Tulare County Science & Engineering Fair

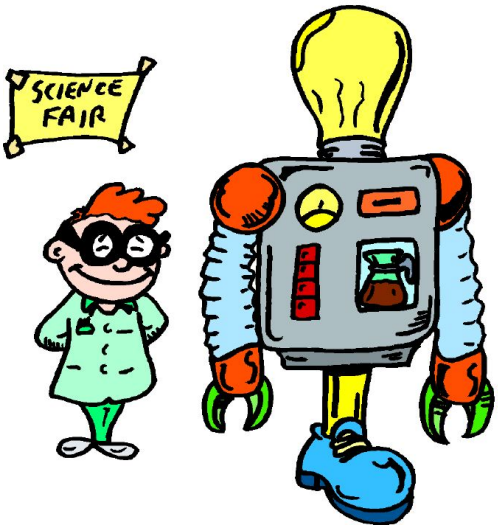
TCSEF Event Handbook

March 14, 2015
Lindsay High School

All information can be found at:
www.tcoe.org/sciencefair
commoncore.tcoe.org

Tulare County Office of Education
Jim Vidak, County Superintendent of Schools

Science Rocks!



Science isn't just for "nerds" or "eggheads." It is a fun way of trying to gain, organize, apply, and convey knowledge about the world in which we live. It is trying to understand the patterns that are around us.

Science is not just what you know; it's how you know it. Science follows a logical sequence of investigative events. It is organized. It requires clear thinking, checking and rechecking, planning, analyzing, interpreting, summarizing, and publishing your results. In other words, it is a method, a scientific method. Through this method, our culture and society has flourished!

Scientists and engineers publish their results in journals and magazines; otherwise, how would others know of their findings, and benefit from their work and the new knowledge? Your TCSEF project will be displayed not just with judges, but also with the public, as a way of sharing your work as a scientist and engineer.

Engaging in the TCSEF requires hard work, study, organization, and a great deal of time; **it is worth it**! Science fair projects have changed the lives and begun the careers of many young people. You will be off on an adventure that will have profound impact on your life and your future, your country, and your world.

This handbook was designed to provide assistance and guidelines to students who have decided to work on an independent or group science or engineering project. You may not need to use all of the handbook information, and we suggest you read through it to select the parts that will help you most.

There are many ways to do an independent or small group science project. You may chose to participate in the TCSEF Competitive Category or Non-Competitive Category. For either category, investigations can be as creative as the investigator's mind. This handbook will help get you started. It includes project ideas, tips to keep you going, and instructions for creating your display.

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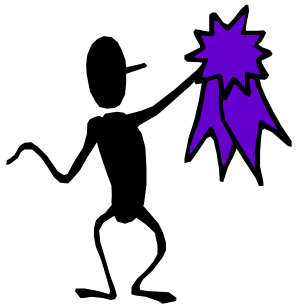
MISSION STATEMENT

The Tulare County Science & Engineering Fair mission is to:

- Motivate and develop the interests of ALL students in STEM fields,
- Recognize the achievements and efforts of students in STEM,
- Encourage independent research and development in STEM, and
- Identify exemplary projects that will advance to the California State Science and Engineering Fair.



WHAT IS A SCIENCE FAIR PROJECT?

A science and engineering fair project is:

- An attempt to answer a question using the scientific method, or it is an effort to design a solution that addresses a problem through the engineering design process.
- The display of an individual student's or a small group's effort. Students are expected to receive guidance, suggestions and evaluations from advisors; however, the majority of the thinking, investigation and construction of the display are to be that of the student(s).

A SCIENCE FAIR PROJECT - "WHAT IT IS & ISN'T"

A Traditional (Competitive Category) Science Fair Project is:

- A display of a first–hand investigation by a student.
- An attempt to answer a question by designing and conducting an experiment or a series of experiments.
- An attempt to design and conduct a survey of people's attitudes toward specific issues.
- A report of observations of humans and/or other organisms.
- A design and construction of a project to test a mathematical or engineering principle or concept.
- A systematic approach to solving a problem using the Scientific Method.

A Traditional (Competitive Category) Science Fair Project is NOT:

- A demonstration. A demonstration shows how something works or tries to explain why something happens the way it does. Demonstrations are not appropriate for competition, because they lack hypothesis development and experimentation.
- Any of the following do not pose a scientific query: a collection, a diagram, a table or chart, a model, an illustration, or a specimen.

BEWARE OF "CONSUMER REPORTS"!

A "Consumer Reports" project is not recommended for competition. Typical titles for "Consumer Reports" projects are:

"Which paper towel absorbs the most water?"

"Which is the best mouthwash for killing germs?"

"What is the best deodorant?"

These types of projects have difficulty in developing a valid hypothesis. Research is difficult to find, sometimes skipped entirely, done after the completion of the project. Many projects testing a specific product require information that is proprietary and is not published.

or

**"Consumer Report" and "Demonstration" projects may be entered into the Non-Competitive Project Category. Please, see more information for this Category on page 9.

GUIDELINES FOR EXCELLENCE

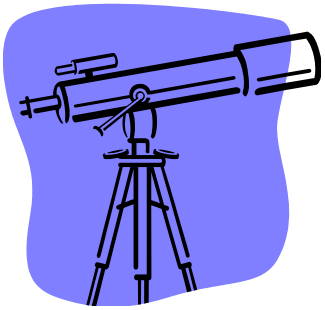
A project is not simply a display, but a process of identifying a problem and answering a question. The process includes many steps, steps that you'll find on page 20. The checklist will help you see an overall picture of the work you must do to complete a research project. Many students find the criteria for judging helpful in setting quality standards for their projects. Read the judging standards section on pages 21-22 to see what the science fair judges will be looking for. Be organized in thought and in actions, and above all else, follow the rules and regulations for Tulare County Science and Engineering Fair found in this handbook.

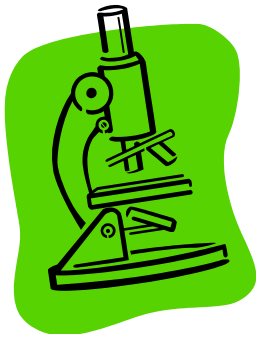
Project Categories

Project Categories for the 2015 Tulare County Science and Engineering Fair are:

***Life Science**
***Earth and Space Sciences**
***Physical Science: Chemistry**
***Physical Science: Physics**
***Engineering and Mathematics**
***Behavioral and Social Sciences**

When registering for the TCSEF, please note on your application in which category you intend to enter your project. The coordinators of the TCSEF will determine final project category placement.





