Project Creation Manual

Introduction

An amazing variety of projects appear at the science fair each year. Most of the ideas come from interesting problems encountered in every day life. School work, a hobby, club or activity also generates ideas.

By providing access to this manual, it is our hope that while you are creating your project and preparing it for the fair, you will encounter fewer problems, and in the process learn a lot.

Check the rules and regulations in the “Fair Manual”. They are strict.

If you find errors in this manual, please bring them to our attention.
Email Jim Forsyth *jimphyllis@sympatico.ca*

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NOTE: Other downloadable “Manuals” available on our website: - Fair Manual
- Fair Day Manual
- Judging Sheets

"That is the essence of science: ask an impertinent question, and you are on the way to the pertinent answer." *Jacob Bronowski*

FIRST STEPS FOR DOING A PROJECT

Selecting a topic; asking a good question

Try to write a question that clearly outlines the project. A good project is original, useful and understandable.	An ***original*** project deals with a subject that has not been proven or seen before. A ***useful project*** solves a problem and adds to the knowledge of science. An ***understandable*** project can be repeated in the future with similar results. Many of the projects seen each year are original, useful, and understandable.

Researching the Topic:

To do a good project the topic or problem must be researched. Possible sources of information are libraries, teachers, television shows, newspapers and people who work in that area. General information is available in encyclopaedias. For more specific information, books or science magazines are better. Excellent sources of very current data can most often be found on the Internet. (There is a lot of bad information on the internet that needs to be discarded.) Use index cards, a notebook, or your computer to record all important information, keeping track of the source of the information. When you write your report you will need to include the sources of all information so detailed records are important.	Your research should be attempting to determine answers to the following or similar questions (not all questions apply to all projects): • On what scientific principle(s) is your project idea or topic based? • What basic information is needed for someone to understand your idea or topic? • What historical development has occurred related to your topic? • How does your topic relate to other areas of science or engineering? • What research is currently being conducted related to your topic? • What questions still remain unanswered related to your topic? • What are the practical applications related to your topic? • How does it affect mankind or life on Earth?

Reading the Rules and Regulations

Many science fair projects can become quite complex and involve potentially dangerous or harmful materials. It is essential that all science fair rules and regulations are read, understood, and followed by science fair participants so that accidents do not occur and that time is not wasted developing an unsuitable project. Projects that violate the rules and regulations will be disqualified.	Besides the general rules for the fair, there are very specific and strict rules for projects dealing with animals or using humans in scientific research. These rules are found in the Fair Manual, a downloadable file on our website page “Fair Information”.

DOING the PROJECT

Conducting the Experiment(s), Study or Innovation

Use the established scientific method to produce accurate results.
Start with a purpose or question, followed by the hypothesis, then the procedure, which includes materials and methods, followed by results and conclusion.

1. Purpose:

Every experiment, study or innovation must have a purpose stating what you are attempting to do. The purpose should include an hypothesis. The project title should reflect the purpose.

2. Developing a Hypothesis:

Once the background information has been collected, an educated guess can be made about the solution to the problem. This educated guess is called an hypothesis.

3. Procedure:

List and describe all of the materials used, explaining how each was used when you did your project. A method, describing how the project was done, must also be written. The most sophisticated studies involve the clear definition and control of all variables. The variables a scientist changes are called independent variables. The things that change as a result of the experiment are called dependent variables. A good experiment or study changes only one independent variable at a time because any change in the experimental result can then be attributed to the change of that independent variable. A Study or Innovation type project still needs to have a procedure that outlines the steps taken in gathering and assessing data or in the development and testing of the innovation.

4. Keeping a Project Notebook:

As you work on your project, keep a notebook, logbook or journal that describes your progress. It should be at your side throughout the work you do, and therefore holds all of your "rough work". Your original notebook, rough as it may appear, is a very important part of your project. It should not be a copied or laundered version. It should contain your ideas, including ones that you decided were wrong, notes on books you have read on your topic, people you contact, etc. As you do your project, record all observations and raw data here, both successes and failures. It is from this notebook that you will extract the information for your display, your written report and your interviews.

