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Introduction

Thank you for serving as a judge at the annual George Washington Carver Science Fairs.

The Carver Science Fairs encourages urban youth to pursue academic achievement, careers in science, civic involvement, and character development. Jointly sponsored by The School District and The Archdiocese of Philadelphia, Temple University, and the Academy of Natural Sciences of Drexel University, the Fairs are open to all Philadelphia public, charter, parochial, and private school students, and students in out-of-school time programs, in grades four through twelve. Since its inception in 1979, tens of thousands of students have participated in the Carver Science Fairs and have, in many cases, moved on to compete in the Delaware Valley Science Fair.

As in previous years, the interviewing day includes the opportunity to network with colleagues, a continental breakfast, project evaluations, a buffet lunch, and individual student interviews. Judges also receive free parking.

What Are We Judging?

Your main concerns are with the kinds of questions the project answers and the extent to which the project mimics what scientists actually do in an investigation. The project must involve experimentation, laboratory, field, or theoretical work. If the project was done at a research or industrial facility, you should determine the degree of independence of the student in conducting the project. See form 1C (Regulated Research Institution/Industrial Setting).

Descriptions of Elementary School Project Categories

Consumer Science
Study or comparison (including business applications) of products, systems, or materials used by consumers in homes, workplaces, schools, recreation, etc.

Earth Science
Study of the processes that are carried out on our planet. Earth Science covers soil, air, and water.

Life Science
Study of how organisms operate, from bacteria to dinosaurs.

Physical Science
Study of energy and non-living matter.

If you feel that the project is in the wrong category, don't rate it as high. The students and teachers pick the category.

Descriptions of Secondary School Project Categories

Behavioral and Social Sciences
Human and animal behavior, social and community relationships—psychology, sociology, anthropology, archaeology, ethology, ethnology, linguistics, learning, perception, urban problems, reading problems, public opinion surveys, educational testing, etc.

Biochemistry
Chemistry of life processes—molecular biology, molecular genetics, enzymes, photosynthesis, blood chemistry, protein chemistry, food chemistry, hormones, etc.

Botany
Study of plant life—agriculture, agronomy, horticulture, forestry, plant taxonomy, plant physiology, plant pathology, plant genetics, hydroponics, algae, etc.

Chemistry
Study of nature and composition of matter and laws governing it—physical chemistry, organic chemistry (other than biochemistry), inorganic chemistry, materials, plastics, fuels, pesticides, metallurgy, soil chemistry, etc.

Computer Science
Study and development of computer hardware, software engineering, internet networking and communications, graphics (including human interface), simulations/virtual reality or computational science (including data structures, encryption, coding and information theory).

Consumer Science
Study or comparison (including business applications) of products, systems, or materials used by consumers in homes, workplaces, schools, recreation, etc.

Earth and Space Sciences
Geology, mineralogy, physiography, oceanography, meteorology, climatology, astronomy, speleology, seismology, geography,

Engineering
Technology; projects that directly apply scientific principles to manufacturing and practical uses —civil, mechanical, aeronautical, chemical, electrical, photographic, sound, automotive, marine, heating and refrigerating, transportation, environmental engineering, etc.

Environmental Science
Study of pollution (air, water, and land) sources and their control; ecology

Mathematics
Development of formal logical systems or various numerical and algebraic computations, and the application of these principles—calculus, geometry, abstract algebra, number theory, statistics, complex analysis, probability.

Medicine and Health
Study of diseases and health of humans and animals—dentistry, pharmacology, pathology, ophthalmology, nutrition, sanitation, pediatrics, dermatology, allergies, speech, hearing, etc.

Microbiology
Biology of microorganisms—bacteriology, virology, protozoology, fungi, bacterial genetics, yeast, etc.

Physics
Theories, principles, and laws governing energy and effect of energy on matter—solid state, particle, nuclear, atomic, plasma, superconductivity, fluid and gas dynamics, quantum mechanics, thermodynamics, optics, acoustics, semiconductors, magnetism, biophysics, etc.

Zoology
Study of animals—animal genetics, ornithology, ichthyology, herpetology, entomology, animal ecology, paleontology, cell physiology, circadian rhythms, animal husbandry, cytology, histology, animal physiology, invertebrate neurophysiology, studies of invertebrates, etc.

If you feel that the project is in the wrong category, don't rate it as high. The students and teachers pick the category.

Elements of a Successful Project

1) Project Data Book

Accurate and detailed notes make a logical and winning project. Make sure each entry is dated. Data tables are also helpful; they may be a little 'messy' but be sure the quantitative data recorded is accurate and that units are included in the data tables.