WHAT ARE THE REASONS AND REWARDS?

There are many reasons for a student to undertake a Science Fair project:

- Curiosity about some aspect of our world and/or the universe
- Desire to study and learn about science, technology, math or engineering
- Desire to improve upon another's Science Fair project idea
- A career goal in science, technology, math or engineering
- Desire to solve social problems through the application of scientific thought
- Encouragement by a teacher

There are many rewards for a student to undertake a Science Fair project.

- Learning to be responsible for your own education
- Development of skills in scientific inquiry
- Increased knowledge and appreciation of the project content and an appreciation of scientific thought
- Improved skills in literature research and organization of data, concepts, and ideas
- The feeling of achievement and validation of the student's efforts
- Experience in the highest form of mental application, i.e., analysis, synthesis, and evaluation
- The top students will have the opportunity to participate in the California State Science Fair

RULES AND REGULATIONS

The organizers of the Tulare County Science and Engineering Fair (TCSEF), under the auspice of the Tulare County Office of Education, believe that all students have the right and opportunity to compete fairly for all awards. The following regulations will keep projects uniform for judging and ensure that they abide by federal, state and local laws, as well as the State of California Education Code. For these reasons, the following will be strictly enforced:

- The Tulare County Science & Engineering Fair Director, or his/her representatives, reserve the right to not display any materials which might be offensive to the general public, especially elementary school–aged children who frequent the fair.

- Any exhibit or part of an exhibit, which, in the judgment of the Fair director or his/her representatives, poses any safety threat to the public or to other exhibits, will be removed and not judged for any awards.

Competitive Project Category

Students in grades 3 through 12 attending a Tulare County school (public, private, or parochial) or any adjacent neighboring county may enter exhibits in the Fair. All projects must be checked and **approved by** a sponsoring teacher and/or administrator from the school/district.

- ***If your school has a science fair, you must enter that fair in order to enter TCSEF.***

- ***Schools in districts having district-wide fairs participating in TCSEF may enter only through the district fair.***

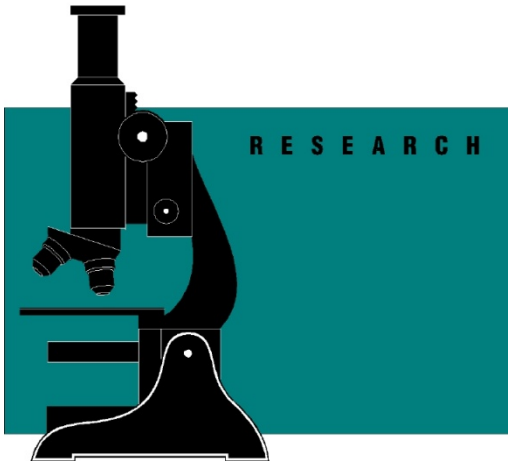
Senior Division: Students in grades 9 through 12 are eligible to enter a project as individuals or as members of a team (teams consist of two or three students). Projects must be submitted within one of the 6 categories.

Junior Division: Students in grades 6 through 8 are eligible to enter a project as individuals, or as members of a team (teams consist of two or three students). Projects must be submitted within one of the 6 categories.

Elementary Division: Students in grades 3 through 5 are eligible to enter a project as individuals, or as members of a team (teams consist of two or three students). Projects must be submitted within one of the 6 categories.
Grades 3, 4 and 5 are **NOT eligible to qualify for the California State Science Fair.

Competitive Project Category Continued

- Students who have prepared a project in conjunction with any study or research in industry, university, hospital or institution <u>other than their school</u>:



  - Must provide a letter from the principal research director. The letter should indicate the relationship of the student project to the research activities of the institution.
  - Project must clearly distinguish between the work of the student entrant and the work of others.
  - Must show only student's personal research in the display
  - May mention the research of others only if student clearly specifies the assistance received and the contributions of others in research related to the project.
  - NOTE: Research includes the use of laboratory equipment and/or space other than that normally available at the student's home or school.
  - Judges will evaluate only the work specifically done by the student.

- COMPETITIVE CATEGORY TEAM PROJECTS may have up to three members:

  - Teams may not have more than three members at a school/district fair and then eliminate members to qualify for the TCSEF.
  - A Team Project cannot be converted to an individual project or vice versa.
  - A new member may not be added to a continuing Team Project, but two original team members may continue their research if the third member no longer participates.
  - Each team should appoint a team leader to coordinate the work and act as spokesperson. However, each member of the team should be able to serve as spokesperson, be fully involved with the project, and be familiar with all aspects of the project.
  - The final work should reflect the coordinated efforts of all team members and will be evaluated using the same rules and judging criteria as individual projects.

- Judges Interview:

  Individuals and teams entering into the Competitive Project Category may participate in the interviews with the judges; however, it is not mandatory that participants are interviewed in order to be eligible for awards or to advance to the California State Science and Engineering Fair. Projects should be able to "stand-alone" and not need for the participant to be interviewed. Interviews are not part of the judging standards; they are an opportunity for participants to practice their interview and public speaking skills.

Non-Competitive Project Category

The organizers of the TCSEF understand that not all students would like to enter into Competitive Categories. We encourage individual students, student groups, and families to enter projects into this category when looking for an opportunity to:

- Become familiar with the Science and Engineering Fair process,
- Collaborate as teams of 2 or more to design and implement a project,
- Learn about the scientific method or engineering design process

Participants whose projects entered in the Non-Competitive Category will not be eligible for judging, interviews, awards, and advancement to the California State Science and Engineering Fair.

Non-Competitive projects will be required to follow all other Rules and Regulations including safety procedures in order to participate.

NOTE: To help determine if your project should be entered into the Competitive Category or Non-Competitive Category, please, see graphic on page 37.

All TCSEF Participants will follow the following Ethics Statement:

Scientific fraud and misconduct is not condoned at any level of research or competition. Plagiarism, use or presentation of other researcher's work as one's own and fabrication or falsification of data will not be tolerated. Fraudulent projects will fail to qualify for competition.

Restricted Projects:

Restricted projects require additional forms. Experiments that involve human subjects, nonhuman vertebrate animals, pathogenic agents, controlled substances, recombinant DNA, or human/animal tissue require approval from the Tulare County Science & Engineering Fair before experimentation begins.

