A teacher was wondering how to arrange the science fair boards so here is a quick review of what the boards should contain and the order in case you or your students are wondering the same thing. . .

The three science fair boards should read like a scientific paper except that the writing should be understandable by the general public. We assume that the public reads left to right up to down as it would read a newspaper article written in column format.

1. INTRODUCTION: At the top left on the first board one normally writes the motivation for the project and some introductory information that was obtained from the library, Internet, or practical experience.

2. QUESTION: The problem being investigated is stated informally. For example, young engineers may ask: "Is it possible to build a working hovercraft using materials found locally?"

A young scientist might ask: "Since plants evolved under sunlight that contains ultraviolet rays, will this component of light alone aid their growth. Since UV light is destructive to living things, perhaps plant growth will be impeded." We like questions that use "because" or "since" in their statements. A question should have a reason for being.

3. HYPOTHESIS: Next comes the formal statement of hypothesis -- or a statement of goals if a hypothesis is inappropriate. A young engineer might write: "I will build a hovercraft using a self-contained power source that can lift at least two hundred pounds."

A young scientist could state the hypothesis statistically using Ho or Ha. The researcher can also be slightly less formal. For instance: "Radish plants grown from seeds and exposed to an ultraviolet (UV) lamp will not grow to the same height as radish plants grown under a fluorescent lamp of similar shape and wattage. The height differences between my plants will be shown to occur only one time in twenty by chance." (In this particular case we aren't saying whether the plants will grow taller or shorter; we are only saying that UV light will affect plant growth. While this hypothesis involves a statistical test, it is more open-ended than most.)

4. METHODOLOGY: How will the young engineer build the project (what type of engine, etc.)? How will the young scientist conduct the research (number of plants, type of bulbs, watering times, number of days, etc.)? They may also include a materials list.

The middle board is normally reserved for the experiment and its results.

5. EXPERIMENT: We like pictures of hovercraft being built or of radishes being grown or whatever. All photographs should be labeled and tell a story in comic-book style. Logbooks can be kept by engineers and scientists so that they can accurately record what is going on

and gain additional insight into their queries as they are being answered. A narrative can be distilled from the logs and placed upon the boards. Anything unusual should be reported.

6. RESULTS: Hovercraft can be tested to see how much weight they can lift and how long they can run. For the radishes, we like line graphs, charts, and pictures that are clearly labeled. (Line graphs are often appropriate where time is an important variable. We encourage scatter plots and regression lines whenever one continuous variable could be the cause of another.) All graphs and charts should be stand-alone. I often say that you should be able to rip a chart off the boards and show it to your grandmother. A good chart can explain the entire project by itself.

I can't over-emphasize the story aspect of projects. Like most stories, science projects begin with an unresolved question and end with an answer. The body of a traditional story is often how a hero encountered a problem and solved it. It is the same for a project. As the boards are read, the reader becomes interested in the question and wants to know how the researcher found the answer.

All projects need some way in which to fail. Engineering projects fail if they don't meet their goals. The hovercraft fails if it can't lift two hundred pounds. However we shouldn't be absolute: One can call this project partly successful if it lifts only a 150 pound person. Still, technically, engineering projects fail if they cannot meet their initial goals. This distinguishes them from science projects.

One needs a statistical test (t-test) to check on the plants. We'll be glad to be of assistance. If the test finds no significant differences, the science project doesn't necessarily fail since you can learn as much from a null result as from a positive one. There are some famous examples in physics.

The last board is normally reserved for a discussion and a conclusion.

DISCUSSION: The young scientist or engineer explains the meaning of the results. How did the hovercraft behave? How could it have been built better? If the plants under UV light experience differential growth, what is the probable cause? Can anything be learned by inspecting the plants? Questions often lead to new questions. Is there a mix of UV light and fluorescent light that might be optimal for plants?

CONCLUSION: This is a stand-alone summary of what was done and what was learned. I often call projects "stamp collecting" when the student has amassed a huge amount of data -- such as an insect collection -- but cannot tell us what it means. At the International Fair, many students forget to do this and, of course, they win nothing.

In sum, winning projects ask a pertinent question and answer it through some sort of test where nature is the ultimate judge. They end by telling us what was learned in the process.