2) Abstract

The abstract needs to be a maximum of 250 words on one page. An abstract should include the a) purpose of the experiment, b) procedures used, c) data, and conclusions. It also may include any possible research applications. Only minimal reference to previous work may be included. The abstract must focus on work done in the current year and should not include a) acknowledgments, or b) work or procedures done by the mentor.

3) Visual Display

Easy for interested spectators assess the study and the results obtained. Convinces them that the research is of sufficient quality to deserve scrutiny. Make the most of space using clear and concise displays.

a) Current Year. Make sure the board reflects the current year's work only. Prior year's data books are permitted at the project.

b) Good Title. A good title should simply and accurately present the research and depict the nature of the project. The title should make the casual observer want to know more.

c) Photographs. Many projects involve elements that may not be safely exhibited at the Fair, but are an important part of the project; photographs of important parts/phases of the experiment should be used in the display. Credit must be given for all photographs.

d) Well-Organized. Make sure the display follows a sequence and is logically presented and easy to read. A glance should permit anyone (particularly the judges) to locate quickly the title, abstract, experiments, results, and conclusions. Graphs that show the relationships of the two variables tested.

e) Eye-Catching. The display should be neat and exhibit colorful headings, charts, and graphs. Pay special attention to the labeling of graphs, charts, diagrams, photographs, and tables to ensure that each has a title and appropriate label describing what is being demonstrated. Anyone should be able to understand the visuals without further explanation.

f) Correctly Presented and Well-Constructed. Please Note: *You are judging the research, not the display.* So, don't spend an excessive amount of time on the board. Judge on the science, not the show!

How to Conduct Good Interviews

Being a judge for the George Washington Carver Science Fair is challenging, but it's worth the effort. You are making a memorable impact on the lives of talented young people. For some students, you are the first professional they have ever met who does a science or engineering job for a living. Part of your job at the Science Fair is to be an ambassador for your profession. Students' perceptions of you could influence their career choices. It is a good idea when you approach a student to introduce yourself and describe your background.

GENERAL GUIDELINES

Every student must be interviewed.
This ensures that each project is seen by a sufficient number of judges to ascertain its potential for winning. This is also the student's opportunity to meet with professional scientists and engineers. The interview should be an educational experience for the students.

The judging process must be as fair as possible and must appear as fair.
Students are to give only their first name. Please don't ask for their last name or the name of the school they attend. These have also been left off the boards on purpose, to ensure fairness.

Your fairness is indicated by a few *simple actions*:

- You spend about the same amount of time with each student (no more than 10 minutes!)
- You listen to the student's explanation of the project
- The questions you ask are intended to find out more about the project and how it was done—*not* to embarrass or intimidate the student

Every student should be treated with respect.
Students and their projects should be treated with due consideration, even if the science is flawed. The goal is to have students leaving the Carver Fair knowing more than when they arrived and feeling good about themselves and their project, so that they will continue to pursue science and engineering. Please do your best to make sure that all of the participants remember the Carver Fair as a positive experience.

Every student should receive a student evaluation feedback form.
Students value your feedback. Since judges are unable to spend a large amount of time with students, we ask that after you have decided the winners of your category, your judging team provides each student with at least one completed Student Evaluation form (ideally, one form from each judge if time permits). Please keep in mind that these are meant to encourage students to continue their participation in future fairs, but it is also important not to give all high or excellent marks to students who were not chosen as winners. Give them tips on ways they might improve to create a winning project in the future.

INTERVIEWING
The most important aspect of this fair is that *all students* come away with a *positive experience*.

- Students are to give only their first name—don't ask for a last name or the school they attend. We have asked them not to include this information so we can eliminate any bias.
- Try to put students at ease; they are all nervous.
- Remember the age level of the students you are interviewing—some are only 9 or 10 years old.
- Listen carefully to what the students have to say.
- Encourage students rather than criticize them.
- Reward students through your comments for all their effort, etc.
- Explain what could be done differently next time to improve the project.
- Interview students as a team, with only one person asking questions. Other team members may ask questions at the end.
- At the conclusion of the interview, ask the student if there is anything that they wish to add.
- Please don't discuss the project's merit in front of the student.
- Begin interview by asking what the project is all about and how they became interested in this topic.
- Try to get a clear answer from the student on what they learned from the project—what was their conclusion.
- Asked who helped them—remember, we encourage parental participation—but the student must be able to explain their experiment and demonstrate understanding.
- Ask how could they change, extend, or improve the project?
- Remember, you are meeting very motivated students, many who have been working on their project for 3 or 4 years. This is an asset.

Every interview should last about 10 minutes.
An interview of less than 5 minutes cannot satisfactorily determine the extent of a student's knowledge of his/her project, while interviews of longer than 15 minutes will slow the judging process and may result in other students not having enough time with judges.