Any project that involves vertebrate animals must:

- Conform to the regulations listed within this handbook and on the Tulare County "CERTIFICATION OF COMPLIANCE FOR RESEARCH INVOLVING HUMAN SUBJECTS, THE HUMANE TREATMENT OF LIVE VERTEBRATE ANIMALS, AND TISSUE SAMPLE SOURCES" form. (**COMPLETE ONLINE FORM**)

- Follow all federal and state laws which includes California State Education Code Section §514540 (see below), the Code of Federal Regulations 45 CFR §46.102, the Code of Federal Regulations PL 99-158 and Animal Welfare Act Title 9 Volume 1 Parts 1-199

California State Education Code Section §51540.

In the public elementary and high schools or in public elementary and high school school-sponsored activities and classes held elsewhere than on school premises, live vertebrate **animals** shall not, as part of a scientific experiment or any purpose whatever:

(a) Be experimentally medicated or drugged in a manner to cause painful reactions or induce painful or lethal pathological conditions.

(b) Be injured through any other treatments, including, but not limited to, anesthetization or electric shock.

Live **animals** on the premises of a public elementary or high school shall be housed and cared for in a **humane** and safe manner. The provisions of this section are not intended to prohibit or constrain vocational instruction in the normal practices of animal husbandry.

- Display a copy of the completed form with the exhibit. Vertebrate animal studies without this certification will not be allowed in the Fair for exhibition or judging.

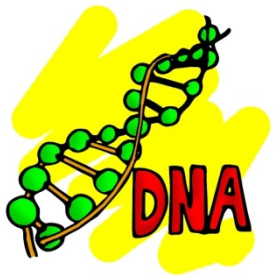
Any project that involves human subjects in a survey or study must:

- Conform to the regulations listed within this handbook and on the Tulare County "CERTIFICATION OF COMPLIANCE FOR RESEARCH INVOLVING HUMAN SUBJECTS, THE HUMANE TREATMENT OF LIVE VERTEBRATE ANIMALS, AND TISSUE SAMPLE SOURCES" form. (**COMPLETE ONLINE FORM**)

- Display a copy of the completed form with the exhibit. Human studies without this certification will not be allowed in the Fair for exhibition or judging.

Students may not be involved in the direct acquisition of recombinant DNA, tissue, organs, or other body parts (including blood and meat) from human or vertebrate animals. Any project that involves tissues samples or DNA must:

- Conform to the regulations listed within this handbook and on the Tulare County "CERTIFICATION OF COMPLIANCE FOR RESEARCH INVOLVING HUMAN SUBJECTS, THE HUMANE TREATMENT OF LIVE VERTEBRATE ANIMALS, AND TISSUE SAMPLE SOURCES" form. (see **FORM 2**, page 18)



- Display a copy of the completed form with the exhibit.
- Tissue Studies without this certification will not be allowed in the Fair for exhibition or judging.
- Human parts, even teeth, hair, nails and histological sections may **NOT** be exhibited.

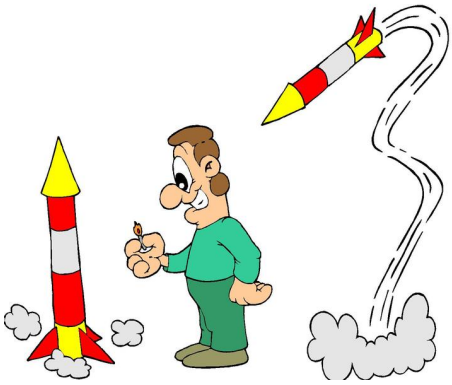
Any project that involves pathogenic agents, caustic chemicals, or hazardous or dangerous equipment must:

- Conform to the regulations listed within this handbook and on the Tulare County "CERTIFICATION OF COMPLIANCE FOR RESEARCH INVOLVING PATHOGENIC AGENTS, HAZARDOUS EQUIPMENT AND/OR CHEMICALS" form. (**COMPLETE ONLINE FORM**)

- Display a copy of the completed form with the exhibit. Studies involved with pathogenic agents such as bacteria, viruses or fungi, or studies involved with hazardous equipment and/or hazardous chemicals without this certification will not be allowed in the Fair for exhibition or judging.

- The display of bacterial cultures, live or dead vertebrates, invertebrates, or microorganisms, or their parts, is **NOT** permitted. This includes, but is not limited to: embryos, microbial cultures or fungi, whether known to be disease causing or not. Only illustrations or photographs of microorganisms and animals are permitted, although sealed insect collections at the discretion of the Science Fair Director could be permitted on display.

- Exhibits may not display photographs of procedures detrimental to the health and well being of vertebrate animals or humans. Performance of, or results of surgical or medical procedures may not be shown.



All exhibits must adhere to all county, state and federal laws and regulations regarding wiring, toxicity, fire hazard, and general safety.