5. Results:

Record all observations. Keep complete and accurate notes of everything you see, smell, hear or feel. There are two types of observations, those that are sensual (qualitative) and those that are accurately measured (quantitative). Measuring devices include metre sticks, thermometers and clocks. Record all results, even the unexpected. As mentioned above, it is important to record what appear to be failures or things that don't work or come out as expected. This is a critical part of the scientific process - learning and formulating new ideas from the so called failures. Remember - results are never wrong. Tables or graphs can organize data, or results. They should provide support that the hypothesis appears to be right or wrong. If the hypothesis is wrong it can be changed and other experiments conducted. Projects that prove an hypothesis wrong, however, are equally valid and acceptable.

6. Conclusion:

An analysis should be made on completion of the research explaining how the hypothesis was arrived at and whether it was found to be correct. Other researchers should be able to reach the same conclusion by following the described research procedure. The conclusion should include additional background information, any sources of error that may have been present, and possible practical applications for the results. Ideas for further research are described in this section.

WRITING the RESEARCH REPORT

When you are doing your project you should keep a detailed record of what you did in a notebook or ring binder that you bring to the fair in case the judges want to see it. Do not keep the records on a computer because when you print them they will look “perfect” and not like what you would write which probably would have scratched out bits, perhaps spill marks and other indications that it was created as you did the work.

The **research report** requires you to demonstrate your ability to write a **summary of your project** using a standard scientific style of reporting. It requires that you select only what is important and state it in a succinct way, however it should be nearly as long as the 600-word space allowed on the registration form. It is a **report** about what you did, **not a detailed record** of what you did.

- The research report will be is entered online as part of the WWSEF Application/Registration in the **Project Information** section in the field labelled "Summary". If the report is longer than allowed then the extra words at the end just disappear.
- It may be written in a word processing application, such as MS Word, and copied into the "Summary" field.

On Line Research Report Requirements: (Use these guidelines for the report summary you submit when registering on line)

1. The first line of the report should be the title. The title should be relatively short. If it is longer than the size limitation on the registration form it will be chopped off with strange results.
2. The second line should be the name(s) and the school of the exhibitor(s), leave one blank line and then begin the report.
3. The report is in four sections.
   i) Background and Purpose (and/or Hypothesis)
   ii) Procedure
   iii) Results and Conclusions
   iv) Acknowledgments
4. The style is clear and concise with correct spelling and grammar.
5. No raw data or detailed observations are included in the report or in any appendices to the report. These are the main material of the project notebook or logbook.
6. The maximum length of the report is 600 words with most reports usually being between 400 and 600 words. A counter below the "Summary" field shows the number of words in the report as it is entered. If the number of words exceeds 600 it will not be possible to save and complete the Project Information section.
7. There are six examples of reports, two in each category. You can also check the archives for reports from projects that went to the Canada-Wide Science Fair.

Explanatory Notes:

1. The Background and Purpose section is intended to describe information that explains why the project was done. It is not to be a theoretical discussion.
2. The Procedure must be a very brief outline of the materials and methods used in the project.
3. The Results and Conclusions section should summarize what the researcher found and show how that relates to the purpose. A brief discussion of the limitations, or suggestions for further research, may be included.
4. In the Acknowledgments paragraph, recognition should be given to all who provided significant assistance to the researcher in development of the project, in the form of guidance, materials, or facilities. The judges may use this information when formulating questions for the interview with you and when deliberating on the quality of your work. This section of the report will not be marked.

Displaying Your Research Report:

The online report will be judged by a professional marker and will not be seen by the judges who assess your project. You should have another copy of your report visible at your display during judging. It should follow the same requirements as above however you may add a cover page.
Display of the report during other times is at your discretion.
The marked copy of your report will be returned before the conclusion of the Fair.