Every interview should have educational value.
The interview should provide some educational benefit to the student, particularly those who are not serious contenders for a prize. Your approach and the nature of your questions will educate the student as to how a scientist thinks, and about the questions they should be asking themselves about their project. Your interview could set the student on the track to a better project for next year.

However, the student should be doing most of the talking during an interview. Some judges have been observed to pontificate enthusiastically while a student stood idly listening. The interview is not a good opportunity for this, no matter how much it might benefit a student to listen to you.

Try to put students at ease.
Be aware that the students are all very nervous. As a judge, you will need to *reduce the intimidating image* that you will have to most students. The more you can do so, the more likely you are to reduce student nervousness, and to have a better interview discussion.

Simple actions by a Judge can make a difference:

- Make eye contact with the student.
- If the student is short and you are tall, stoop, bend, or squat down to lower your eye level (if your knees won't allow this, ask to judge the Secondary School category).
- Tip your head to the side a little to indicate interest (this is a universal nonverbal form of communication; even your dog does it).
- If you wear glasses, look at the student through them, not over the top of the frames.
- Whenever a student shows a good idea, a clever way to get extensive results with inexpensive equipment, or anything you can compliment, be sure to use a compliment.
- Use a tone of voice indicating interest or inquisitiveness, not skepticism or contempt.

Asking Good Questions in the Interview
Your best tool in judging is your ability to ask questions. Be sensitive to what the student knows. Remember, too, the age level of the students you are interviewing. Some in the 4th-6th grade Fair are only 9 or 10 years old.

You can always ask questions that the student can answer, and keep a conversation going. There are *some questions all students should be able to answer*, including variations on:

- How did you come up with the idea for this project?
- What did you learn from your background search?
- How long did it take you to build the apparatus? How did you build the apparatus?
- How much time did it take to run the experiments (collect each data point)?
- How many times did you run the experiment with each configuration?
- How many experiment runs does each data point on the chart represent?
- Did you take all data (run the experiment) under the same conditions, *e.g.*, at the same temperature (time of day) (lighting conditions)?
- How does your apparatus (equipment) (instrument) work?
- What do you mean by (terminology or jargon used by the student)?
- Do you think there is an application in industry for this knowledge (technique)?
- Were there any books that helped you do your analysis (build your apparatus)?
- When did you start this project? (Or) How much of the work did you do this year? (Some students bring last year's winning project back, with only a few enhancements.)
- What is the next experiment to do in continuing this study?
- Are there any areas that were not have covered which you feel are important?
- Do you have any questions for me?
- (At the conclusion of the interview) Is there anything you would like to add?

(Note: these are only suggestions to keep the dialogue going. You may find other questions to be more useful in specific interviews.)

Things to Avoid in the Interview
One *type of question to avoid* is "Why didn't you do …?" A solution to or extension of the work presented may be obvious to you, with all of your years of experience, but the student may not understand why you're asking such a question. If you ask a question of this type, be sure to imply the correct intent, as in "Could you have done …?" or "What do you think would have happened if you had done …?" When phrased this way the question is an invitation for the student to think about the experiment in a different way and can turn the question into a positive experience.

Please *avoid lecture-style teaching* during interviews. You may come across a project in a technical area with which you are intimately familiar, but where the student just didn't get it. The student may have made some incorrect assumptions, come up with a false conclusion, or the like. It can be tempting to share your knowledge about the topic, but this is not the opportunity to expound at length on the subject.

You may try with your questions to lead the student toward the right answers, but *please don't give the answers*. If you really feel compelled to make explanations, save them until near the end of the judging time. Alternatively, you may give the student your card and invite future discussion about the project.

Special Situations
A student may monopolize your time with a well-rehearsed pitch that prevents real interaction between you. The best way to break into such a patter is with a polite interrupting inquiry: "I'm sorry, I didn't quite catch the relationship between that adjustment and this result" or "How many experimental runs are represented by each data point?" This will stop his/her tape recording and get the student to think about what is being communicated to you.

When facing an incredibly impressive display and a bright or supremely confident student you may feel that the student's research is beyond your knowledge. However, even if a project is truly outside your experience, you are still knowledgeable in the area of problem solving and the process of science. Concentrate on these aspects rather than on the details of a particular project. If you are unclear about a project, focus your questions on those aspects most familiar to you and continue to familiarize yourself with the project's process, procedures, intent, and outcomes. Remember, too, that you are not the only judge who will talk to the student. If something is not completely clear, bring it up later in the judging meeting. Judges who are familiar with the applicable science will have sorted it all out.