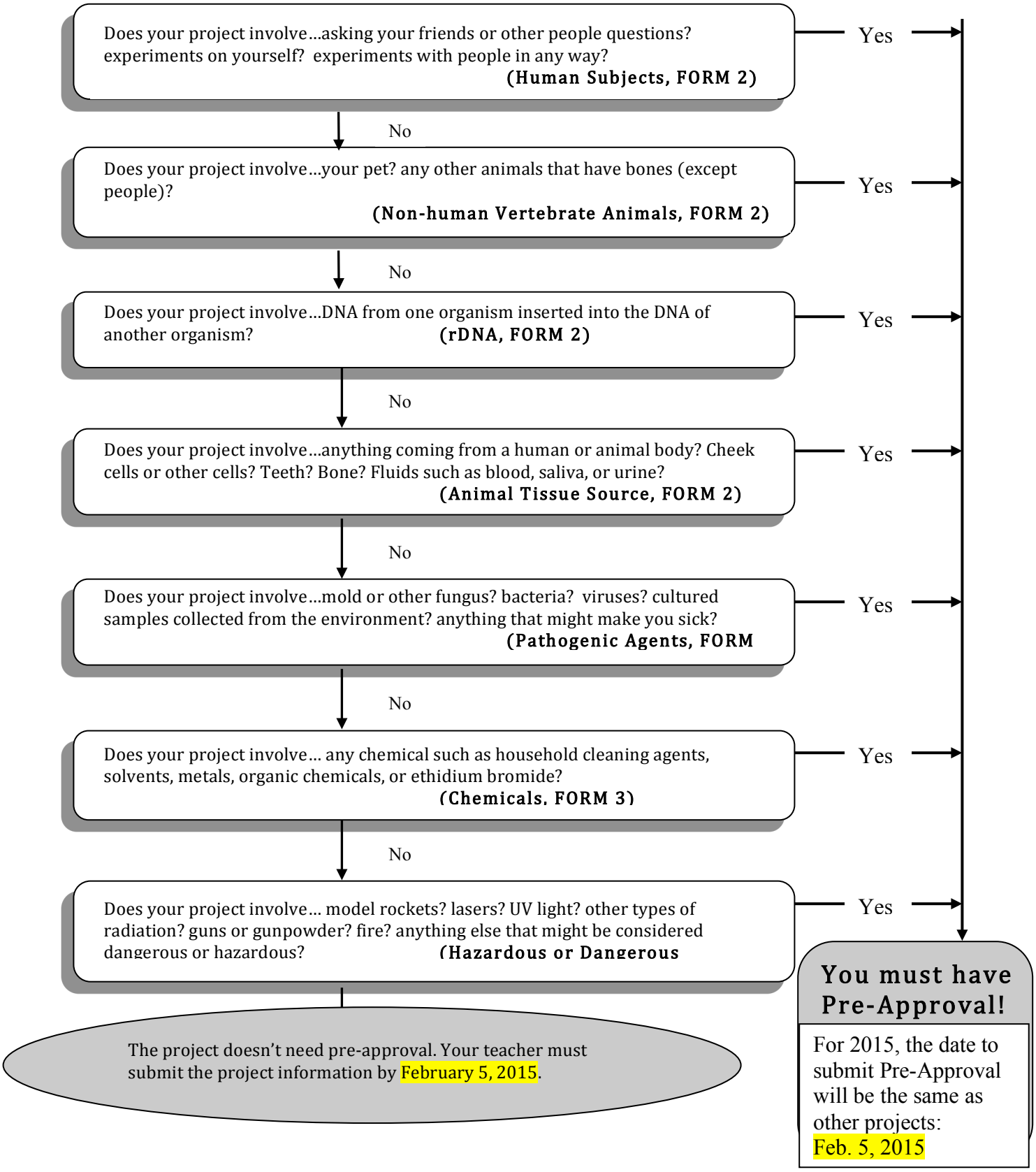
- Lasers may be displayed but not operated at any time.
- Containers for high-pressure gases must be empty.
- No open flames or highly flammable materials are allowed.
- Dangerous, combustible, and cryogenic materials are prohibited.
- Syringes, pipettes, knives and other similar devices are prohibited.
- Any apparatus with unshielded belts, pulleys, chains, or moving parts with tension or pinch points may not be operated.
- No perishable food items are allowed.

Toxic and hazardous chemicals are prohibited.
No gas or water outlets are provided.

IS YOUR PROJECT RESTRICTED?

Tulare County Science & Engineering Fair Pre-approval Requirements

Does your project involve any of the following?



Although the management of the TCSEF takes many precautions to protect the exhibits, we assume no responsibility for any items lost or damaged during the Fair. Valuable material and equipment should be simulated or pictured; they may be brought for demonstration during judging and then removed. All parts of the exhibit should be securely attached to the exhibit.

Please, be prepared with the following:

- A copy of the logbook and/or notebook along with the **Official Project Abstract** (see **Form 1,** page 49-51) must accompany the project and be displayed with the exhibit. (It is recommended that the original logbook and/or notebook be kept in the possession of the student at all times.)
- Awards, medals or flags from previous school/district fairs are not allowed.
- Please do not display your name, or your school's name on the front of your exhibit.
- Please leave a space in front of your project for the Project Abstract form.

Exhibits requiring electricity:

- Electrical cords for 110-volt AC exhibits must be UL-approved, 3-pronged electrical cords at least 9 feet long in order to use the provided electrical sources.
- You must provide 10 amp fuses or circuit breakers in your circuit.
- If wiring carries more than 20 volts, wiring must be of adequate size and well insulated. Connectors must be soldered or secured by UL-approved fasteners. Open knife switches or doorbell-type push buttons are not permitted above 20 volts.
- Exhibits producing temperatures exceeding 100° C (212° F) must be adequately insulated.
- Batteries with open tops are not permitted.
- High Voltage equipment, large vacuum tubes or dangerous ray-generating devices must be properly shielded.

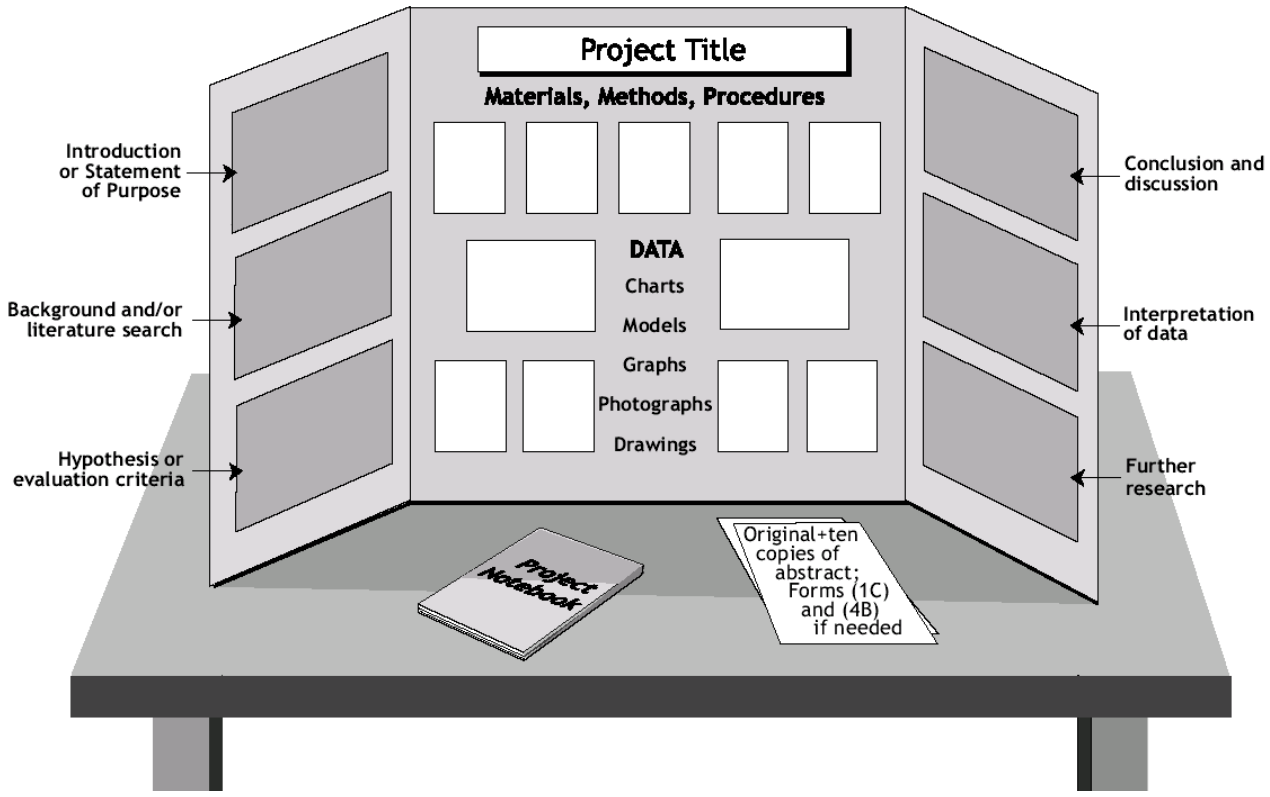
Display Guidelines:

- Maximum exhibit size is 4 feet wide by 2-1/2 feet deep by 6-1/2 feet tall. Oversized exhibits will not be eligible to be judged for awards.
- Students must take full responsibility for the safety of all parts of their exhibits. If a project is deemed unsafe by TCSEF coordinators, it must be immediately removed from the premises.

Exhibit backboards:

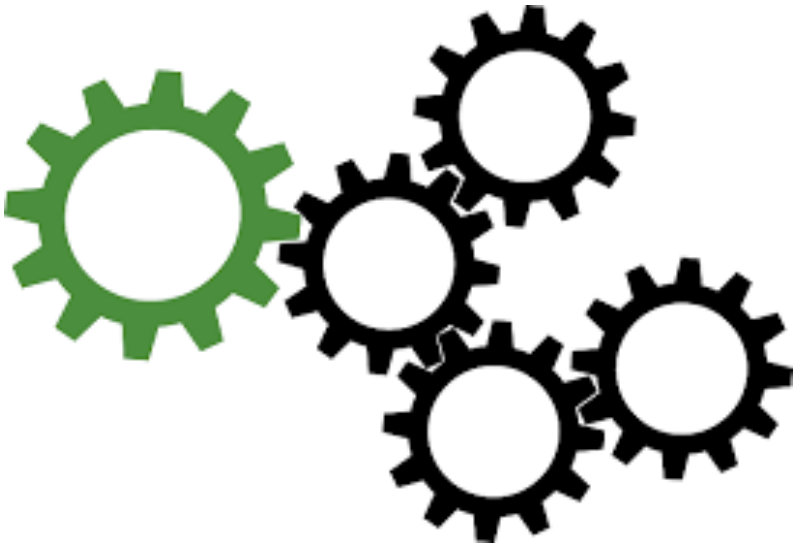
Must be constructed of rigid material or be reinforced with framing. Materials may be: masonite, pegboard, hardboard, foam-core board (purchased commercial backboards are recommended) to which poster paper, cardboard or fabric may be securely attached.

Material normally included on a typical project display board



A project entered into the Fair will remain at the Fair from Registration/Set-Up to the conclusion of the Awards Ceremony.

- All projects must be set-up and picked-up only during designated hours.
- **Projects not picked-up by the end of the AWARDS CEREMONY will be discarded.**
- **We hope that projects will be displayed through the end of the STEM Expo and removed at the conclusion of the AWARDS CEREMONY.**



"The important thing is not to stop questioning. Curiosity has its own reason for existing. One cannot help but be in awe when he contemplates the mysteries of eternity, of life, of the marvelous structure of reality. It is enough if one tries merely to comprehend a little of this mystery every day. Never lose a holy curiosity."

- Albert Einstein

JUDGING STANDARDS

Projects should demonstrate and display the mathematical, engineering, or scientific principles studied in a way that is clear to other people. Displays may consist of a demonstration experiment, a working model, or of charts, diagrams or collections with a scientific objective.

Judges evaluate and focus on the following:

- **Originality/Creativeness**

Original ideas and the creative use of resources are usually impressive. This originality may be in the scientific concept, a new approach to solve an old problem, or a new interpretation of data. The uniqueness of the approach and the handling and interpretation of the data should be commensurate with the grade level of the student. However, an original project must be well executed. Original projects are those that go beyond the textbooks and explore new ground and innovative techniques.

- **Comprehension/Scientific Thought**

Comprehension is the understanding and appropriate use of scientific theory, terms, techniques, and methodologies. Students should have a depth of knowledge about the scientific and engineering principles and practices, which can be shown by the ability to extrapolate what was learned from the project and applied to the principle. Depth includes understanding the basic science behind the project topic, comprehension at a finer level of detail, and awareness of the influence that the project has on related material in the subject topic.

Scientific Thought: The project shows depth of study and effort in employing scientific procedures in the solution of a clearly defined problem including study of background, organized procedures, appropriate sampling, orderly recording and analysis of data and the formulation of logical conclusions.

Engineering Goals: The project has a clear objective relevant to the needs of the potential user. The product or process has been tested and is working and feasible economically and ecologically.

JUDGING STANDARDS CONT.

➢ Organization and Completeness

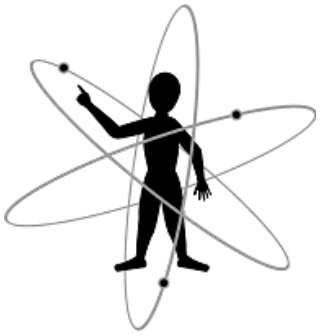
The project should have a well-defined goal or objective. The materials, methods, and experimental design should be sufficient to answer all the appropriate questions. A second component of organization is thoroughness, which includes not only the issue of how well the original questions have been addressed, but also the issue of how fully questions arising during the project have been addressed. It is the duty of all scientists to provide evidence in support of their claims. The burden of proof does not rest with the observer. Without supporting results or data, the science project is not a completed work.

➢ **Effort, Motivation and Skill**

The amount of time a student has spent doing the actual science project and the amount of time the student has spent reading and learning the subject should both be considered. While motivation and effort are not the same, the amount of effort that goes into a project is usually an indication of a student's motivation. Credit will be given for special skills needed for the construction or use of equipment and for mathematical, computational, observational and design skills.

