Completing a Science Fair Project:
5 Steps to Success

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INTRODUCTION

So why do science fair projects? The author had the privilege to work at the Mayo Clinic in Rochester, Minnesota for a number of years as a summer research fellow. This experience encouraged the author to publish two papers in the field of renal physiology (Mann et al., 1991 and 1992). This experience encouraged the author to incorporate the scientific process into the classroom. The author has 15 years of experience in science fair. Students have created very interesting projects that impact their life. Students from the science fair programs are now doctors, engineers, professors and teachers sharing their knowledge of science with others. Students have presented projects all over the United States. Some have even advanced to the European Symposium in London and the Nobel Conference in Sweden. Students have even presented work on the Today Show and CNN News. Student success encourages the author to continue to work to help student's process science. Although some projects may be submitted for publication, it is more important to learn how to do science than to get "good" results.

The trend in science education, through the adoption of state and national standards, is to incorporate more inquiry learning in the classroom (Llewellyn, 2002). A variety of state and national standards will be met or exceeded through the completion of a science fair project. Although a lot of time is required to complete a science fair project, the results will far outweigh the time spent. Students will be able to answer the how and why questions that are frequently seen on standardized tests in science.

So what is inquiry? Many educators think that inquiry is simply hands on activities. Although most inquiry involves hands on work, there are many hands on activities that educators use that do not involve inquiry (Llewellyn, 2002). Inquiry can be defined in many different ways. The Exploratorium in San Francisco identified several statements regarding the definition of inquiry. According to the Exploratorium,

> Inquiry is an approach to teaching that involves a process of exploring the natural or material world, that leads to asking questions and making discoveries in the search of new understandings. Inquiry, as it relates to science education, should mirror as closely as possible the enterprise of doing real science.
> The inquiry process is driven by one's own curiosity, wonder, interest or passion to understand an observation or solve a problem.
> The process begins by the learner noticing something that intrigues, surprises, or stimulates a question. What is observed often does not make sense in relationship to the learner's previous experience or current understanding.
> Action is then taken through continued observing, raising questions, making predictions, testing hypotheses and creating theories and conceptual models.
> The learner must find [his or her] own idiosyncratic pathway through this process: it is hardly ever a linear progression, but rather more of a back and forth or cyclical series of events.
> As the process unfolds more observations and questions emerge, giving

> occasion for deeper interaction and relationship with the phenomena-and greater potential for further development of understanding.
> Along the way, the inquirer is collecting and recording data, making representations of results and explanations, drawing upon other resources such as books, videos, and colleagues.
> Making meaning from the experience requires intermittent reflection, conversations and comparison of findings with others, interpretation of data and observations, and applying new conceptions to other contexts as one attempts to construct new mental frameworks of the world.
> Teaching science using the inquiry process requires a fundamental Reexamination of the relationship between the teacher and the learner Whereby the teacher becomes a facilitator or guide for the learner's own Process of discovery and creating understanding of the world. (Llewellyn, 2002)

The classroom will provide the student with a wide variety of sources to use throughout this process. A variety of science fair manuals and project idea books can be found in the media center as well as the classroom. These include titles such as Science Fair Manual: An Independent Research Guide (Carnahan and Hartmann, 1988), Students and Research (Cothron et al., 1989), Prentice Hall Science Fair Manual: A Step By Step Approach (Hulse and McMullin, 1991), Students as Scientists (Pellegrini and Olson, 2000), and Giant Book of Science Experiments (Press, 1998). A large selection of teaching textbooks, in all fields of science, are also available. Most libraries will have many sources to help the student as well.