At the other extreme, a few projects are "snow jobs." *However, do not underestimate the student.* Students may have worked in conjunction with personnel in a university or industrial laboratory. Form 1C must be displayed and if not, ask to see it. (Also, see section entitled, Comparing Projects That Aren't Comparable.) If you think the student did not produce the project, it will become apparent if you ask for explanations of words that the student uses. Don't just assume a student knows what a technical term means. They may also not know what a piece of equipment does, how it works, or why it was used. Students should be able to explain the components of their project to your satisfaction. Chances are if it doesn't make sense to you, it doesn't make sense. Of course, as with all questions or concerns that arise, discuss these projects during the judging meeting. There will probably be others on your panel of Judges with similar reservations.

Special Note: Items may have been removed from the display that for safety reasons were disallowed.

Evaluation Criteria

Judging is conducted using a 100-point scale with points assigned to
the research question (10),
design and methodology (15),
data collection, analysis, and interpretation (20),
creativity (20), and
presentation (35).

Following is a list of criterion that can assist you in interviewing the students and aid in your evaluation of the student project. *You are looking for good research and the use of scientific methods.* However, engineering, computer science, mathematics, and some theoretical physics do not follow the traditional scientific method and use different criteria. The ISEF Judges Scoring Rubric of the point values is located at the end of these criteria.

Scientific Thought

(If an engineering project, the more appropriate questions are those found in Engineering Goals.)

1) Is the *problem stated clearly* and unambiguously?

2) Was the *problem sufficiently limited* to allow plausible attack? Good scientists can identify important problems capable of solutions.

3) Was there *a procedural plan* for obtaining a solution?

4) Are the *variables* clearly recognized and *defined*?

5) If *controls* were necessary, did the student recognize their need and were they correctly used?

6) Are there *adequate data* to support the conclusions?

7) Does the student or team recognize *the data's limitations*?

8) Does the student/team understand the project's ties to *related research and applications*?

9) Does the student/team have an idea of what *further research* is warranted?

10) Did the student/team cite *scientific literature, or only popular literature* (i.e., local newspapers, Reader's Digest)?

Engineering Goals

1) Does the project have a clear objective?

2) Is the objective relevant to the potential user's needs?

3) Is the solution workable? …acceptable to the potential user? …economically feasible?

4) Could the solution be utilized successfully in design or construction of a product?

5) Is the solution a significant improvement over previous alternatives?

6) Has the solution been tested for performance under the conditions of use?

Thoroughness

1) Was the purpose *carried out to completion* within the scope of the original intent?

2) How complete are the project notes?

3) Where *did the equipment come from?* Did the student or team build it independently? Was it obtained on loan? Was it part of a laboratory where the student or team worked?

4) Are the conclusions based on a single experiment or *replication*?

5) Is the student/team *aware of other approaches or possible explanations*?

6) Is the student/team *familiar with* scientific literature in *the studied field*?

Creativity

1) Does the project *show creative ability* and originality in
    the questions asked?
    the approach to solving the problem?
    the analysis of the data?
    the interpretation of the data?
    the construction or design of new equipment?

2) *Creative research* should support an investigation and help answer in an original way.

3) A creative contribution promotes *an efficient and reliable method for solving a problem*. When evaluating projects, it is important to distinguish between gadgeteering and ingenuity.

Presentation

1) How clearly does the student discuss his/her project and *explain the purpose, procedure, and conclusions*?

2) Does the *written material reflect* the student or team's *understanding of the research*?

3) Are the important phases of the project *presented in an orderly manner*?

4) How clearly are the *data presented*?

5) How clearly are the *results presented*?

6) How well does the project *display* explain the project?

	Excellent/ Expert	Good/ Proficient	Needs Improvement/ Emergent	Not Present/ Novice	
Research Question (10 pts)	**10-9** ● Clear & focused purpose ● Identifies contribution to field of study ● Testable using scientific methods	**8-6** ● Research question has minor clarity and focus issues ● Research question is not fully testable	**5-3** ● Research question is not answerable or does not fit with the actual experiment performed	**2-0** ● No attempt to define a research question	
Design & Methodology (15 pts)	**15-12** ● Well designed plan and data collection methods ● Variables and controls defined, appropriate, and complete	**11-8** ● Method had minor flaws, but an attempt for control or comparison was made	**7-4** ● Method was inappropriate, but an attempt for control or comparison was made	**3-0** ● Experimentation was not performed (i.e., demonstration or exhibit). ● No control group present	
Execution: Data Collection, Analysis, & Interpretation (20 pts)	**20-16** ● Systematic data collection and analysis ● Reproducibility of results ● Appropriate application of mathematical and statistical methods ● Sufficient data collected to support interpretation and conclusions	**15-11** ● Minor errors or flaws in technique(s) ● Measurements mostly accurate and precise	**10-6** ● Major errors or flaw in technique(s) ● Little attention paid to accuracy and/or precision ● Too few trials or sample size too small	**5-0** ● No techniques reported ● No accuracy or precision in measurements	
Creativity (20 pts)	**20-16** ● Project demonstrates significant creativity and originality in two or more of the above criteria	**15-11** ● Project demonstrates creativity in the one of the above criteria	**10-6** ● Project demonstrates some creativity – a new twist on an old experiment	**5-0** ● Project lacks creativity: experiment copied exactly from a published source	
Presentation: Poster (10 pts)	**10-9** ● Logical organization of material ● Clarity of graphics and legends ● Supporting documentation displayed	**8-6** ● Information and results displayed somewhat organized, some difficulty in following ● Minor errors in graphics or legend ● Some background information given	**5-3** ● Information and results could be more organized, major difficulty in following ● Major errors in graphics or legends ● Little or irrelevant background information given	**2-0** ● Unorganized poster ● Graphics or data tables missing ● No supporting documentation of research provided	