➢ **Clarity**

The purpose, procedures, and conclusions are clearly explained orally and through the display. Ideas should be clearly presented and easy to understand. The project notebook is well organized, neat and accurate. Sources of ideas, data, and assistance are clearly identified. A well-written abstract, easy to follow visual aids, and clear and concise answers all add to the quality of a project.



SCIENCE FAIR INVESTIGATIVE CHECKLIST

- ❑ Check your topic or problem.
- ❑ Obtain signatures for the necessary certification. All projects require teacher-supervisor approval.
- ❑ Develop the questions you want to use to guide your investigation.
- ❑ Prepare your time schedule. Plan to work on your project at least 3 times per week.
- ❑ Conduct research in the library and/or the internet.
- ❑ Write a statement of your problem or idea.
- ❑ Make a preliminary outline.
- ❑ Search the literature.
- ❑ Read and take notes.
- ❑ Revise outline.
- ❑ Refine the statement of your problem.
- ❑ Develop your working hypothesis.
- ❑ Design your investigations, experiments and/or observations.
- ❑ Obtain necessary supplies and equipment.
- ❑ Control Variables.
- ❑ Record your results (data.)
- ❑ Organize your data (graphics, charts, tables.)
- ❑ Analyze your data.
- ❑ Interpret your data (What does it mean?)
- ❑ Formulate your conclusion by reviewing your results.
- ❑ Summarize your work.
- ❑ Write your Science Fair Abstract.
- ❑ Refine or redesign you investigation.
- ❑ Design and build your Science Fair display.

A REVIEW OF THE SCIENTIFIC METHOD

The Scientific Method is a logical process to arrive at the best answers to questions based on observable facts. The method provides good answers when using the following:

STATEMENT OF THE PROBLEM OR QUESTION:

A clear, short statement of the investigation problem or question must be worked out so that any observer can understand what you are doing.

Example: Can houseflies distinguish between artificial sweetener and sugar?

HYPOTHESIS:

A hypothesis is a statement that serves as a possible explanation or answer to a problem or question. It can also serve to give direction to your investigation or experiments. Your hypothesis is to test, not to prove.

Example: If houseflies can distinguish artificial sweeteners from sugar, they will respond or behave in a different manner when fed the two substances.

RESEARCH:

Search the literature (books, magazines, journals) and take notes on what others have learned about your topic. Often personal interviews with experts on your subject will be of great value. You need to know a lot about your topic before you can design and carry out good investigations and experiments. WARNING: The internet is a great resource for information, but do not rely on it solely. Much of the information obtained online is misleading and of little value.

Example: Look up and take notes on houseflies and their behavior, the feeding mechanism of insects; learn about sugar and artificial sweeteners.

EXPERIMENTATION:

A good experimental design will allow you to gather factual information on your problem and test your hypothesis. Accuracy in measurement is vital when recording your data. Remember, **your hypothesis is to test, not to prove.**

Example: Fifty houseflies were selected to be tested for 10 trials in sugar solution (10%) and artificial sweetener (10%). Each fly was glued to a small stick by the wings and during the trial the flies' feet were immersed in the solutions. The observation recorded was the extension of the flies' proboscises into the solutions.

A REVIEW OF THE SCIENTIFIC METHOD CONT.

When setting up your experimental design, use the following guidelines:

Control the Variables. You must eliminate other factors that could alter or influence your results. (Nothing should vary in the fly problem but the sugar and the artificial sweetener. Everything else must be the same: temperature, light, time of day, condition of the flies, etc.)

Collect DATA. During your experiment you must indicate in detail what you did and how you did it, and all of your observations. The data should be quantitative where possible (how much, how high, how hot.)

Example: 47 out of 50 flies lowered their feeding proboscises when placed on sugar water; whereas 3 out of 50 flies lowered their feeding proboscises when placed on artificial sweetener "A."

Sample Properly: Use as many trials or subjects as practical to eliminate any individual differences.

Ensure Reproducibility: Your experiment must be designed and described so that others following your procedure would get the same results.

Analyze and Display Data: After collecting your data, it must be organized, analyzed and displayed in tables or graphs.

Example: The results of the 10 trials in sugar and 10 trials in sweetener "A" should be listed on a table and the average (x), standard deviation (s), and probability (p) should be calculated. (You may need help to learn to do the calculations.)

CONCLUSION:

Discuss how the data (your results) compare with your hypothesis. Was your hypothesis correct? You cannot change the data, but you could alter or modify your hypothesis and perhaps design and run a new set of experiments.

Example: The fly experiment data supports the hypothesis that houseflies can distinguish between the two substances. They appear ready to feed on the sugar, but not on the artificial sweetener "A."

SELECTING YOUR PROJECT TOPIC

This step may appear to be simple, but it may be difficult for some students. You may feel that you lack ideas and directions. This section of the handbook was designed to help you find the idea or problem that best fits you.

Look through Science Publications to find something that interests you.

- Science textbooks
- Lab manuals
- Science/Science Fair Websites
- Science magazines (not technical journals.)

Make a list of five things that seem interesting to you.

"Why does paint peel?"
"Why do bicycles with low tire pressure coast a shorter distance?"
"How do snails reproduce?"
"What type of weight lifting increases muscle mass the fastest?"
"Do TV commercials control buying habits?"

Make a list of things you've always wondered about or wanted to do:

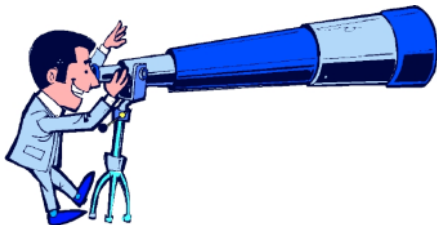
"Making a Program that . . .
. . . Teaches Others to Write Programs"
. . . Controls Roof Solar Panels"
. . . Simulates Predator-Prey Relationships in a Nearby Habitat"
. . . Regulates Greenhouse Temperature"

SELECTING YOUR PROJECT TOPIC CONT.