How the Research Reports are graded:

The written reports, assigned 5, 4, 3, or 2 marks, are evaluated on overall approach, organization, content, writing skills (grammar, spelling and punctuation) and style (clarity, precision and economy). A mark of zero will be assigned if no report is submitted with the application form.
Copies of typical of well-written reports, can be found in the archives on our website. We have included a few in this manual to give you a start. (see below)

DISPLAYING YOUR PROJECT

Building a Backboard:

Before you begin, please refer to the rules governing your display at the Fair. The Fair Manual on the Fair Information page of the website will help you.

Projects, which do not follow the rules, have to be disqualified.

Science fair projects need freestanding backboards made of sturdy material such as masonite, pegboard, plywood or coroplast, although strong corrugated cardboard seems to work.

A coat of paint helps improve the backboard's appearance.

Designing the Display:

Pictures of the research projects, which were sent to the Canada-wide Science Fair, are worth looking at. Check out the Archive page on the website.

The exhibit should be visually attractive and exciting to attract the attention of visitors and judges.

It's also important that it be sturdy with all parts securely fastened.

Visual effects - charts, graphs, drawings, photographs, and lights - add a lot to a display.

Tip:

Try to design a display that is easily and quickly set up.

Research Report Examples

"The whole of science is nothing more than a refinement of everyday thinking."

Albert Einstein

TWO JUNIOR CATEGORY REPORTS

How Does Stress Increase Smoking Behaviour?

Your name(s) and your school's full name

Background, Purpose and Hypothesis:

Nicotine is a toxic chemical that is commonly found in tobacco products. When tobacco is smoked or chewed, nicotine enters the bloodstream and is carried to the liver. An enzyme then changes nicotine into a water-soluble form that then can be excreted in the urine. This process is called nicotine metabolism. People then need to smoke more to replace the excreted nicotine. The enzyme that is responsible for nicotine metabolism is called CYP2A5 in mice and CYP2A6 in humans and is found in hepatocytes (liver cells). Increased amounts of these enzymes speeds up nicotine metabolism and the urge to smoke becomes more frequent. The purpose of this project is to determine whether hormones called glucocorticoids increase smoking habits by increasing nicotine metabolism. Glucocorticoids are hormones produced by the adrenal glands during stress. I hypothesize that glucocorticoids such as dexamethasone (a man-made drug) and cortisol (a natural hormone) induce the enzyme CYP2A5 in mouse hepatocytes and increase nicotine metabolism.

Procedure:

The amount of CYP2A5 that is being produced can be measured at the RNA and protein levels and by measuring nicotine metabolism. I treated mouse hepatocytes in 6 well plates (2.5 million cells/well) with 1 micromolar of dexamethasone and control cells were treated with 0.01% dimethylsulfoxide (DMSO). To measure RNA levels, cells are then harvested into a chemical called TRIzol to maintain the integrity of the RNA. The total RNA is then quantified using the Nanodrop spectrophotometer. To determine the amount of CYP2A5 RNA, it is first reverse transcribed into cDNA and then the PCR technique (Polymease Chain Reaction) is used to amplify CYP2A5 cDNA. To measure enzyme activity, hepatocytes were treated with dexamethasone and DMSO, harvested, homogenized and incubated with nicotine (3 micromolar) to measure metabolism. Nicotine metabolites were then measured using an HPLC technique.

Results and Conclusions:

Cultures of mouse hepatocytes treated with dexamethasone for 24 hours significantly increased CYP2A5 RNA by 5 fold. Currently, I am determining whether dexamethasone also increases the production of nicotine metabolites by mouse hepatocytes. I will also determine the effect of cortisol on CYP2A5 RNA levels and nicotine metabolism in mouse hepatocytes. These findings suggest that stress may increase smoking habits by increasing nicotine metabolism.

Acknowledgements:

I would like to thank (insert name) who put his time and effort to teach me the lab techniques, and also by designing the project. I would also like to thank (insert name) for her difficult questions and excellent advice.

Butterflies and Knees

Your name(s) and your school's full name

Background, Purpose and Hypothesis

This project is about how the knee moves and what injuries are possible from the butterfly movement of goalies. I searched the Internet for background information and talked to Professor Somebody and Professor Somebody else at the University of Knowledge to make sure the project had not been done before and to borrow two professional accelerometers to make the measurements. I hypothesize that hyperextension, impact and torque can cause injury to a butterfly goalie's knees.