Presentation: Interview (25 pts)	**25-20** ● Clear, concise, thoughtful responses to questions ● Understanding of basic science relevant to project ● Understanding interpretation and limitations of results and conclusions ● Degree of independence in conducting project ● Recognition of potential impact in science, society, and/or economics ● Quality of ideas for further research	**19-14** ● Clear, concise, thoughtful responses to almost all of the questions ● Student has some misconceptions about the science related to the project ● Student can answer most questions posed, but had not really given ideas much thought prior to interviews	**13-7** ● Student cannot answer some questions clearly, but generally understand his/her project ● Student can answer a few questions posed to some extent, but had not really given ideas much thought prior to interviews	**6-0** ● Student unable to explain their project ● Student unable to explain the science related to their project. ● Student did not conduct this project independently – parent did all of the work ● Students can not communicate any ideas for future research	

Selecting Winners

Although each Judge will score each student project individually, all the panel judges will do selecting the winners in a category together. In categories with a large number of entries, there will be at least two panels of judges who are evaluating different set of projects. The two panels then confer and share their judgments to arrive at the final awards for the category.

BASIC GUIDELINES

Each category must have a single first place winner.
Since you are judging projects in comparison to each other, rather than to an outside standard, there will be one project that is the best. This will be the first place winner. There will also be *one* winner for second and third places.

Please limit honorable mentions.
Although students need recognition, it is important that the awards are meaningful. As a guideline, there should be no more than one or two honorable mentions per 10 projects. This number is entirely at the discretion of the judging panels, however. There may be more exemplary projects, or fewer, in your category than usual. Some categories also have more projects than others do, which will affect the number of honorable mentions.

Some simple guidelines for judging
The process of deciding on final winners can be a difficult one. Judges of different backgrounds and experience will naturally have different scores for each project. In the final discussion, it is important for judges to listen to one other in an open-minded manner and to be clear about the reasons for their own viewpoint and scoring. It helps if everyone uses the same guidelines in judging and the same evaluation criteria (which follow this section.)

However, the point system is a guide only—the final awards come from consensus. If judges are "deadlocked," the majority must rule. A filibuster by one person or group, or a random coin toss, is not professional methods to use here.

- The quality of the student's work is what matters, not the amount of work.
- If the project is one you have seen done before, remember that it is new to the student. How the student approached and carried out the project is the basis for judging it.
- Do not assume that a young student could not do a highly sophisticated or ambitious project. Some students are very capable. Some have been conducting science projects for many years. The interview process will allow you to assess how independently the student worked and how much the project is his/her own.
- With projects that have been continued over a number of years, judge this year's work only. Do not penalize continuous work. Many students continue a project because of suggestions and guidance from Science Fair Judges or other mentors. Ongoing research is appropriate.
- Team projects are judged like other projects—it is the quality of the work that matters (an individual project of equal quality to that of a team project may be ranked higher because of the comparatively greater effort required by the individual.)
- *A less sophisticated project that the student understands gets higher marks than a more sophisticated project that is not understood.*
- *Access to sophisticated lab equipment and endorsements from professionals do not guarantee a high quality project (Did the student really understand what was going on?)*
- Conversely, do not penalize work that has been done in an outside lab or institution. Most students who work at this level have worked quite independently.
- It's okay if the student ended up disproving the objective or hypothesis of the experiment.

High marks should go to:

- Genuine scientific breakthroughs
- Discovering knowledge not readily available to the student
- Correctly interpreting data
- A clever experimental apparatus
- Repetitions to verify experimental results
- Predicting and/or reducing experimental results with analytical techniques
- In engineering categories, experiments applicable to the "real world"
- Ability to clearly portray and explain the project and its results

Low marks go to:

- Ignoring readily available information (e.g., not doing basic library research)
- An apparatus (e.g., model) not useful for experimentation and data collection
- Improperly using jargon, not understanding terminology, and/or not knowing how equipment or instrumentation works
- Presenting results that were not derived from experimentation or data (e.g., literature search)

COMPARING PROJECTS THAT AREN'T COMPARABLE

Projects with different levels of sophistication

One of the most difficult judging tasks is comparing projects carried out in university or industrial laboratories under professional guidance with projects done at home with no professional help. Judges should not be in the position of arguing that a particular student would have done much better (or poorer) had only they had access (or no access) to state of the art equipment.

