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<td><strong>November 18th</strong></td>
<td>Letter to Parents and Packet Posted on the Website and/or Letter to Parents and Packet sent home to students participating in the Fair</td>
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<td><strong>December 12th</strong></td>
<td>Request Forms Due</td>
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<td><strong>January</strong></td>
<td>Invitation for Engineering &amp; Science Fair sent home</td>
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<tr>
<td><strong>February 14th</strong></td>
<td>Registration for District’s Science &amp; Engineering Fair is due before 5:00 p.m. (5th &amp; 6th Grade only)</td>
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<td><strong>February 18th</strong></td>
<td>Projects due (Teachers may request an earlier due date.)</td>
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<td><strong>February 20th</strong></td>
<td>Barbara Bush’s Science &amp; Engineering Fair</td>
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<td>Student Body Time TBA at a later date</td>
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<td>Friends and Family @ 5:30 p.m - 6:30 p.m.</td>
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<td><strong>February 21st</strong></td>
<td>Busing and judging schedule announced for District Fair</td>
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<td><strong>February 25th &amp; 26th</strong></td>
<td>District Science &amp; Engineering Fair: Skyline High School</td>
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<td><strong>Note:</strong> You are welcome to visit the District’s Science &amp; Engineering Webpage for any updates (<a href="http://www.mpsaz.org/ssrc/dist-sci-fair/">http://www.mpsaz.org/ssrc/dist-sci-fair/</a>).</td>
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<tr>
<td><strong>February 28th</strong></td>
<td>Winning projects announced by phone call to parents. Students, families, and teachers invited to the Awards Ceremony</td>
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Selecting A Topic

There are a few key ideas to take into consideration before you select a topic. The first is to understand the **three science categories**, and second, it is essential to know that there are **five basic types** of science projects:

**The Three Science Categories:**
1. **Physical Science:** Do you find yourself wondering why or how things work? If so then you might want to choose Physical Science for your category. Topic examples may include things about matter, electricity, magnetism, sound, light, or energy.
2. **Earth and Space Science:** Do you find yourself curious about our earth or outer space? If so then this may be the category for you. Topic examples may include things about weather, geology (things that make up the earth such as rocks, fossils or volcanoes), or our sun, stars, and planets. Just a reminder, a model is not an experiment, so be careful when thinking about your investigation.
3. **Life Science:** Do you like plants, animals or are curious about why humans behave certain ways? If so, then Life Science may be the category your investigation could fall under. (There are special rules anytime you work with animals. Please pay attention to the project display guidelines to ensure you are following any rules.)

**Five Basic Types of Science Projects:**
1. **Descriptive:** This is basically a science report that describes an existing situation — global climate change, for example — with maybe a visual aid requirement. This type of project is usually required in elementary or middle school rather than high school.

2. **Collection:** Collecting leaves or insects are a common project for elementary or middle school. Most high school teachers require more than a simple collection.

3. **Demonstration:** This type of project is a demonstration of a known science principle or phenomenon, such as floating a needle to demonstrate water tension. You aren’t really learning anything new. Check with your instructor to see if this type of project is allowed.

4. **Engineering:** This type of project involves designing, analyzing and improving a device, material or technology. An engineering project involves building a prototype or developing a simulation to test the effectiveness of design changes or differing materials.

5. **Experimentation:** This is the type of project most commonly required at the high school level. Students are expected to use what they have learned about science processes to develop and carry out a “fair test” experiment and to report findings.

Since you will be spending quite a bit of time working on your project, you will want to choose a topic that truly interests you. Following are steps to guide you through the process of choosing a topic:

1. Make a mind web or mind map. Start with a big blank sheet of paper, draw a circle in the middle and label it with a word representing one of your interests.

2. Draw several lines, or spokes, radiating from the central circle and free-associate other words that you think of when you think about the central topic.

3. For example, if you choose “sports” as your central idea you might label the spokes “basketball, football, baseball, running, golf.”

4. Draw several more lines from each of these spokes and write several questions for each of the topics. The best science questions usually begin with one of the following words: **what, when, which, who, why, where or how.** Try to write at least two questions for each of your spokes.

5. Eliminate irrelevant questions. Deciding what is “best” often means that you would be basing your results on your opinion instead of evidence. This is called “bias” and is not appropriate for science.

6. Find the questions that have both an independent and a dependent variable. The independent variable is a factor that you can change in order to test the effects of the change. A
dependent variable is something you can measure which shows the effect of the change that you made.

7. Example to number 6: One question might be: “When is the best time to work out?” This question has an independent variable — you can choose to work out at different times, but it lacks a way to measure which time is “best.” You need a dependent variable. The easiest dependent variables to measure include numbers such as changes in size, time, speed, or distance. Some experimental questions have changes that cannot be measured with numbers and must be characteristics that can be easily described such as a change in color.

