Dear students and mentors,

We're delighted that you've done a research-based project and would like to participate in an INSEF fair. Over more than 10 years of mentoring students for various science fairs, we've come up with a list of handy tips which could help you with your project. Right from the abstract to the final display, we'd like to share with you some information which we hope will ensure that you highlight the important aspects of your project, and also make the evaluation process easier for both you as well as the judging team at INSEF.

While going through the abstracts, we often find some common errors, misconceptions etc. in many projects, and we would like to alert you to some of these. Not all of them might be applicable for all projects, but do go through them, as a few may be useful for you to note.

We would also like to inform you about the judging process at INSEF. We follow international practices for judging high-school science and engineering projects, and it will help if you know what judges are looking for when they see your project and interview you. Do go through this list carefully, as it will help you understand how we evaluate research-based projects, and the importance of having the appropriate supporting materials with you.

We hope some of these tips will help you in submitting an appropriate entry to INSEF and making a good presentation at the Fair. There are also a lot of excellent on-line resources that discuss various aspects of science project data analysis and presentation. Please do make best use of these materials.

We're sure you'll find the INSEF Fair not only an intense scientific experience but also a lot of fun!

All the best!

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A. What is NOT a research-based project?

- Repeating a standard school "text-book" science expt. – e.g. generating oxygen from hydrogen peroxide, simply germinating some seeds etc. In some cases, a text-book experiment can be modified to vary some conditions and study their effect on a parameter, and one can convert a simple experiment into a research project.

- Making a wild hypothesis without personally doing any experiment or calculation to verify the feasibility of the proposal – e.g. a new design for a car / plane / space-station etc., or even a new way to remove toxic gases from car exhaust, but with no experiments to show that it works, or even theoretical calculations to show that the proposal is valid.

- Writing an essay on science topic – e.g. uses of nuclear energy, rain water harvesting etc.

- Making unsubstantiated claims that violate known laws and principles of science – every year we get a lot of ideas which are "perpetual motion machines" – trying to get energy out of nothing, or making cars that do not need fuel, etc.

- Simple posters and models explaining science/technology principles – these might be good teaching aids but are not research-based projects – e.g. Pascal's triangle or some easy way to visualize Pythagoras' theorem in maths, or a way to balance equations in chemistry etc.

- "copy-paste" directly from "science-fair" websites, journal articles etc. Please use these to get ideas, but at least do the expt. yourself! We take plagiarism very seriously. If you are caught copying, you will of course be disqualified, but we may even blacklist all projects from your school or guide!

B. Writing a proper title and abstract for a project

The first thing that is seen in a project is the title, and it must convey what has been done in the project correctly. Also, the selection for any fair is based on judges evaluating your abstract, which is usually just about a half a page to a page. This must be carefully written. In most cases we find that students spent way too much space on describing the problem(s) they are trying to solve, rather than what they have actually done. The key point of the abstract is to make sure the reader can find out quickly what exactly the project was about and what work was done.

A few examples of good and bad project titles are given below. Note: these are all fictional examples, but very close to those seen in many science fairs.

- "A new way to make plastic" – this doesn't say much about the project. A much better title would be something like "Biodegradable plastics made from fibres of the Hoohaa plant"
- "Miraculous effect of Hoohaa plant" – there are no miracles in science! A much better title would be "Effect of extract of Hoohaa leaf on the yield of P. Somethingamus seeds"
- "Micronutrients – a boon to agriculture" – this could be an essay. Let us be specific. "The effect of dilithium on the shoot length growth of P. Somethingamus"
- "Sea-wave energy" – again nothing specific. Why not something like "A prototype of a device to convert tidal wave motion into electrical energy"
- "Different brick" – what does that tell us? Wouldn't "Study of bricks constructed using fly-ash residue" be better?
- "Herbal iguana repellent" – What herb?? "Iguana repellent made from Hoohaa and Somethingamus leaves" is better. Please remember that your title should not be misleading. If you have studied the mixture of A,B, and C, to repel cockroaches, please make sure you list A, B, and C, and not just A.
- "Narayan's Super Invention" – No personal names in title, and it doesn't say what it is. "An open source fair judging algorithm" is much better.