There are twenty assignments broken into 5 steps that the student will complete throughout the process of this project. The teacher will give feedback and suggestions for improvement. The student will have time to make revisions on all assignments. This will be a huge change for the student. Students typically hand in work once and forget about it. This class expects the student will rework assignments until they are excellent. Students who rework assignments will most likely have a higher grade and a higher quality project. The choice is up to each student. Each step will be given a 30 point grade. It is very important that the student keep up with assignments and the student will find that revised work will benefit their grade tremendously. Students will find a list of criteria at the end of each task. The individual assignments will address all of these criteria. The student will be able to rework all steps for two weeks after the step due date. Each student will have flexibility to meet all grades. Each project will be independent however key parts need to be completed on a timely basis to make a high quality project. Procrastination is not an acceptable excuse. There is no substitute for hard work. It is better to make your best attempt at an assignment and allow the teacher or mentor to give you feedback. Revisions will expand the student's knowledge base and allow for a more professional product. When confused, ask for help! Students may work on projects individually or in teams of two or three students. Realize that higher expectations are placed on team projects. For example, if 5 sources are expected for an individual project then ten would be expected for a team of two. More heads can make for more complex projects.

At the completion of this process the student will have written a scientific paper, completed a project display board, and have a well documented journal. The journal will show the progress of your project from beginning to end. The journal is essential for documenting your progress on your project.

A sample journal sheet may look like the following

SCIENCE FAIR PROJECT JOURNAL

Name:_____Date:_____

Please check the type(s) of journal activity(ies) covered in this entry:

_____Proposal/Forms	_____Literature Search
_____Hypothesis	_____Experimental Plan
_____Data Collection	_____Data Analysis
_____Writing Paper	_____Display Board
_____Presentation Preparation	_____Other,_____

Please journal below the key things that you accomplished on your project today. Attach all pertinent papers, such as plan sheet, to this entry.

Researcher Signature:_____

Teacher Signature:_____

You are about to embark on one of the biggest challenges, your science fair project. Be inquisitive, be flexible, work hard to learn as much about your project, and most of all have fun!

STEP 1: PROJECT PROPOSAL

The first step that you will be faced with is the project proposal. A well designed project must follow all International Science and Engineering Fair (ISEF) rules. These rules may be found at http://www.societyforscience.org/index.html. The science fair is guided by rules that protect you from dangers, including safety, as well as protection from legal action. We may think that any project is acceptable. Be very careful to follow all rules, especially if you are completing a project with human subjects, microorganisms, or vertebrate animals. Before you begin your project you must complete all forms and signatures. A well planned project will work smoother in the long run. Take the time to evaluate each step. Enjoy, have fun, and impress yourself with the best project that you have ever completed.

For many science fair projects, the most difficult task is getting started. As you prepare yourself for this amazing journey; there are a few things that must take place before we begin. To begin, you must have a topic for your project. The research project plan, as described by ISEF, is the development of a scientific research project involving several sets of data and experiments. A good project should contain a controlled experiment with as many trials as can be accomplished. A good statistical test usually requires 30 tests for best results. A MINIMUM OF 3 TRIALS IS MANDATORY FOR ALL PROJECTS. You will find a variety of sources in most libraries that will get you started on possible topics. Remember these are projects that have already been accomplished and you may need to take the idea or procedure and modify it into a new and unique project.

Here are a few suggestions for selecting a topic:

a. Talk with your parents, friends, teachers, or those in the scientific community about your ideas. Discuss time limits (all data should be completed by January 1), budget limits, and possible outcomes of the project.
b. Choose a lab topic that interests you. Look for something you are curious about. You will be spending months on this project, it should be something you consider fun and challenging.
c. Choose a topic which is feasible. Be sure it is at your level. Don't choose a college level project, you will be overwhelmed. Don't choose a very basic project because you think it will be easy to do. These projects end up requiring a lot more time and energy trying to create more things to do to get it up to your level. Work with materials that you have access to utilize. Projects with humans and vertebrate animals will take a considerable amount of time and

energy to get everything approved and all forms completed. Choose wisely!

d. Try to narrow your topic without making it too difficult to find sources. You will want to find 10-15 sources to have an effective project. For example, cancer is a very broad topic which could be narrowed down to treatment of bone cancer.
e. Don't try to design your experiment completely at this time. Allow your topic ideas to develop as you conduct your literature search on your topic. Your sources will help you develop a well designed controlled experiment as you collect notes on your topic. Don't limit yourself at this time.
f. Incorporate your topic ideas into the scientific process: 1) observation, 2) ask questions, 3) form a hypothesis, 4) experiment, 5) gather and record results/data, and 6) conclusion. Will your topic fit into this framework?
g. The following categories represent areas from which you may develop topic ideas:

Animal Sciences	Energy & Transportation
Behavioral/Social Science	Environmental Management
Biochemistry	Environmental Sciences
Cellular and Molecular Biology	Mathematical Science
Chemistry	Medical/Health Science
Computer Science	Microbiology
Earth & Planetary Science	Physics and Astronomy
Engineering: Electrical & Mechanical	Plant Sciences
Engineering: Materials and Bioengineering	

Once you have settled in on a category you need to bring your focus to a specific problem to solve. ISEF also includes subcategories that fit under each of the above categories. These may aid in narrowing your topic. A well-defined problem will help you to focus your project, define the data to be collected, and speed up the process of implementing your experimental plan.

Scientific research will deepen your understanding of a subject through problem solving. By applying the processes and procedures of scientific research to your project, not only are you immersed in an interesting project, the results may yield benefits to all humans.

Assignment 1: DEFINE PROBLEM

The most frequent question asked by a judge at a science fair is, “Why did you do this project?”. Before you begin a project you will want to address this question. Why are you doing a project? Why is it important to you, your school, the scientific community, or society?

To define the problem, you begin by asking to whom is the problem a problem. Who owns the problem? Who are the stakeholders that are directly involved with the problem? Who or what is being acted upon? Who or what would benefit from improvement in the problem? How you define the problem will affect what you decide to research. For example, let's say you wanted to test the effects of seed type on growth in your garden. The following is one example for defining this problem:

WHO? The producers (farmer or home gardener)
STAKEHOLDERS? Farmers, gardeners, chemical company that produced the seed, seed company, salespeople, state or federal regulatory agencies, advisors (county extension agent, consultants)
ACTED UPON? Seed Types, Soil Conditions, and Growth Conditions
BENEFITS? Farmer or home gardener, consumers of the products, profits for company, environment

Knowledge of who is involved and why your project is important will help you understand more about why this project is important to society. A judge needs to know that you understand why you did this project and why it is important to you. A project that shows an important application in your life will be more successful than a project assigned as a classroom project. Seek out a project that will hold your interest throughout the six to nine months that you will work with this topic. Don't hesitate to ask your teacher or parents for help if you can't seem to get started.

The following worksheet will help you to define your problem as you begin to explore the importance of this project. A copy of this worksheet can be found on the CD at the back of this book.

DEFINE THE PROBLEM

Name_____
Topic of Interest_____
AP Biology Lab Number _____
Category_____

1. Define or explain the potential problem that you want to solve this year.

2. Who or what are the stakeholders that are involved with this project.

3. Why is this project important for you? the community? mankind?

4. List all practical applications of real life for this project.

5. Why do you want to do this project?

ASSIGNMENT 1

1. Complete the Define the Problem Handout.

Assignment 2: FORMS

Forms are probably the most frustrating part of the science fair project. They can be a lot of work, however if they are completed before the project begins, most problems can be avoided. The best place to begin the forms is to use the Rules Wizard at http://www.societyforscience.org/index.html. This will identify which forms are necessary for your project. These forms help to document your project, which will ensure safety for you and the subjects along the way. Although these seem very tedious to complete, it is essential that they all are on file with proper signatures BEFORE you begin experimentation.

All projects must complete forms 1A and 1B. These are approval forms and all required signatures before starting your project. Your teacher will be the Adult Sponsor and will complete the Adult Sponsor and Safety Form. Other projects may require additional forms, such as working in another lab or dealing with humans, microorganisms, or vertebrate animals. Your teacher will provide you with current form copies to complete, or you can go online to http://www.societyforscience.org/isef/students/wizard/index.asp. These forms can be completed on-line and printed for your teacher. Be sure you are using the current year forms (DO NOT COPY FORMS FROM AN OUTDATED BOOKLET!)