Procedure

The butterfly movement was tested carefully to discover the possible ways the knees could be injured. The normal range of rotation of the goalie's knees and hips were measured while the goalie was in a sitting position, a standing position and a kneeling position (without equipment on). The angles of the knees and hips were also measured at different stages of the butterfly, using photographs of the butterfly motion, then compared to the normal angles of rotation. The number of butterflies a goalie did each week was counted. The weight of the goalie and the equipment was accurately measured using a Thermo Nobel scale. The acceleration of the goalie was measured using an accelerometer at the stomach and one on the goalie pad or leg. The forces were calculated using the acceleration and the weight of the equipment and the goalie. These forces were compared to the estimated forces found by determining the speed, the distance traveled, and the acceleration of the goalie from images taken with a digital video camera. The torque at the knee was determined by multiplying the force by the distance between the knee and the skate blade or ankle in each stage of the butterfly (as measured from the digital videos). The results were studied to make conclusions about how the knee might be injured.

Results, Conclusions and Applications

It was found that the normal range of rotation of the goalie's knees was exceeded during the butterfly, so hyperextension is possible. The force with which the goalie hit the ground was not great enough to cause any extremely harmful damage but it could cause bruising and make the knee more susceptible to other injuries. The torque on the goalies knees would be the most likely thing to cause injury. It was found that during the butterfly, more torque than an estimated normal amount was put on the goalie's knees. This could definitely cause injuries such as tears of the menisci (tissue between the femur and the tibia preventing rubbing of the bones) or tears or pulls of the ACL/PCL which are important ligaments in the knee. Since the butterfly motion is repeated about 93 times per week, any of these injuries could likely happen. In the future, goalies should increase the padding around their knees so as not to cause impact injuries and make the knee less susceptible to other injury. Also they should loosen their pads around their ankles so that their lower legs are not so immobile and so cause less torque on the knees. To prevent hyperextension injuries, goalies should not twist their legs out so much when they are doing the butterfly.

Acknowledgements

I would like to thank my mother, Professors Somebody and Somebody else and Mr. Who for his tough questions and need for perfection.

TWO INTERMEDIATE CATEGORY REPORTS

The Amazing EV Road Race

Your name(s) and the schools full name

Background, Purpose and Hypothesis:

The world we live in is far too dependent on gas-guzzling cars. In fact, for the first time ever in the U.S.A, there are more cars than drivers! However, batteries developed by Altair Nanotechnologies and A123 Systems hold promise for the future of electric cars.

The purpose of this experiment is to power a small-scale electric vehicle using batteries from Altairnano and A123, and to evaluate their relative performances. It is hypothesized that the Altairnano battery will allow the vehicle to travel a greater distance than the A123 battery; that the Altairnano battery will demonstrate superior speed maintenance near the end of each discharge cycle; and that both batteries will maintain safe temperatures throughout.

Procedure:

A miniature electric concept car was constructed and placed on rollers in order to test each battery. During discharge, a Venom Speed Meter was used to display speed, and this data was recorded using a web cam. An Xtrema charger was used to charge the batteries according to the battery manufacturer's recommendations. The XtremaLog program was used to capture charge and discharge data.

To simulate highway driving, the motor was set at high speed, and run constantly until the battery reached the cut-off voltage: 60% of its charging voltage. While the motor was running, the following variables were recorded: distance traveled, time, speed, acceleration, horsepower, and temperature.

To simulate stop and start patterns of city driving, the motor was set at low speed, under an algorithm of 10 minutes driving and one minute stopping, until the battery reached the cut-off voltage. These results are incomplete and will be reported later.

Results, Conclusions and Applications:

Mean distances for the highway test were calculated for both batteries. The Altairnano battery traveled 54.88 miles on a single charge, while the A123 traveled 42.73 miles. Altair predicts that their full-sized 35 kWh battery will run 136 miles on a single charge, while the A123 claims a range of 210 miles. However, the present results suggest that Altair offers a greater range.