And here is a typical bad and good abstract example as well:

Adulteration of Cement" (BAD EXAMPLE)
In today's fast growing world corruption and the need to get hyper profits leads to adulteration in everything. There is no guarantee of quality and originality and adulteration is common. It is difficult for a consumer to figure out how to check if the cement they are buying is genuine and they feel helpless in trying to find out if the shopkeeper is mixing something in it. The test involved is not possible for them to do in the shop. Mostly cement is adulterated by adding "choona" to it. Many buildings collapse and helpless people die because of this. In my method I will add a commonly available chemical, locally known as hoohaa, (dilithium superoxide) to this and heat the mixture. The colour of the ash that is left behind after the mixture is heated is changed if there is adulteration. This is a simple test that anyone can carry out.

Reaction with Hoohaa: A simple test for adulteration in cement" (GOOD EXAMPLE)
There is a severe problem of adulteration in cement sold in India, which is often mixed with choona. Laboratory tests are often time consuming and cannot be done on site. I propose a simple test, which utilizes the colour change on heating of a mixture of cement and hoohaa (dilithium superoxide) as an indicator for the presence of choona in cement. To test the sensitivity of this method, I first used controlled compositions of 0.1, 0.5, 1 and 5% mixtures of choona in cement (X&T brand PPC grade, obtained from ABC). While the 0.1% concentration could not be identified, the presence of choona above 0.5% gave a green tinge to the residue after heating. To test this further, 15 cement samples of various vendors were obtained from different shops. Our tests showed 12 of these samples to be adulterated. Details of the reaction mechanism, and test conducted will be discussed.

See the difference – don't waste words in coming to what you have done!

C. Some common errors, misconceptions which are seen in a number of projects.

Do check to see if your project contains any of these; discuss this with your guide as well.

1. **"internet science":** While the internet is a great resource for all sorts of information, and science project related information in particular, one has to be cautious of the accuracy of what's available on the web. In particular, there is a trend of *"I saw this on the net, and hence this must be correct".* Further, there is also clearly a widespread use of the copy-and-paste method of writing reports, without understanding what is really been copied, or without bothering to change the context, grammar, etc. of the paragraph! Judges are usually smart enough to figure out if you have copied something!
2. **"significant digits":** There is poor appreciation of the importance and relevance of significant digits, experimental accuracy and errors, and the correct treatment of data. This includes
   - (i) having results with too many digits beyond the decimal point (often up to the 9th decimal place because the calculator said so!) For example, if you are making measurements using a ruler where the least count is a millimeter, and have reading of 5.3, 5.5 and 5.2, the average should be written as 5.3, and not 5.3333333. Similarly, when using software like Microsoft Excel, be sure that you do not have extra digits which are not meaningful
   - (ii) making unwarranted conclusions based on such data (eg. if the average values of some quantities A, B, C are say 185.4, 186.7 and 120.5, it is perhaps OK to say that A and B were better than C, but one can't say B is better than A, especially if the individual variations in data points are more than the difference between A&B)
3. **"Be scientific":** The use of proper (preferably SI) units is a must! (please note that the symbol for grams is g, not gm or gms!), similarly, please use scientific units - weights in g, not in teaspoons, etc., saying things like 'I stirred it for "some time,"' is not acceptable.