Although your teacher does not want to limit your topic choice, previous experience has shown that human projects, microbiology projects, and vertebrate animal projects require a lot of extra effort on your part to get all forms completed. These usually involve prior approval before beginning your experimentation. Although this should not keep you from a project, you must address all other possible projects that could be completed without the use of humans or vertebrate animals. Seriously consider using an invertebrate

animal for test subjects.

You probably are already overwhelmed with requirements. The process is very time consuming. You should plan on spending 2-5 hours a week if you plan on completing an excellent project. It will take a lot of hard work and perseverance to complete the project.

Stick with it. Stay disciplined and get your work in on time. Your teacher can be an excellent help for you. YOU must, however, get your work turned in on due dates for teacher comments to help you out.

ASSIGNMENT 2

1. Complete Form 1A, 1B, and other forms as needed.

Assignment 3: HYPOTHESIS

BEFORE you begin work on your project, you must create at least one hypothesis. You may find that your project does involve three or more alternative hypotheses. You will need to prioritize these hypotheses to determine your plan of attack for addressing these hypotheses. Scientific knowledge is obtained through the process of developing an idea, hypothesis, experimental plan, and then developing conclusions based on these results. Scientists use deductive reasoning to process an idea. This is based on previous knowledge that the learner has already acquired. You will find an informative chapter of ideas on how we acquire knowledge in Anton E. Lawson's book, Biology: A Critical-Thinking Approach (Lawson, 1996). Although this is written in a biology viewpoint, it can be used across the sciences to understand how scientists solve problems. As you read this, think about how your hypothesis fits with your previous knowledge base and your experimental plan.

The hypothesis is more than simply an educated guess as most books like to address it. The hypothesis is an idea or prediction which you see as the best possible solution to your problem. Keep in mind that the hypothesis must be capable of being tested. When writing the hypothesis, try to limit it to four or five sentences. A clear and concisely written hypothesis will tell the reader what it is you think will be the solution to the problem being tested.

ASSIGNMENT 3

1. Develop a clear hypothesis that is based on all previous knowledge and fits into your
experimental plan.

Assignment 4: EXPERIMENTAL DESIGN

Now that you have a preliminary hypothesis, you are ready to begin the process of designing your experiment. The main focus of this chapter will be exploring the basic procedures that you want to accomplish. Remember this is only a plan. It may change as you continue to progress through the project. This plan will be used by the scientific review committee to approve your work before you begin. Be sure to give enough detail so that someone else could repeat your work. Realize that if your plan changes, you will need to have it reevaluated by the review committee. This may lead to a three to four week delay. It is very important to do the planning work up front to avoid changes.

You may find it helpful to look in various books to help you understand the experimental design process. One of the best sources is Students and Research by Julia H. Cothron (Cothron, et al., 1989). You may find many other sources in the teacher's classroom or a local library.

You should include the following ideas in your plan: variables, treatments, controls, experimental procedures and replications, plans for data collection, methods of data analysis, and necessary materials and equipment needed to complete this project. You should also include a brief timeline, which outlines the timeframe for experimentation. Adequate time must be saved for data analysis and presentation preparation. Begin experimentation as soon as you have approval. DO NOT WAIT TO SET UP YOUR EXPERIMENT BECAUSE YOU THINK IT CAN BE DONE IN TWO DAYS! You may encounter many challenges that could delay your project.

You should continue to turn in journal sheets for each day that you work on your project. Judges want to know that this is your work, and the journal verifies each day that you work on your project.

The experimental design plan sheet will ask that you complete the following parts:

1) Title: The title should concisely describe your project. It should catch the reader's attention and show what the project is about. The best project titles are between 8-10 words in length.

2) Independent Variable: This variable is the one which you are using to test your hypothesis. This is what you, as the scientist, are manipulating in the experiment.

3) Dependent Variable: This is the variable that you are measuring as data in your experiment. This variable is dependent upon what the independent variable is causing in the experiment. This is the information that you are going to use to try to analyze the effect that your independent variable had on the experiment.