Among students with access to professional laboratories, every year there are those for whom the facilities are the enabling mechanism for their efforts, and there are those for whom the facilities are a mask for little effort. Both types of students should be judged on their personal scientific accomplishment and their *use* of these resources.

Students who work on their own may appear to be at a disadvantage but the interview is where the playing field is leveled. It is vital to identify how the student made a difference in the direction of the project.

Regardless of where the science project is conducted, good scientific principles and engineering practices must be evident. The student's level of scientific understanding should be consistent with the project's level of technical sophistication and complexity. Judges should apply this standard in evaluating the student's project.

TEAM PROJECTS VS. INDIVIDUAL PROJECTS

Judging the Science

It is important that judges keep in mind that all projects, regardless of the number of participants, are to be evaluated primarily on the quality of the personal contribution(s) of the student(s) to the science in evidence. In order for the judge to be able to evaluate the level of science of a team project, it is essential that all students in the team participate in the interview (unless otherwise acknowledged).

All students on the team should have general and specific knowledge of the project such as how the question was conceived and subsequently answered. The judge has the freedom to ask a question of anyone in the group. However, the judge should be aware that the group has the equivalent freedom to choose a spokesperson and may refer a particular question to a specialist.

Judging the Effort

In judging a team project versus one done by an individual, it is fair to have a higher expectation of the team projects regarding the overall level of effort involved in the project. In other words, team projects have greater resources (the number of minds working together) and therefore a greater capacity for more research and data collection, more time, effort, and thought spent on the project, and more analysis than someone acting alone.

There also must be evidence of team collaboration and synergy among team members (which should become evident during the interview process). In particular, the judge should try to ascertain how fully the resources of the group have been exploited. Remember that one of the primary goals of team projects is to encourage students to work as a team (mimicking the way science is done in the real world), and to encourage project management. Each team member should have made a significant contribution to the overall project.

Judging Criteria for Engineering Projects

Research Problem:

- description of a practical need or problem to be solved
- definition of criteria for proposed solution
- explanation of constraints

Design and Methodology:

- exploration of alternatives to answer need or problem
- identification of a solution
- Is the solution workable?
- Is the solution economically feasible?
- development of a prototype/model

Execution: Construction and Testing

- Prototype demonstrates intended design
- prototype has been tested in multiple conditions/trials
- prototype demonstrates engineering skill and completeness

Creativity:

- in the use of instruments
- in the design or construction of new instruments
- project demonstrates significant creativity in one or more of the above criteria

Presentation:

a. Poster

- does it attract attention?
- logical organization of material
- clarity of graphics and legends
- supporting documentation displayed
- what parts of the display were created by the student? Were others involved?

b. Interview

- clear, concise, thoughtful responses to questions
- understanding of basic science relevant to project
- understanding interpretation and limitations of results and conclusions
- degree of independence in conduction project
- recognition of potential impact in science, society and/or economics
- quality of ideas for further research
- for team projects, contributions to and understanding of project by all members.

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Instructions for Category Judges

BEFORE JUDGING STARTS:

1. Let the staff at the Judges' Table know you have arrived. (Special Awards Judges should go to the staff at the Special Awards Table.)

2. Pick-up a Judge's Folder (and post-it notes for the Head Judge.)

3. Choose the category that you want to judge and put your name in one of the empty slots on the Category Posters. Each category will be divided by grade level, with a team of two Judges plus one Head Judge. (If you have been a Judge more than once at the Fair in this category, please consider signing on as the Head Judge.) Each grade level may be further divided into lettered “panels” if there are a large number of entries, with each lettered “panel” having its own team of Judges. Write down the project ID numbers (next to the slot where you sign your name) for reference.

JUDGING THE PROJECTS:

4. The team should meet at one of the Category Tables during breakfast, or at your first project ID number after breakfast.

5. Each individual Judge uses their own Judges' Scoring Summery Grid to grade the projects.

6. In the morning session, after all Judges examine a project, the Head Judge places a blank post-it note next to the project’s number on the table.

7. During lunch, the team discusses the results and prepares questions for the interview.

8. Interview students as a team, with only one person asking questions. Other team members (and any Special Awards Judges) may ask questions at the end. **Every interview should last about 10 minutes.** An interview of less than 5 minutes cannot satisfactorily determine the extent of a student’s knowledge of his/her project, while interviews of longer than 15 minutes will slow the judging process and may result in other students not having enough time with Judges. A student may monopolize your time with a well-rehearsed pitch that prevents real interaction between you. The best way to break into such a patter is with a polite interrupting inquiry: "I’m sorry, I didn’t quite catch the relationship between that adjustment and this result" or "How many experiment runs does each data point on the chart represent?"

