your results do not support your hypothesis, that's still research! Try to explain why you obtained different results than expected. Think "How could this project be used in the real world?" Finally, explain how you would improve the experiment and what would you do differently.

Elements of a Successful Project

I. Project Data Book:

An accurate and detailed project data book full of your notes is your most treasured piece of work. It will help you when writing your research paper. Make sure you date each entry and if you draw data tables in your project book, place units in a legend to remind yourself later.

II. Research Paper:

While writing your research paper, it would be helpful to have your project data book, any necessary forms, and relevant written materials at hand. A good paper includes the following:

a.) Title Page & Table of Contents – this organizes your thoughts before writing

b.) Introduction – this helps set the scene: includes the purpose, a hypothesis, your why, what and how.

c.) Materials & Methods - Describe how you collected data, made observations, designed your apparatus, etc. Only include this year's work. Your research paper should be so detailed that after reading it, someone could repeat it to someone else.

d.) Results – This should include your statistics, graphs, changes, and pages with raw data.

e.) Discussion – Compare your results with other research you've found. Discuss possible errors. How were your results affected by uncontrolled events? What would you do differently? What follow up experiments should be conducted?

f.) Conclusions - Summarize your results. Mention practical applications. State your findings and support your data, but do not introduce new concepts. Always give credit to those it is due!

g.) References/Bibliography – This should include any documentation that is not your own.

a. There are three common and acceptable reference styles:
   i. APA (American Psychological Association) Style: http://apastyle.apa.org/
   ii. MLA (Modern Language Association) Style: www.mla.org/style
   iii. Chicago Manual of Style: http://www.chicagomanualofstyle.org/home.html

Patent and Copyright Information

You may want to consider applying for a patent or copyright if you want to protect your work.

United States Patent and Trade Office
Customer Service: 1-800-786-9199 (toll-free);
571-272-1000 (local); 571-272-9950 (TTY)
http://www.uspto.gov/
http://www.uspto.gov/patents/process/index.jsp
European Patent Office
http://www.epo.org/
http://www.epo.org/applying/basics.html

III. Abstract:

Typically, an abstract is written after experimentation to enable the inclusion of results of your project. For the Sacramento Regional STEM Fair, you will need to submit an abstract with your registration to participate in our fair. On our registration application, you are directed to submite a preliminary abstract, if you have not completed your experimentation. This prelimindary abstract must be a summary of how you developed your hypothesis, your experimentation and what you expect to happen. If you have finished the experimentation prior to registration (for those students working in Regulated Research Facilities this will be true), you can follow the instructions on abstracts below:

After finishing research and experimentation, you need to write an abstract that is a maximum of 250 that should include the a) purpose of the experiment, b) procedures used, c) data, and d) conclusions. Only minimal reference to previous work may be included. See below for an example of an appropriately written abstract.

IV. Visual Display:

You want to attract and inform. Make it easy for interested spectators and judges to assess your study and the results you have obtained.

Helpful hints for display:

a) Current Year – Make sure you only focus on what you did for this year's science fair.
b) Good Title – Make it sound interesting and fun!
c) Take Photographs – A picture is worth a thousand words
d) Be Organized – You have to present this to judges – people who have never seen it before, remember that!
e) Eye-Catching – Give the judges a good visual aide that also attracts them
f) Correctly Presented and Well-Constructed – Don't get too complicated

Note: The judges are judging your research, not the display. So don't spend an excessive amount of time or money on the board. You are being judged on the science, not the show!

Sample Abstract

Effects of Marine Engine Exhaust Water on Algae
Mary E. Jones
Hometown High School,
Hometown, PA, United States