4) Control: The control is a group of identical constants set up to compare to the independent variable(s). YOU MUST HAVE A CONTROL TO MAKE ANY VALID CONCLUSIONS OR COMPARISONS OF THE DATA COLLECTED!

5) Constants: These are everything that is kept the same in both the experimental and control group settings. The more constants that you control in your experiment the easier it will be to analyze your data and come up with valid conclusions. A common error in science fair projects is when these are not identified.

6) Repeated Trials: Every experimental design requires more than one trial for reducing possible errors in your experimental design. The number of trials will depend upon the availability of subjects, cost of materials, and ease of collecting data. A MINIMUM OF THREE TRIALS MUST BE COMPLETED FOR ALL PROJECTS. Statisticians recommend 30 trials for good statistical evidence when using analysis such as the T-Test.

7) Procedure: The procedure describes what you plan to do with the project. Remember this is only a plan, and things may change. Theoretically, another scientist should be able to duplicate your work by following this procedure.

8) Materials Needed: A detailed list of materials needed will help you to get organized before you begin your research project. It will also allow your teacher to see what equipment the school may have to help you with your project. Be as specific as possible here, as this will save you a lot of time later in the project.

You will find a variety of sample experimental plans and ideas in the classroom. Once again, don't hesitate to ask for assistance from your teacher or parents. A well-designed experiment will run much smoother in the later steps.

ASSIGNMENT 4: Experimental Plan

1. Complete experimental design sheet.

EXPERIMENTAL DESIGN PLAN SHEET Name_____

Project Title:

_____

_____

Independent Variable:_____

Dependent Variable:_____

Control(s):_____

Constant(s):_____

_____

Repeated Trials:_____

Procedures:

Materials Needed:

Assignment 5: Key Sources

The final step in the project proposal is to locate at least five key sources that you will use to find background information about your project. These should be primary authoritative sources. This means the source should contain original data or information that is verifiable in a scientific way. These could include books, magazines, scientific journals, interviews, or abstracts. You should avoid internet websites, unless you can verify the credibility of the source. Beware of fake internet sources that look like scientific research. Usually, most internet sources from educational sources (www.???.edu) or government sources (www.???.gov) are credible. A good scientific search engine or database may be a good starting place. When you find a source, be sure to copy all necessary information needed to find the source again or to document in your paper. We will discuss proper format for sources at a later time.

You have now completed all work for step 1. You should turn in all forms and the research plan attachment. This will be your project proposal. Be sure to type this work so that it may be reviewed by other scientists. Their input may save you many hours of frustration at a later time.

Be sure to keep yourself organized. Save all work on your computer as well as a storage device. Keep a backup in case something happens. As you continue to put your project together you will need every step from the process. DO NOT waste your time retyping earlier work. When we get down to "Crunch Time" your organization will be very helpful. Hang in there; put together a great project, and most of all HAVE FUN!

ASSIGNMENT 5

1. Develop a list of at least five key sources to be used in your project.
2. Include one source for care of animals if completing a project with animals.

STEP 1 GRADE CRITERIA

E=Excellent S=Satisfactory N=Needs Work

The following grade criteria will be used to assign points for this assignment:

_____ problem defined

_____ forms completed as needed

_____ forms signed and dated properly

_____ hypothesis is concise, clearly stated, and testable

_____ experimental design plan sheet/procedures

_____ sources are primary authoritative

Format (Grammar, Spelling, Typed, Style) _____

Content (Information, Documented, Reliable, Journal) _____

Creativity/Originality (Ownership of Project, Ingenuity) _____

EXCELLENT WORK: 28-30
SATISFACTORY WORK: 24-27
NEEDS IMPROVEMENT: 21-23

Total Points _____/30 points

Suggestions for Improvement:

STEP 2: LITERATURE SEARCH

One of the most important aspects of the science fair project is for you to become the expert about your topic. The only way that you will be able to make informed decisions about your project is for you to do as much research as possible relating to your topic. I realize that this is not a popular step, but it is crucial to the success of the project. This background information will be the basis for the introduction to your paper. It will also help you to answer the questions that the judges will ask you at the science fair. Remember, you must be the expert in your field of study to be able to successfully discuss your project with others.