4. **"V, not I":** For many of the electricity generation / conservation / use experiments there are measurements only of voltage, with no consideration for current. It is very easy to generate (even large) voltages, particular in open circuit conditions, but the key parameter is how much current can be generated (even the measurement of short circuit current, if not under load). Many projects particularly those with solar cells, or other electricity generation methods are in this category. Please ensure that you measure both current and voltage!
5. **"Statistics and controls**": In many cases, just doing an experiment once is not sufficient to draw solid conclusions; you may need to repeat your experiments. Also, in most cases, appropriate positive and negative control experiments are necessary – e.g., if you have used an alcohol extract of some plant as a (say) insecticide, then you must see if alcohol alone has the same effect. Also, in many cases one needs to perform appropriate statistical tests to see if the data is meaningful.
6. **"Practicality":** some ideas sound nice, but a good reality check on how practical (feasibility, costs, efficiency, etc.) will it be, particularly if it has to be useful under life-like conditions. E.g., if you are generating electricity from potatoes – how much would you need to generate say at least a few amperes of current at 12V. Most projects on electricity from speedbreakers / passing traffic / people walking across a turnstile etc. need to consider this aspect. If your generation is not continuous, how will you store the energy? How much energy will you realistically generate in say a year? How long will it take you to even recover the cost of the device used to generate the electricity? If you do all these calculations, you will often find that many ideas might be great in theory but may not be really very practical or economical.
7. **"Know your instruments":** If you are using any instruments to gather data – e.g. a lactometer to check milk quality or a device to measure wind speed, you must have some basic idea of how it works, and the limits to which it can be used. Otherwise it just gives a number, which means nothing.
8. **"References":** usually similar work would have been carried out earlier in related areas, and it is important that you show that you have made efforts to find out about such earlier work, and reference it. This way it is easier to show what the novel aspect of your work is! You must list the references correctly. Just saying "google.com" or "Wikipedia" or "science text book" is not enough. You must try and give the original source page (if online) or exact name of the journal or book, page number etc.
9. **"Negative Results" :** in scientific experiments, often things do not work the way one expects, and the results do not make sense or support the hypotheses. In engineering projects, there are many failed trials before one can come up with a final design. Showing failure is perfectly fine, and a good project documents everything. In case some of your experiments or samples did not work - please do not discard the data! Note it down and have it ready to show if needed during the fair.

D. **What do judges look out for, and how can I best present my work at the fair?**

Do remember that judges will focus on 1) what YOU, the student or team did in the project; 2) how well you followed the scientific method; 3) the detail and accuracy of research as documented in the data book; and 4) whether experimental procedures were used in the best possible way. We are always looking out for innovative ideas, original work, well thought-out research and scientific or engineering skill.

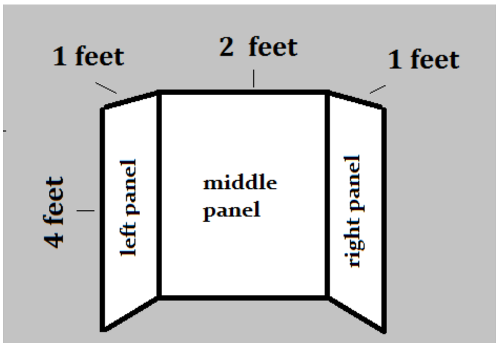
At an INSEF fair, your project display must be complete, and comprehensive such that, *as far as possible, it is possible for someone visiting your project to get the total picture of the work done WITHOUT YOUR PRESENCE.* Please note that a part of the judging may be carried out in the absence of participants, when the judges go through your project display as well as your logbook/original data etc. **This means that it is VITAL that your ORIGINAL DATA, WITHOUT MODIFICATIONS is available to be viewed.** Your results alone without the data to substantiate your work are not enough. Original laboratory readings are never neat, and we do not expect them to be! We would like to see how your project has progressed over time. *Please do NOT "copy into fair" your data, or print it neatly,* it does not impress judges, on the contrary, it is counted against you!

Also, be sure to bring along all supporting information for your project. Often you cannot bring your experiment, but please do take pictures or videos and bring them to show at the fair. Usually we go through many failed tests before getting the final results, in that case that some of your experiments or samples did not work - please do not discard the data. Do record it and get it during the fair.

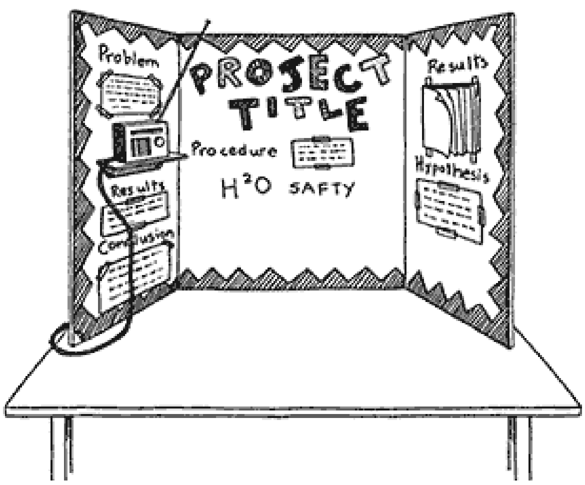
Do make sure that your project display is such that it is readable from a comfortable distance (typically 1m away). Make your title clear and easy to read. Avoid type styles that may be hard to read. Fonts that have shadows or outlines may seem like a great idea but they are harder to read than simple lettering. The title lettering should be at least 5cm high.(For those using computer based word-processors/presentation software, a *minimum* font size of 20 point is recommended). Do NOT display pages of text, but summarize the important aspects of your project. Plotting relevant graphs, charts etc. can often be much more instructive than showing huge tables of data.