This project in its present form is the result of bioassay experimentation on the effects of two-cycle marine engine exhaust water on certain green algae. The initial idea was to determine the toxicity of outboard engine lubricant. Some success with lubricants eventually led to the formulation of "synthetic" exhaust water which, in turn, led to the use of actual two-cycle engine exhaust water as the test substance. Toxicity was determined by means of the standard bottle or "batch" bioassay technique. Scenedesmus quadricauda and Ankistrodesmus sp. were used as the test organisms. Toxicity was measured in terms of a decrease in the maximum standing crop. The effective concentration - 50% (EC50) for Scenedesmus quadricauda was found to be 3.75% exhaust water; for Ankistrodesmus sp. 3.1% exhaust water using the bottle technique. Anomalies in growth curves raised the suspicion that evaporation was affecting the results; therefore, a flow-through system was improvised utilizing the characteristics of a device called a Biomonitor. Use of a Biomonitor lessened the influence of evaporation, and the EC 50 was found to be 1.4% exhaust water using Ankistrodesmus sp. as the test organism. Mixed populations of various algae gave an EC 50 of 1.28% exhaust water. The contributions of this project are twofold. First, the toxicity of two-cycle marine engine exhaust was found to be considerably greater than reported in the literature (1.4% vs. 4.2%). Secondly, the benefits of a flow-through bioassay technique utilizing the Biomonitor was demonstrated.

Sacramento Regional STEM Fair Category Judging

The Sacramento Regional STEM Fair has 7 categories that students may choose to enter their projects into. These categories are judged based on either a Scientific Process or Engineering Design Process rubric. Please see below for information regarding your specific category:

Scientific Process Rubrics:

1. Behavioral & Social Sciences
2. Biology & Health Sciences
3. Chemistry
4. Physical Sciences & Math

Engineering Design Process Rubrics:

1. Applied Engineering
2. Computer Software & Technology
3. Sustainable Technology

Note: *Students are able to change their selected category up until 2 weeks prior to the scheduled STEM Fair. Students are NOT able to change categories on-site.*

Scientific Category Judging

Category award judges are experts in their fields. Judges evaluate and focus on:

- Current year information
- If you followed the Scientific Process
- Detail in your project book
- If your experimental procedures actually testedhypothesis well
- How your project will affect its field
- How thorough you were in experimenting
- How well planned out your research project is

Right off the bat, judges get their information from your board, abstract and research paper, so make it count. However, the biggest part of your project for the judges is:

The Interview:
Judges are not interested in memorized speeches or presentations – they simply want to talk with you about your research to see if you have a good grasp of your project from start to finish. Make sure to greet the judges and introduce yourself. You want to make a good first impression.
A few common questions are:

1. "How did you come up with this idea?
2. "What was your role?"
3. "What didn't you do?"
4. "What further plans do you have to continueresearch?"
5. "What are the practical applications of yourproject?"

If you prepare for some of these questions, it will help you with others they may ask.

The judges will make sure you:

1. Have correctly measured and analyzed the data

2. If you can determine possible sources of error
3. How you might apply your findings to the 'real'world

Overall the judges want to encourage you in your scientific efforts and your future goals/career in science. Remember to relax, smile and be enthusiastic about your findings!

Sample Judging Criteria - Scientific Category (by points)	
Creative Ability	30
Scientific Thought	30
Thoroughness	15
Skill	15
Clarity	10
Teamwork (team projects only)	16

Engineering Design Process Category Judging

Category award judges are experts in their fields. Judges evaluate and focus on:

- Current year information
- If you followed the Engineering Prototype Model
- Detail in your data book
- If your experimental prototype actually tested/fulfilled your project design well
- How your project will affect its field
- How thorough you were in experimenting
- How well planned out your research project is

Right off the bat, judges get their information from your board, abstract and research paper, so make it count. However, the biggest part of your project for the judges is:

The Interview:

Judges are not interested in memorized speeches or presentations – they simply want to talk with you about your research to see if you have a good grasp of your project from start to finish. Make sure to greet the judges and introduce yourself. You want to make a good first impression.
A few common questions are:

1. "How did you come up with this idea?
2. "What was your role?"
3. "What didn't you do?"
4. "What further plans do you have to continue research?"
5. "What are the practical applications of your project?"

If you prepare for some of these questions, it will help you with others they may ask.

The judges will make sure you:

1. Have correctly measured and analyzed the data

2. If you can determine possible sources of error
3. How you might apply your findings to the 'real'world

Overall the judges want to encourage you in your scientific efforts and your future goals/career in engineering. Remember to relax, smile and be enthusiastic about your findings!

Sample Judging Criteria - Engineering Design Process Category (by points)	
Creative Ability	30
Engineering Goals/Research Problem	30
Thoroughness/Methodology	15
Skill / Execution of Design	15
Clarity	10
Teamwork (team projects only)	16