A literature search should cover all varieties of sources available to you. Sources may include, but are not limited to, books, newspapers, magazines, scientific journals, brochures, reports, tapes, videos, lectures, interviews, or the Internet. The key is to find as much information as possible. Don't set your goals low. It is better to set a goal to find 15 sources and only find 10, rather than having a goal of 3 and finding 3. Search the media center, the teacher's room, the Internet, or at home. Ask your parents or teacher for ideas. Don't waste time searching. If you can't find something ask someone for help. Materials don't magically appear. It takes a lot of hard work and MANY hours of dedicated research to develop an adequate file of information.

You will want to search for primary authoritative sources. These are sources that have original research results with the original author(s). Journals, magazines, books, and newspapers are your best choices to find original research. Secondary sources are not as good; however; they may provide some good general background information about your topic. Realize that these sources are written about the topic, but are not authoritative regarding factual results or conclusions. A good file will have a good assortment of both of these types of sources.

It is recommended that you explore beyond the Internet. Although the Internet has a vast array of information, it may be difficult to determine the validity of the site. If there is not an author or date published it is probably not a very good source. It is recommended that for every Internet site found, you should find a non-internet site. This will help to balance your sources so you have a variety of viewpoints. There are some excellent search engines that directly connect you to a journal. InfoTrac is an excellent tool to find primary authoritative sources on-line. Proquest is a good search engine for newspaper sources. MINITEX Library Information Network will provide many possible sources. Electronic Library for Minnesota (ELM) is a resource available to all citizens of Minnesota. You can access this through your local library or from home you can visit www.elm4you.org . Internet sources can be fabricated very easily. Some may even look like research, but they are fake. Check out the sample in the classroom showing data on the California Velcro Crop. Reputable cites usually end in .edu or .gov. Be careful with Internet sources!!!!

Some areas that you should be trying to locate include similar scientific studies, current and historical studies, alternative viewpoints about the problem, information about sub problems, or interviews with informed people in the field. Remember your goal is to develop a question to be solved. You need a strong background of information to help you accomplish this goal. The library or media center can help you a lot when searching for scientific information. Don't hesitate to ask for help as you are searching.

As you search for sources, don't eliminate or try to evaluate the source for your project. You might use it after four weeks of testing. You want to keep a research file with copies of as many sources as possible. This research file will be used extensively throughout your project. A box or file system is recommended.

Once you have obtained your sources, you need to document them for future use. It is recommended that you create a bibliography source card for every source that you have found. Be sure to use a common format for bibliography cards. MLA, APA, and Chicago style are all acceptable formats. Pick one and use it consistently throughout your paper. See the following pages for examples. Keep your bibliography cards alphabetized. This will help you when you need to type your cited sources. It is suggested that you begin with a minimum of ten sources. You may add more as your project progresses. If you are using animals in your research, YOU MUST HAVE ONE SOURCE DESCRIBING THE CARE OF THE ANIMAL. This is an ISEF regulation. It does make sense that you should know how to care for an animal BEFORE you begin working with them. Your teacher has a variety of sources that will help you here. You may need to check sources in the classroom that will help you with proper formatting for these bibliographies. (Brooks, 1995; Gibaldi, 1995; Gubanich, 1985; Leahy, 1983: Pechenik, 1997; Turabian, 1987)

SAMPLE BIBLIOGRAPHIC ENTRIES

Traditional Sources

BOOK:

Author (last name first). Book Title. City of Publication: Publisher, copyright date.

Example:
McDougall, Walter. The Heavens and the Earth: A Political History of the Space Age. New York: Basic Books, 1985.

BOOK WITH 2 AUTHORS:

Example:
Kerrighan, Brian W., and Dennis M. Ritchie. The C Programming Language. Englewood Cliffs, NJ: Prentice-Hall, 1978.