From the list, pick a topic…

– that interests you

– is specific enough to make into conduct an experiment



Examples:

– "The Effect of _____ on _____"
– "The Design and Construction of a simpler (less expensive) _____"

You will want to avoid:

– **Topics that are too general**
Cannot be made into problem and experiment
Make more specific: "Bacteria" becomes… "Effect of Bacteria on Plant Roots"

– **Topics that require unavailable equipment**
"Deep Sea Hydrothermal Vents"
"Advantages of Two-Engine vs. One-Engine Cars"

– **Topics that require too much time**
"Designing a Submarine that can also fly"

– **Topics that are potentially dangerous**
"Building Better Explosives"
"Effects of Different Gas Mixtures on Breathing"

– **Projects that are mainly a tool or organism that interests you**
– "Microscopes"
– "A Computer I Built"
– "The Hamster as Research Animal"

– **Topics that tend to be weak projects**
– "Which toothpaste tastes the best?"

Six Key Aspects of a Successful Science Project

1. Your Question - The essential starting point for your project.

Science is asking a question of nature and making sense out of the answer. Engineering is figuring out how to solve some problem by designing a new way to make or do something and showing that it works.

A science or engineering research project is ONLY as good as the question on which it is based.

You will want to choose a question that can be answered by some experiments that YOU can do by yourself, with only a little help from others.

If your question is "How do volcanoes work?" you will probably not do very well. That question is just too complex and needs much harder experiments than you are likely to have time, equipment or skills to handle.

If your question is "Do rats jump if you step on their tails?" you also will not do well. That question is too simple, not to mention that to do the experiment would be rather cruel. We do not allow any experiments on vertebrate animals that might harm them.

A good question is clear and direct and helps you see what experiment to do to answer it. The best questions will also lead naturally into other questions by which you can extend what you are able to learn by some related experiments.

Now, let's look at a concrete example of how you might go about developing your question. For example, you might decide that you would like to know something about why cockroaches go to certain places in a house more than others. That is a general statement of what you are interested in learning. Your specific question (which suggests a particular experiment that could be the center of your research project) might be:

"What colors of floor material do cockroaches (Blattidae) prefer?"

2. Gathering Data or Recording nature's answers to your question.

Having a question and thinking of some experiment that could give you an answer to that question is only the beginning. Now you have to do the experiment and write down what happens.

Data are the numbers, observations, and other things you can write down to say what happened when you did your experiment. Some data you get by counting, some by measuring with an instrument (like a thermometer or a voltmeter, etc.) and some is simply your written description of what you saw.

> In the cockroach experiment you might DESCRIBE the various floor colors you tried and also COUNT the number of cockroaches that you found on each color. You might also MEASURE the brightness of the light (with a photographic exposure meter, for example) and maybe MEASURE the temperature of the different colored floors (with a thermometer or thermocouple).

You will need to have a "logbook." This is a research notebook in which you write your data, and it is also a place to record what you did to produce those data.

You need to bring your research notebook to the Fair as a part of your exhibit. The judges will be looking for your observations and data, so be sure you write down each day as you do the experiments, not later on after all the experiments are done.

3. Precision also known as “How well did you measure it?”

Data are only useful if you can believe them. One important test of your data is: *Do you get the same results when you repeat the experiment a second (or third, or tenth) time?*

Try it and see. Notice how much the answers you get change from the first time you do the experiment to the next time. None of the answers you get is more correct than any other, so each answer is uncertain by about as much as any one answer differs from another.

This is called the "Precision" or "Repeatability" of your data.

If you are doing a physics experiment, you probably can just measure the same thing several times with the same apparatus. If you are doing a biology or psychology experiment, you may need to repeat your experiment several times using many different subjects (different plants or different people) each time.

> In the cockroach experiment, you could repeat the experiment several times with a new handful of roaches for each pair of floor materials you are testing.

Suppose when you do your experiment five times, the numbers you get (for example, the number of roaches on one particular color of floor) are 76, 79, 72, 81, and 74. The average of these numbers is 76.4. But you should not conclude that the "correct" value is 76.4: that would be claiming more than you really know. Instead, you could say "after five measurements the answers ranged from 72 to 81 with an average of 76." That tells both what the average value was and something about how much the different values you recorded varied from one another.

Another, more technically complete, method of giving this information would be to say, "In five measurements, the average value was 76.4 with a standard deviation of the mean of 1.6." If you wish to learn how to do this more mathematical kind of data analysis, consult any standard book on experimental statistics. We especially encourage high school students to use this approach.

Record your data in a table or chart and then plot them. This will help you (and the judges) "see" what is going on.

4. Controls, also known as "How do you know that what happened was because of what you did?"

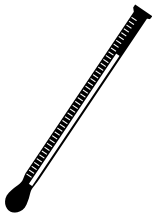
Your experiment will very likely attempt to answer some sort of "What if..." question. You are trying to find out what happens when you change something about the situation.

> In the cockroach experiment you will be looking for changes in the number of roaches that choose either of the two floor colors in the box when you change their choice of colors.

It is important to be sure that the differences you see are, in fact, caused by the changes you meant to make, and not by something else you just didn't notice.

> If you had two regions of colored floor, one black and one white, and they were both under a strong light, the black floor would get hotter. If the cockroaches preferred the black floor, you might actually be observing their preference for a warmer area and not really a preference for a darker color.

Repeating your experiment is one way to check on this. If you don't get the same result when you repeat the experiment, clearly you are not measuring what you thought you were (or, something else is also happening). Another way to check on your results is to use a CONTROL situation.



A related question is how accurate your measuring instruments are. You may be able to read the temperature indicated on your thermometer to within one-tenth of a degree, but what if the thermometer is not measuring the actual temperature of the floor or whatever you wanted to measure? Or what if it is not calibrated correctly - it might be wrong by five degrees?! (You could, perhaps, check that by using a second thermometer.)

5. Analysis or Making sense of what you have done.

Most likely, no experiment will actually answer your question for you. You have to look at the data and then do some organized thinking about these data to arrive at an answer to your question.

Sometimes you will have to make a graph of your data, or compute some averages, or compare what you measure to what someone else has measured in a different situation.

– "The Effect of X on Y"

Your work is still not done. Doing an experiment and taking some data is not all there is to science. You must figure out what it all means. And then you can tell others (including the judges) what you figured out.

After you have presented all the data you took in a way that lets you see some patterns you should write down what you think it all means. State your conclusion and your reasons for them. Your logbook is a very good place to put all these graphs, computations, etc. That way all your work is shown in one place. Later on, when you prepare your display, you may copy just those graphs that best show your results.

6. The Research Report or Tell us all about it.

The logbook, if you use it correctly, will have all the details of what you did and what you saw and what you calculated and what that all means to you. But it will, very likely, not be easy to read and understand.