8. Example to number 7: “Does running in the morning increase my heart rate more than running in the evening?” has both an independent variable (different workout times) and a dependent variable (heart rate — you are measuring the speed at which the heart beats.) Notice the wording change — you have narrowed “working out” to “running.” You also have only three possible outcomes: heart rate can increase more in the morning, it can increase more in the evening, or it can be the same in the morning and evening.

This example is from Live Science.

After You Select A Topic

Once you are clear on the type of science project and topic, it’s time to receive approval from your parents. However, it is important for parents to read about their role, first.

Tips for Parents

1. **Be a guide.** As tempting as it might be, allow your child to do the work. It might not look as organized and pretty, but your child needs time and space to be curious and creative.

2. **Be positive** about your child’s work.

3. **Be honest** with your child. If you don’t know the answer, tell your child that you do not know, but offer to help locate a source of information that may help.

4. **Help** your child look around for ideas. Go to your local library, the Internet, etc.

5. **Help** seek out people to help—other adults, teachers, and/or other professionals.

6. **Help** your child collect and save materials. Inexpensive materials found around the home often work the best.

7. **Allow** your child to “mess around” with materials without your intervention.

8. **Allow** your child time for thinking, exploring, and doing the experiment. (See number 1.)
9. **Emphasize** “how-to” skills – e.g., observing, rather than memorizing facts.

10. **Examine** issues with moral consequences – e.g., animals used for experimentation.

11. **Encourage** your child to keep a daily log of their research activities.

12. **Attend** the Engineering & Science Fair and take lots of pictures.

One of the major objectives of doing a science fair project is to acquire more knowledge about the world around you. You are able to choose from two processes: the **Scientific Method** process or the **Engineering Design** process.

**Steps of the Scientific Process**

1. **Making an Observation**

   The first step of the scientific method is to make an observation about the world around you. Before hypotheses can be made or experiments can be done, one must first notice and think about some sort of phenomena occurring. The scientific method is used when one does not know why/how something is occurring and wants to uncover the answer, but before one can even question an occurrence, they must notice something puzzling in the first place.

2. **Asking a Question**

   Next, one must ask a question based on their observations, such as: why/how is this occurring? Why/how does it happen this way? Sometimes this step is listed first in the scientific method, with making an observation (and researching the phenomena in question) listed as second. In reality, both making observations and asking questions tend to happen around the same time, as one can see a confusing occurrence and immediately think, “why is it occurring?” When observations are being made and questions are being formed, it is important to do research to see if others have already answered the question, or uncovered information that may help you shape your question. For example, if you find an answer to why something is occurring, you may want to go a step further and figure out how it occurs.

3. **Forming a Hypothesis**

   A hypothesis is an educated guess to explain the phenomena occurring based on prior observations. It answers the question posed in the previous step. Hypotheses can be specific or more general depending on the question being asked, but all hypotheses must be testable by gathering evidence that can be measured. If a hypothesis is not testable, then it is impossible to perform an experiment to determine whether the hypothesis is supported by evidence.
4. **Performing an Experiment**

After forming a hypothesis, an experiment must be set up and performed to test the hypothesis. An experiment must have an independent variable, which is something that is manipulated by the person doing the experiment, and a dependent variable, which is the thing being measured (and which may be affected by the independent variable). All other variables must be controlled so that they do not affect the outcome. During an experiment, data is collected. Data is a set of values; it may be quantitative (e.g. measured in numbers) or qualitative (a description or yes/no answer).

For example, if you were to test the effect of sunlight on plant growth, the amount of light would be the independent variable (the thing you manipulate) and the height of the plants would be the dependent variable (the thing affected by the independent variable). Other factors such as air temperature, amount of water in the soil, and species of plant would have to be kept the same between all of the plants used in the experiment so that you could truly collect data on whether sunlight affects plant growth. The data that you would collect would be quantitative, since you would measure the height of the plant in numbers.

5. **Analyzing Data**

After performing an experiment and collecting data, one must analyze the data. Research experiments are usually analyzed with statistical software in order to determine relationships among the data. In the case of a simpler experiment, one would look at the data and see how they correlate with the change in the independent variable.

6. **Forming a Conclusion**

The last step of the scientific method is to form a conclusion. If the data supports the hypothesis, then the hypothesis may be the explanation for the phenomena. However, multiple trials must be done to confirm the results, and it is also important to make sure that the sample size—the number of observations made—is big enough so that the data is not skewed by just a few observations. If the data do not support the hypothesis, then more observations must be made, a new hypothesis is formed, and the scientific method is used all over again. When a conclusion is drawn, the research can be presented to others to inform them of the findings and receive input about the validity of the conclusion drawn from the research.