BOOK WITH MANY AUTHORS:

Example:
Case, Christina et al. Microbiology. London: Benjamin Cummings Publishing Company, 1982.

PERIODICAL (MAGAZINE/NEWSPAPER):

Author (last name first). "Title of Article." Title of Periodical, Volume/Issue number (or full date of publication), page number.

Other Magazine Examples:

Weber, Bruce. "The Myth Maker." New York Times Magazine, 210(20 Oct. 1986), 23.

Camille, Andre. "Deciding Who Gets Dibs on Health-Care Dollars." Wall Street Journal, (27 March 1984), 30A and 14E.

"Rehearsal for a Space Rescue." Discover, September 1983, pp 24-27.
(NO AUTHOR GIVEN)

REFERENCE BOOKS:

"Title of Entry." Title of Reference Book. Date.

Examples:
"Voluntary Health Agencies." The Medical and Health Encyclopedia. 1987.

"Geochemistry." Webster's Seventh New Collegiate Dictionary. 1988.

INTERVIEW:

Interviewee (last name first), job title, place of work, city, state. Interviewer and date of interview. (Place of interview, if pertinent)

Example:
Morris, Franklyn B., neurologist at Mayo Clinic, Rochester, Minnesota. Interview by author, 27 Sept. 1994. St. Mary's Hospital, Rochester, Minnesota.

FILM:

Title. Director. Names of lead actors or narrator. Distributor, year. Running time if pertinent.

Example:
Much Ado About Nothing. Dir. Kenneth Branagh. With Emma Thompson, Kenneth Branagh, Denzel Washington, Michael Keaton, and Keanu Reeves. Goldwyn, 1993.

VIDEOTAPE:

Title. Videotape. Director. Narrator or actors if pertinent. Distributor. Year. Running time if pertinent.

Example:
Through the Wire. Videotape. Dir. Nina Rosenblum. Narr. Susan Sarandon. Fox/Lorber Home Video, 1990. 77 minutes.

ELECTRONIC SOURCES:

Internet Example:

Author. "Title," complete URL, date.

Yule, James. "The Cold War Revisited: A Splintered Germany," [Online] http://usa.coldwar.server.gov/index/cold.war/countries/former.soviet.block.html , November 5, 1996.

When you have a bibliography card for each source, you will begin taking notes on each source. A note card is a record of one piece of information that you may use in writing your paper. This note card should include the source and a keyword reference. These keyword references will be used as key ideas when writing the introduction to your paper. Be sure to use a keyword on each note card and cross-reference the source so you can use this in documentation later in writing your paper. A good source for note taking is Students and Research which can be found in the classroom (Cothron, et al. 1989). Use of direct and indirect quotations will provide documentation needed in your written paper. Direct quotations are taken word for word from the source. You should include the page number with the quote, as this will be needed later when writing your paper. Indirect quotes involve taking a passage and stating it in your own words without changing the meaning of the original passage. A suggestion is that you do not use more than two consecutive words from the original passage. Be sure to use quotes on all materials that you copy from the source. YOU MUST DOCUMENT ALL QUOTED MATERIAL. You will have approximately 8 weeks to get notes on all of your sources. It is recommended that you begin by taking notes on books or borrowed items that need to be returned. Copied materials will always be in your file for later reference.

Some key ideas that the note cards should include are definitions, facts, previous data or studies conducted on your topic, procedural information, safety guidelines, etc. If you think you may use the information as background information in your paper it must be recorded on the note cards. These will save you a lot of time when writing your paper.

A sample note card is shown below.

Author, Date	Keyword
"Direct Quotation" (page number) An indirect quote allows you to include information Which is not taken word for word from the text.	

Don't underestimate the importance of this step. You must be the expert if you are going to convince a judge that you are responsible for this work. Good luck in your search.

This step involves the preliminary stages of taking notes. Remember you will continue this process for many weeks. It is important that your notes are complete and organized by keywords. This will help you as you begin to write the introduction of your paper. You will save yourself A LOT of time if you take good notes.