9. In the afternoon session, after the team of Judges interview a student, the Head Judge places a large “X” on the post-it note.

AFTER THE INTERVIEW:

10. Although each Judge will score each student project individually, the team of Judges will select the winners in a category/grade together. In grades with a large number of entries, there will be at least two teams of Judges who are evaluating different set of projects. All teams in a category/grade then confer and share their judgments to arrive at the final awards. The Head Judge(s) complete the Category Winners Form with their names and e-mail addresses, and return it to the Projects Table.

11. **Every student should receive a Student Feedback Form.** Students (and parents) value your feedback. Since Judges are unable to spend a large amount of time with students, we ask that after you have decided the winners of your category, your team provides each student with a completed Student Feedback Form. Please keep in mind that these are meant to encourage students to continue their participation in future fairs, but it is also important not to give all high or excellent marks to students who were not chosen as winners. Give them tips on ways they might improve to create a winning project in the future.

Q: What makes for a good science fair project?
Bill Robertson
Science and Children; Dec 2007; 45, 4; Education Module
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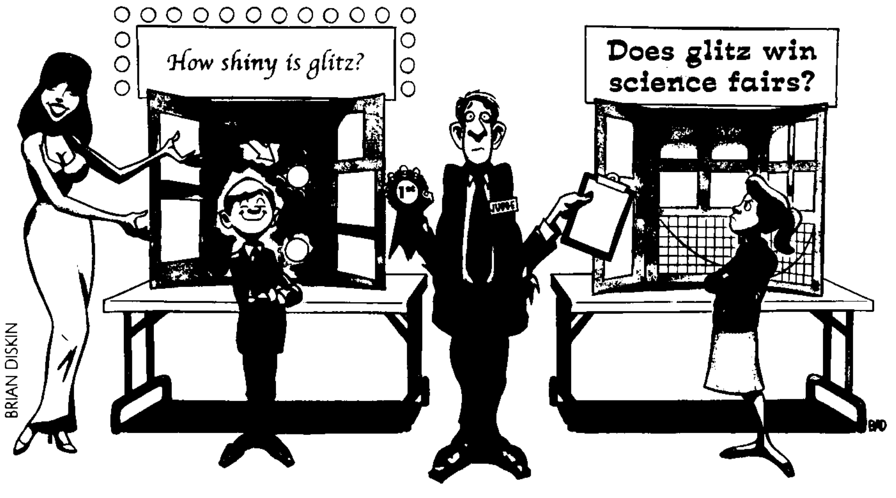
By Bill Robertson



A: Ah, one of my pet peeves. I used to judge a lot of science fairs, but I stopped because I seldom agreed with the evaluations of the other judges. Our main point of disagreement usually centered on glitz versus substance. No doubt about it—a science fair project that *looks* impressive tends to sway the judges. Of course, I had other disagreements with other judges, so I'm glad for the opportunity to suggest what people should look for in judging science fairs, and thus what students should focus on in doing the projects. My main concerns are with the kinds of questions the project answers and the extent to which the project mimics what scientists actually do in an investigation.

Choosing the Right Question

One way to address this issue is to name a few questions that are *not* good for science fair projects. "Why is the sky blue?," "Can plants survive without water?," and "What causes volcanoes?" are examples of questions that aren't so great. The reason they're not great is that scientists already know the answers to those questions. A student doing a project inspired by such questions is simply learning a concept and reporting on it. Now, that's okay for a science classroom. It's good to learn answers to those questions and students can use inquiry to answer those questions. The purpose of a science fair, though, should be for students to answer a question, the answer to which cannot be found in a textbook. Here are a few questions for which you won't find textbook answers and which might be pretty interesting for students to answer:

- Does chewing gum help students do better in school?
- Does playing video games improve your reactions and your memory?
- Do people in certain-colored cars obey traffic laws better?

These happen to be actual science fair questions I've come across over the years. The students who posed the questions had various reasons for asking the questions, but the important thing was that the students genuinely wanted to know the answers to these questions. Clearly, finding out that chewing gum helps you do better in class or discovering that playing video games is good for you are pieces of information useful for the average student. Beyond that, though, the questions lend themselves to true investigation.