A complete science research project will include preparing a research report. This is an organized representation of the information in the logbook (or at least the most essential parts of that information). The reason for representing it is to put it together in a way that makes it easier to read and understand.

An excellent science fair display will have the research report and the logbook attached to the display panels.

> "No amount of experimentation can ever prove me right; a single experiment can prove me wrong."
>
> **- Albert Einstein**

GATHERING INFORMATION

Learn as much about your chosen problem or question before proceeding with the design of your investigation. You need to become a "mini-expert" on your topic.

If you are organized, you won't waste time. Write down all information that you might want to use in writing your abstract. Keep a journal (notebook) on your investigation. A small notebook can be carried easily and will remind you that this educational process is special. Record your personal observations or thoughts immediately.

PROJECT PLANNING TIMELINE

Fill in the estimated time for each area.

TIME (In Days)		Date Due
_____	Organization (Planning, Research)	_____
_____	Construction (Physical Assembly)	_____
_____	Development (Experimental work)	_____
_____	Exhibit (Project Presentation)	_____

School/District Science Fair Date: _____

Tulare County Science Fair Date: **March 14, 2015**

State Science Fair Date: **April 13-14, 2015**

CONSTRUCTING YOUR EXHIBIT

This last step is building your display. There were several steps to doing a good Science Fair project described on page 20 under the heading "Investigation Checklist." Your display will be best if it shows what you did at each step (in summary form, not in full detail).

Your display is a special way to "tell a story." Before you design your display be sure you understand what story you wish to tell. That means you need to show what you were trying to find out (your question), what you did to find out (your experiment), what results you got (your data), and, finally, what conclusions you reached.

The detailed description of all this will be in your research report. The display should show only the essence of each section; just enough to help anyone who quickly looks at your exhibit find out what it is all about. If you get the viewer's interest, then perhaps he or she will stop to study your research report in order to learn more.

Use photographs (with no faces of people visible), graphs, and drawings, not just words.

Being clear is the whole aim. For example, judges like neat graphs, but they are not particularly impressed by computer drawn graphs (unless the computer was used to control the experiment and/or to make difficult calculations on the data before they could be graphed).

Although it definitely helps to be neat, you do not need to buy commercial letters or hire a graphic artist to help you. Please, do check the spelling of everything on your display panels. Misspellings influence the judge's impressions more than poor lettering quality.

CONSTRUCTING YOUR EXHIBIT CONT.

Add to your flat display boards some objects sitting on the table (your apparatus, perhaps, or a model.) 3-dimensional objects are valuable to display at the Fair.

Before you actually begin building anything, make a drawing of what your display will look like. Even build a model of the display if that helps you to see what it will be before you build it.

Have another person look at your drawing or model of the display. He or she can often tell you what is clear and what is not. Listen to him or her and make whatever changes you need to in order to make your display tell your story clearly.

PROJECT ABSTRACT

The Project Abstract is a requirement for both Competitive and Non-Competitive Category projects. After finishing research and experimentation, you are required to write a one-page abstract. An abstract should include:

-Purpose of the experiment
-Procedures used
-Data
-Conclusions

It also may include any possible research applications. Only minimal reference to previous work may be included. The abstract should focus on work done since the last fair and should not include:

-Acknowledgements
-Work or procedures done by a mentor

See the following page for an example of an appropriately written abstract. This abstract will be displayed in front of your science fair project.

PROJECT ABSTRACT CONT.

Sample Abstract

Project#_____
(project # will be assigned by TCOE)

Title of Project: Effects of Marine Engine Exhaust on Algae

Category:
(circle one)

Behavior & Social Sciences
Earth and Space Science
Engineering & Mathematics
Physical Science: Chemistry
Physical Science: Physics
Life Science

Grade Category:
(circle one)

ELEM. (3-5) JUNIOR (6-8) **SENIOR (9-12)**

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 lubricant 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 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 contribution 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.

SAMPLE

PARENTAL INFORMATION: 30th ANNUAL TCSEF

March 14, 2015

Lindsay High School

1. Space must be reserved in advance of your son/daughter's participation in the Tulare County Science & Engineering Fair. Grade level participation is determined by the local school district.
2. The number of school science projects is limited to the number of spaces reserved for each school district. The number of spaces is mainly determined by the size of the school district and number of school districts participating. A school and/or district may request more project spaces. These extra spaces will not be confirmed until approved by the Tulare County Science & Engineering Fair Coordinator.
3. The school district determines which science fair projects are to be displayed at the Tulare County Science & Engineering Fair. All displayed science fair projects must be judged to be the "best" or the "top winners" from each school district as determined by a prior class/school/district science fair contest.
4. No project shall violate the "Safety Standards" set forth in the Tulare County Science Fair Student Handbook.
5. The maximum size is 4 feet wide by 2 ½ feet deep by 6 ½ feet tall.
6. All science fair project students will receive a "Distinguished Project Ribbon" for their contribution to the development of scientific research.
7. All projects must be delivered and set-up in the Lindsay High School Gym on Friday, March 13, 2015 between 3:30 to 7:00 pm **or** Saturday, March 14, 2015 between 7:00 to 8:30 am. All projects must be picked-up on after the conclusion of the Awards Ceremony on Saturday, March 14th.
8. Judging of Science & Engineering Fair projects will be conducted from 8:30 am to 12:30 pm on Saturday, March 14, 2015.
9. **School or classroom visits to the Tulare County Science & Engineering Fair are encouraged. Viewing times begin at the completion of judging on Saturday. Please, register your school online to let us know that you plan on coming.**
10. The Tulare County Science & Engineering Fair will be open to parents and the community at the conclusion of judging. An awards ceremony will be held on Saturday, March 14, 2015, at 3:00 p.m. in the Multi-Purpose Room at Lindsay High School.
11. TCOE assumes no responsibility for loss or damage to any project or part thereof. Display of valuable items is discouraged. Such items should be simulated if necessary to the display. Any exhibit, or part of an exhibit, which, in the judgment of the Fair director or his/her representatives, poses any safety threat to the public or to other exhibits, will be removed and not judged for any awards. Items such as: glass, animals, bacteria, explosives are NOT ALLOWED.
12. ***Group projects will be accepted for competition***. A Competitive Category group shall consist of no more than 3 students.
13. ***Please Note:*** All projects must include a copy of all original data and/or notes as well as a completed **Project Abstract Form**. Judges will also be looking for ways in which students apply the knowledge learned in the project to some real life situation.