**Putting it all together on a display board! Here is an example, from Science Buddies, using the Scientific Process:**
Written Report Using the Scientific Process

At this point, you are in the home stretch. Except for writing the abstract, preparing your science fair project final report will just entail pulling together the information you have already collected into one large document.

- Your final report will include these sections:
  - Title page.
  - Abstract. An abstract is an abbreviated version of your final report.
  - Table of contents.
  - Question, variables, and hypothesis.
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○ Background research. This is a Research paper you wrote before you started your experiment.
○ Materials list.
○ Experimental procedure.
○ Data analysis and discussion. This section is a summary of what you found out in your experiment, focusing on your observations, data table, and graph(s), which should be included at this location in the report.
○ Conclusions.
○ Ideas for future research. Some science fairs want you to discuss what additional research you might want to do based on what you learned.
○ Acknowledgments. This is your opportunity to thank anyone who helped you with your science fair project, from a single individual to a company or government agency.
○ Bibliography.
● Write the abstract section last, even though it will be one of the first sections of your final report.
● Your final report will be several pages long, but don’t be overwhelmed! Most of the sections are made up of information that you have already written. Gather up the information for each section and type it in a computer if you haven’t already.
● Save your document often! You do not want to work hard getting something written the perfect way, only to have your computer crash and the information lost. Frequent file saving could save you a lot of trouble!
● Remember to do a spelling and grammar check. Also, have a few people proofread your final report. They may have some helpful comments!

**Steps of the Engineering Design Process**

The engineering design process is a series of steps that engineers follow to come up with a solution to a problem.

1. **ASK:** Students identify the problem, requirements that must be met, and constraints that must be considered.

   ● **What is the need or problem?** If there is a need that has not yet been fulfilled, the design process is for an invention. If there is a problem identified with an existing solution, the design process is for an innovation. Be it an invention or innovation, it is very important for the design team to fully understand the need or problem. Asking the people who need or use the product, speaking with experts, finding information online or in books, and analysis to identify the real problem, can do this.
   ● **What are its requirements:** Every need or problem has a set of requirements that are called criteria and constraints. Criteria are quality standard or features that can be
measured and need to be met for the design to be successful. Constraints are limitations on the design (examples of these are – size of design, material that can be used, cost of solution, etc.). During every step of the process, the design team compares their solution design against the constraints and criteria to ensure they are on the right track.

2. IMAGINE: Students brainstorm solutions and research ideas. They also identify what others have done.

- Brainstorming is to generate many different ideas.
- Research and investigate one or more of these ideas using online sources, books, and performing experiments.
- Are there any alternate solutions available that can fill one or more of the requirements? If yes, can the existing solution be modified to meet all the requirements?
- If not, the designer or team design one or more solutions to fit the problem.

3. PLAN: Students choose two to three of the best ideas from their brainstormed list and sketch possible designs, ultimately choosing a single design to prototype.

Choose one of the solutions generated, by asking these questions:

- Does the solution meet all the requirements?
- Is the raw material required for solution available?
- Is the raw material durable?
- Is the raw material cost-effective/affordable?
- Can the solution be manufactured locally?
- Is the manufacturing process cost-effective?
- Can the manufacturing process meet demand quickly?

4. CREATE: Students build a working model, or prototype, that aligns with design requirements and that is within design constraints.

- A prototype is an early single model of a product. It is built to test a solution. This is an easy, cost-effective way of finding mistakes or issues with the chosen solution and to test it among a small focus group, before you manufacture large quantities of it. 3D printing, for example, has become an easy, inexpensive and quick way to create prototypes and test them before release.

5. TEST: Students evaluate the solution through testing; they collect and analyze data; they summarize strengths and weaknesses of their design that were revealed during testing.

- Test the prototype to see if it meets all the requirements of the problem it is trying to solve. Quality of prototype and durability are also tested in this stage.
6. IMPROVE: Based on the results of their tests, students make improvements on their design. They also identify changes they will make and justify their revisions.

- Once issues in design, quality, durability and other areas have been identified in the prototype, the design team goes back to the drawing table to redesign the solution and improve the product. This entire process is important and sometimes repeated multiple times until the right solution has been identified and the design has been improved.