Do What Scientists Do Rather Than Follow the "Scientific Method"

In the heading for this section, the words scientific method are in quotes because there are disagreements as to what constitutes the scientific method. There is a "textbook" definition, though, that goes something like the following:

- Ask a Question
- Do Background Research
- Construct a Hypothesis
- Test Your Hypothesis by Doing an Experiment
- Analyze Your Data and Draw a Conclusion
- Communicate Your Results

Anyone who has done basic research in any scientific discipline can tell you that scientists only rarely follow this kind of structured approach. Although scientists might begin with a general question, this is followed by a whole bunch of messing around with things to become familiar with the territory. This messing around leads to refinement or even restructuring of the original question, and it might lead to a totally new question. Let me give you an example from my own research and then an example of how this might apply to a science fair project.

When I began graduate work in science education and cognitive science, I wanted to study the difference between people who understand science and people who memorize science. From my experience I knew there was a difference, but I had only primitive ideas of how to determine the difference. It took me a year and a half to get to where I knew how to conduct my research. Part of that was spent researching what others had done, part was spent simply talking to physics students, and part was spent talking to physics professors. My advisor gave me great advice in the beginning, which was to define *understanding* and *memorization* for myself before researching what others had done. That helped me keep my own perspective on the issue rather than simply parrot what other researchers thought. So, I did a lot of messing around before I formulated any kind of researchable question. The bottom line was that I didn't formulate a hypothesis and then jump into my experiments.

Let's apply that to the chewing gum question. To approach this as a scientist might, one should spend a fair amount of time observing other students and talking to teachers in an effort to define what one means by "doing better in school." Do you look at test scores alone? Does attentiveness in class count? There are lots of ways of determining how well one does in school, and you have to refine things down to a specific measure of performance in order to get meaningful results. You also should simply observe students chewing and not chewing gum in a variety of school situations (gotta find a sympathetic teacher to allow you to do this one!). In the process, you might find behaviors related to chewing gum in class that have nothing to do with your original question. For example, you might discover that kids who chew gum in class tend to talk less. How does that relate to performance, or does it relate to performance at all?

Controlling Variables

One of the most difficult things for students to do is figure out how to structure an investigation so as to focus on the question you're asking while minimizing the effect of other factors. For chewing gum in class, you want to be able to control such contributing factors as the time of day, the day of the week, the style of the teacher, the health of the students, and the prior performance of the students. Suppose you are going to measure performance with before and after tests. It would be a good idea to give students various kinds of tests without gum chewing involved at all, so you know something about how much students either improve or don't improve based on things other than gum chewing. In other words, you have to mess around with things again before settling on a procedure. A student who does a good job of messing around and has seriously addressed the issue of controlling variables should be commended for a job well done, even if it means not "finishing" the project with a distinct conclusion.

Sometimes You Discover Nothing

Often scientists learn nothing from an experiment other than how to restructure the experiment. Neat, clean results are the exception rather than the rule. Yet, I have seen many science fair judges mark students down for not getting those neat, clean results. It's okay to learn nothing from an experiment other than what you did wrong, because that's a common result in science. This is especially true given the relatively short amount of time students have for a science fair project. If scientists can go years without a decisive answer to a question, why expect students to get that decisive answer in a month or two?

Judge the Process More Than the Result

Given the short amount of time students have to complete a project, given that questions that truly interest the student are likely to be complicated and difficult to define, and given that true scientific investigation seldom follows the structured steps outlined in the typical expression of the scientific method, it makes sense to grade students with a greater emphasis on the process of the investigation than on an eye-catching, snazzy finished product. In this way, the students gain a better understanding of scientific investigation and learn to focus on what scientists do rather than on how much mom and dad can help them create a cool-looking report.

I should end by saying that, over the years, I have seen improvement in what schools require in a science fair project. It is more and more common to find requirements that the students do an experiment rather than a report. That said, there is still too much reliance on the structured scientific method and not enough focus on, or understanding of, what scientists really do. Needless to say, the judges one uses for a science fair have at least as much influence on what the students get out of the experience as do the requirements outlined by the school.

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G.W. CARVER SCIENCE FAIR
JUDGES EVALUATION FORM

The Carver Committee sincerely appreciates your taking the time and energy to serve as a judge at this year's fair. We want to make the judging experience as enjoyable and effortless as possible, and would appreciate your feedback so that we can make improvements for next year's event.

Category: __________________________________ Grade Level: _______________

1. Please rate the following:

	Strongly agree	**Agree**	**Neither agree or disagree**	**Disagree**	**Strongly disagree**
a. Overall, the judging process ran smoothly.					
b. The material in the judging folder was helpful.					
c. The science fair was well-organized.					
d. I would be willing to invite my colleagues to volunteer for next year's science fair?					

2. Please rate the following:

	Excellent	**Very Good**	**Good**	**Fair**	**Poor**
a. information/communication prior to judging day					
b. morning refreshments					
c. morning orientation					
d. lunch					
e. facilities					
f. parking					

3. How could the Carver Science Fair be improved? (Feel free to use the back of this form for additional comments.)

Please return this form to a Carver Committee member at the end of the day. Thank you!