The Altair battery accelerated from 0-10 mph in 1.56 seconds, while the A123 took an average of 3.52 seconds to accelerate to the same speed. Full sized EV cars are expected to accelerate from 0-60 mph in under 10 seconds when powered by both tester batteries.

When the car was powered by the Altair battery, it drove at a faster speed, which was not unexpected since it started with a slightly higher voltage. To eliminate differences in voltages, speed was divided by voltage and plotted over time, resulting in negligible differences in speed between batteries. The Altair battery also proved to have superior speed maintenance, since the A123 battery's voltage dropped off suddenly at the end of each discharge cycle, while the Altair had a more gradual voltage decline.

There were minimal temperature changes for both batteries during both charging and discharging. High battery temperatures have lead to recalls with many standard lithium-ion batteries such as those used in consumer electronics. However, the battery composition of both tester batteries addresses this problem. Further testing needs to be done to confirm the safety of the batteries, including charging and discharging at higher currents, and arranging larger numbers of cells in closer proximity.

Overall, Altair's battery drove further, accelerated more quickly, offered better speed maintenance as compared to rival A123. The time has come for drivers to get charged up about electric vehicles.

Acknowledgments:

I would like to thank my parents and my grandfather for funding my project, and (*insert name*) for answering my questions.

BIOLOGICAL FUEL CELL

Your name(s) and your school's full name

Background, Purpose and Hypothesis

The purpose of this project was to design; build, and test a biological fuel cell, using electrolysis. A biological fuel cell is a device that generates electricity when provided with an anode and a cathode, an electrolyte, a fuel source, and with bacteria acting to enhance the power produced. Measurement of voltage is a reliable indication of power. The hypothesis was that various combinations of the cell components and different types of bacteria would produce variations in power leading a “best” combination.

Procedure

Select bacteria (E. coli or yeast), the anode (carbon or graphite), the cathode (copper), and the electrolyte (copper sulphate or methyl blue) and record the concentration.
Select two beakers. Place a magnetic stirrer in the bottom of each beaker, and place the beakers on their magnetic stir plates.
Turn the stirrers on and make sure they are in the centre, spinning properly, and not hitting the sides of the beakers.
Pour the electrolyte plus water in one beaker and the bacteria plus water in the other. Use the stirrers on maximum for five minutes to ensure thorough mixing.
Place the copper cathode in the bacterial solution and the chosen anode in the electrolyte.
Reduce the speed of the stirrers to half, and attach the voltmeter to the electrodes.
Place one end of the salt bridge in the electrolyte and the other in the bacterial solution.
Measure and record the voltage.
Repeat steps one to eight until all testing is complete.

Results, Conclusions and Applications

The results of this experiment indicated that graphite is a better electrode than carbon. E. coli produced more power than yeast. E. coli produced electricity for five to six days. This implies aerobic organisms (E. coli) are better for producing electricity than anerobic organisms (yeast). The conclusion was that the most efficient design tested was the graphite, E. coli, Methyl Blue combination. The potential applications of this type of process would be in the power industry as bacteria might be used to breakdown industrial wastes or generate power from sewage

Acknowledgements

This report didn’t have acknowledgements. Most reports do. You would give recognition to all who provided significant assistance to you in this section.

TWO SENIOR CATEGORY REPORTS

PLASTIC NOT FANTASTIC

Your name(s) and your school's full name

Background, Purpose and Hypothesis

Plastic bags are made from polyethylene. Polyethylene is a polymer consisting of long chains of the monomer ethylene. Plastic bags are very popular in our daily lives and have a harsh environmental impact on our ecosystems. Every year, approximately 500 billion plastic bags are used worldwide and billions of those are dumped into the oceans. Countless wildlife, including sea-lions, whales, birds and turtles ingest the plastic bags and die every year. Plastic bags have very high durability, persisting in the environment for 20 to 1000 years before they decompose. Since it is very difficult to prevent the disposal of the bags into the environment, the development of a biotechnological approach to plastic bag degradation is the main goal of this project. The hypothesis is that if polyethylene-degrading micro organisms do exist in the Nature, then it will be possible to isolate them and use them for degradation of plastic bags.