While organizing your display, please ensure that there is a sensible and easy progression through the display so that the average person can easily understand it. While there is no one correct way to set up a display, it must, however, make sense and be easy to follow. Remember that most people read from left to right and from top to bottom. Design what the "center" of your display will be. This is where everyone will look first. Group topics that go together like question, research, and hypothesis; materials and procedures; analysis and conclusion. Make a small sketch of where everything will go and lay it out before you glue anything down to make sure it looks good. (If needed, please number your panels, so that the logical sequence of going through the panels is clear even if you are not present to guide the viewer.)

Colourful glittery posters and fancy thermocole models do not necessarily make a better project! Remember we're looking for the science, this isn't an exhibition of art and craft skills! Often you might need a model to explain what you have done – keep it simple, and focus on getting the science across. For INSEF the recommended display dimensions are:



INSEF Display Board Measurement



An example of a ***good*** *display* *and here's a* ***bad*** *one!*

From Janice VanCleave's Guide to the Best Science Fair Projects, (John Wiley & Sons, Inc., 1997)

Do make sure that all items that are displayed are permissible as per the display guidelines in the INSEF handbook. Basically, anything that is or could be hazardous to other participants or the public is prohibited and cannot be displayed. NO HEATERS or STOVES will be allowed. *ALL electrical appliances MUST have plugs, projects having bare wires inserted into sockets will be disqualified.*

If your work involves working with human subjects, consent forms must have been obtained prior to experimentation, and should be available in case needed. Similarly, any work involving living organisms, human/animal tissues, DNA etc. must have the appropriate documentation if required.

In most cases, similar work would have been carried out earlier in related areas, and it is important that these be appropriately referenced. Ideally, paper or electronic copies of some key references should be available in case these are needed to be referred to.

PRACTICE your presentation! Remember that most judges will spend only about 5-10 minutes with you, where they would like to focus mostly on **what you have done**, rather than the background of the problem, and have enough time to ask you questions and have a discussion**. *So do not come with a "memorized speech", with a long introduction, but be prepared to explain what you have done in your project in as short or long as a time that may be available.*** Practice with your friends and encourage them to ask questions.

Maybe it will help to give some of the overall ideas of what judges look for while going through a project:

1. Clearly defined objectives – what did you want to do, and how did you go about doing it? (Presenting original ideas, Stating the problem clearly, Defining the variables and using controls, Relating background reading to the problem)

2. Skill in performing the project – (knowledgeable about equipment used, Performing the experiments with little or no assistance except as required for safety/special equipment/data collection, Demonstrating the skills required to do all the work necessary to obtain the data reported…)

3. Appropriate data collection – (using a log-book and journal to collect data and document research, Repeating experiment to verify the results, Spending an appropriate amount of time to complete the project, Having measurable results, appropriate control experiments etc.)

4. Correct data interpretation – (collecting enough data to make a conclusion, Using research to interpret data collected, Using only data collected to make a conclusion, Using tables, graphs etc. to visualize the data easily…)

5. Project Presentation (Written Materials, Interviews, Displays)
(Having a complete and comprehensive report, Answering questions accurately, Using the display during oral presentation, Justifying conclusions on the basis of experimental data, Summarizing what was learned, Presenting an attractive and interesting display…)

For the INSEF fair we follow the guidelines of the I-SWEEEP Olympiad to which we are affiliated. Judging will be done using the following broad criteria:
a. Novelty – 10 points
b. Scientific thought / Engineering goals - 10
c. Scientific Method / Engineering Design – 10 points
d. Data Management – 10
e. Applications - 10

All the best for your participation in INSEF!