Putting it all together! Here is an example of a display board using the Engineer Design Process:

<table>
<thead>
<tr>
<th>Display Board example for Engineering Design and Invention Projects</th>
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</thead>
<tbody>
<tr>
<td><strong>Title</strong></td>
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<tr>
<td>Student Name</td>
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<tr>
<td>Background and Real World Connections</td>
</tr>
<tr>
<td>Engineering Question/Goals</td>
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<tr>
<td>Data and Results</td>
</tr>
<tr>
<td>Design Criteria/Design Process</td>
</tr>
<tr>
<td>Prototype Development</td>
</tr>
<tr>
<td>Includes Preliminary Designs, prototype building and testing, prototype redesigning and retesting</td>
</tr>
<tr>
<td>Photos with captions</td>
</tr>
<tr>
<td>Data Analysis and Conclusions</td>
</tr>
</tbody>
</table>

In Front of Display Board on Table: Project Notebook and any other materials you feel would be useful to explain and show how you ran and/or created your project.

The written report for the Design Process is the same as the Scientific Process.

**Project Display Guidelines**

NOT ALLOWED for Project Display
● Living organisms, including plants. Mold, even if enclosed, and bacteria are NOT ALLOWED.
● Taxidermy specimens or parts
● Preserved vertebrate or invertebrate animals
● Human or animal food
● Human/animal parts or body fluids (for example, blood, urine). Teeth that have been decontaminated may be exhibited if kept in sealed containers.
● Plant materials (living, dead or preserved) that are in their raw, unprocessed or non-manufactured state. (Exception: manufactured construction materials used in building the project or display)
● Chemicals, including water
● Poisons, drugs, controlled substances, hazardous substances or devices (for example, firearms, weapons, ammunition or reloading devices)
● Dry ice or other sublimating solids
● Sharp items (for example, syringes, needles, pipettes, knives)
● Glass or glass objects, unless deemed by the Display and Safety Committee to be an integral and necessary part of the project (Exception: glass that is an integral part of a commercial product, such as a computer screen)
● Flames or highly flammable materials
● Batteries with open-top cells
● Awards, medals, business cards, flags, endorsements and/or acknowledgments (graphic or written) — unless the item(s) are an integral part of the project. Display and Safety Committee decision
● Photographs or other visual presentations depicting vertebrate animals in surgical techniques, dissections, necropsies or other lab procedures
● Any apparatus deemed unsafe by the Scientific Review Committee or the Display and Safety Committee (for example, large vacuum tubes or dangerous ray-generating devices, empty tanks that previously contained combustible liquids or gases, pressurized tanks, etc.

Resources
The following list is from the University of North Carolina

- **The WWW Virtual Library** - Science fairs are held around the world. If you want to see what others are doing, this site has links to local, regional, state, foreign and even VIRTUAL science fairs.

- **Science Fairs and Science Projects** - This site contains everything that teachers and students need to know about science fairs including links to the best resources on the Internet. If you are looking for great science fair videos or any printed materials, check out this web site.

- **The Internet Public Library** - The IPL contains the Science Fair Resource Guide that offers teachers, students and parents a complete listing of web sites dedicated to science fairs and projects. The site provides links to how to do a science fair project, samples, ideas, magazines and resources. This site is arranged from the basic to the most detailed, with special notes to teachers and parents.

- **MadSci Net** - This site contains links and resources on everything you ever wanted to know about science fairs from age-specific ideas for projects to learn how to put a science fair together. Some of the links include: School Science Fair Homepage, Science Fair Idea Exchange, The Society of Amateur Scientists, Practical Hints for Science Fair Projects and Yahoo's listing of science fairs.

- **The Discovery Channel's Science Fair Studio** - The "Student" sections are Handbook, Project Ideas, Links and Books. The "Teacher" section deals with issues related to organizing a science fair. The "Parent" section titled "Helping Your Young Scientist" emphasizes that the most important outcome of your child's science project is the joy and learning that comes from scientific discovery—not winning a competition! It provides helpful hints to parents about selecting a project and resources available.

- **Intel International Science and Engineering Fair** The ISEF is the Olympics, the World Cup and the World Series of science competitions. Held annually in May, the Intel ISEF brings together over 1,200 students from 48 states and 40 nations to compete for scholarships, tuition grants, internships, scientific field trips and the grand prize: a trip to attend the Nobel Prize Ceremonies in Stockholm, Sweden. Science Service founded the ISEF in 1950 and is very proud to have Intel as the title sponsor of this prestigious, international competition.

- **Science Buddies** - Hands-on scientific investigations are acknowledged to be the best way to teach science literacy. Science Buddies supports these activities by providing free science fair project ideas, answers, and tools to teachers, parents, and students from all walks of life. Our objective is to save our users' time while guiding them to a successful outcome. By reducing the hassles of doing a science fair project, Science Buddies aspires to improve project quality and increase science fair participation, turning a good learning experience into a great one.