Procedure

1. A few soil samples were collected at a local landfill in Waterloo, Ontario and then mixed together.
2. Plastic bags were grinded to form powdered polyethylene.
3. An enrichment medium was prepared consisting of mineral salts and powdered polyethylene as the only source of carbon.
4. 1 g of the soil mix was added to the first enrichment flask containing 100 mL of enrichment medium. The flask was incubated at ~30 C for 4 weeks.
5. 10 mL of broth was taken from the first enrichment flask, re-inoculated into 100 mL of fresh enrichment medium and cultivated under the same conditions for 4 weeks. The same procedure was repeated a third time.
6. The final broth was filtered through filter paper to remove undigested polyethylene powder and dispersed into plastic test tubes.

Results, Conclusions and Applications

This project describes the isolation and use of a soil microbial consortium for polyethylene degradation. Specific control variables were put in place to measure the:

1. Effect of bacterial amount on the efficiency of plastic bag degradation
2. Effect of incubation temperature on plastic bag degradation
3. Effect of sodium acetate on plastic bag degradation The optimal conditions for polyethylene degradation are:
   a) an incubation time of ~6 weeks;
   b) a temperature of ~30 C;
   c) concentration of sodium acetate- 0.1%;
   d) 20 mL of culture per 50 mL of suspension. Plastic bags are usually buried in landfills or thrown into the oceans and surrounding ecosystems. The process of polyethylene degradation developed in this project can be used on an industrial scale for biodegradation of plastic bags. As a result, this would save the lives of millions of wildlife species and save space in landfills.

Acknowledgments

I would like to thank my (insert name) for her support and enthusiasm at some very tough moments.

Cry of the Onion

Your name(s) and your school's full name

Background, Purpose and Hypothesis

The Allium Test is a screening method for chemicals, pollutants, and contaminants that may be hazardous to the environment or the organisms inhabiting that environment. The onion, “Allium Cepa”, is used in this method because of the great number of mitotic cells in the apical meristem of the root cap, which can be observed easily under a microscope. Profound examination of these mitotic cells may reveal aberrations caused by the toxic nature of chemicals tested. The purpose of my experiment was to determine the carcinogenic potential of various chemicals *(the other test agents should have been listed)* based upon these aberrations at the microscopic level. My hypothesis was that all test agents would be carcinogenic except for whisky and Tylenol 3.

Procedure

Allium Cepa onion bulb were grown in test tubes filled with serial dilutions of the various test agents. The onions were left at room temperature in the dark for forty-eight hours, and then replenished with the appropriate dilutions to compensate for evaporation and plant usage. The onions were then left for another twenty-four hours in the dark. For each dilution of each test agent the onion bulbs were placed on a black surface and the root lengths were measured. Two millimetres of the root tips were cut off, using a scalpel, and two drops of aceto-orecin stain were added to them and they were left sitting for two minutes. The root examined under a microscope to view the chromosomes and detect if any aberration had taken place in the mitotic cells.

Results, Conclusions and Applications

All of the chemicals tested illustrated some sort of mitotic aberration, with the exception of the whisky and the water used as a control. These aberrations included such occurrences as DNA clumping and anaphase bridges. From these results it was concluded that all these chemical possessed some carcinogenic potential, whether strong or weak. This is not to say that the chemicals will give you cancer upon exposure. For example, acetaminophen is a carcinogenic substance that is widely used. On the other hand, cigarettes are known to have carcinogenic effects that may eventually cause damage. The severity of carcinogens varies and as a result they are regulated by the Food and Drug Administration.

Acknowledgements

Special thanks goes to Mr. Pharmacist of the ABC Drug Store and Mr. Science Teacher for their assistance and advice. I’d also like to thank the XYZ Dental Office for providing the amalgam waste, Vapo-steril, and the medications that were used as test agents.