Remember that each note card should focus only on one key idea. It is better to separate all ideas on many different cards. Be sure to include the keyword on each card. Some students have found that highlighting the keywords with a color code is very helpful in putting the same ideas together. Each card should reference the source, either by number or code (if you don't use the complete entry).

The note cards need to reflect adequate knowledge base for the complexity of your project. A general project will have many more note cards than a specific topic, which is narrowed down. It is expected that numerous hours will be needed to prepare you for understanding your project. This is not a step to take lightly. You will save many hours later if you do a good job here. As the saying goes, "you can pay me now, or you can pay me later!" Put in the time NOW!!

An alternative to notecards is to collect sources and keep a copy of each journal. Using a highlighter you can highlight the key ideas in that source. This approach saves you time initially but it will take you longer when you are assembling your paper.

The research file is a compilation of all information that you have collected through your searches. This file will probably have a number of copied sources, note card files, interview responses, notes from experts in the field, and copies of journal articles. It is important that you know everything that is available so you can relate to your topic. This file will continue to grow as you find even more information through future searches. This file will document all of the hours of searching that you have completed on your project. Once again, don't eliminate potential sources. Keep them in your file until you are 100% sure that you won't need them later in the project. The more you search, read, and understand the project, the easier it will be to explain your project to the judges.

Assignment 6: OUTLINE FOR PAPER

Now that you have a good foundation for your project, we need to turn our attention to the early stages of writing a scientific paper. The first section of the paper is the introduction, which summarizes the key background ideas that you have been collecting in your literature search. The author finds it very helpful to establish an outline for writing your paper. You have been accumulating note cards using different keywords. You should be able to take these keywords and organize your paper in the order that you wish to write your introduction. You will want to look at each keyword to identify how you may subdivide the keyword into smaller groups. A sample outline is shown below. Note that you always find two subdivisions below each heading. If you only have one subdivision, then it should be included in the heading. It is recommended that the introduction include a purpose statement and the last paragraph of the introduction focus on the hypothesis of your study.

As you plan your outline, plan so that the ideas flow from one into another. Avoid jumping from topic to topic and then back to the original topic. Keep your ideas together by subject or keywords and you should have no problem. Remember that you will end with the hypothesis for your project. Build up to this with the most important aspect of your background being discussed before the purpose statement and hypothesis.

SAMPLE OUTLINE

I. Main Heading 1

   A. Subheading 1
   B. Subheading 2
   C. Subheading 3

II. Main Heading 2
   A. Subheading 1

1. Idea 1
2. Idea 2

B. Subheading 2

1. Idea 1
    a. example 1
    b. example 2
    c. example 3
2. Idea 2

III. Main Heading 3
IV. Purpose Statement
V. Hypothesis

ASSIGNMENT 6

1. Create an outline using all keyword ideas for your project.

Assignment 7: INTRODUCTION

The introduction is a very important part of your final paper. It provides an adequate review of the literature and it defines key facts and ideas that are central to solving your problem. The introduction is typically one to four pages in length depending on the complexity of your project. Remember the total length of the written paper, including graphs and tables, should not exceed twenty pages. A historical review and any previous studies relating to your problem should be documented in the introduction.

The introduction tells your readers about the topic by briefly describing what you intend to do and what others have already done. Describe any facts that helped you formulate your hypothesis. You must give a clear picture of the work already done in the area you are studying. Be sure to read about the work of other scientists. Avoid the temptation to include all facts that you read about during your note taking experience. You may have discovered many interesting facts during your literature search, but only include material that is important to your project.

It is recommended that you end the introduction with your hypothesis. Some suggestions for your introduction include:

1. Begin with an opening sentence that gets the readers attention.
   Avoid starting your introduction with "My project is about . . ."
2. Define key background terms used in your study. These are probably your keywords from your note cards.
3. Organize your paragraphs by keywords from your research.
4. Include related studies.
5. DOCUMENT all borrowed information by quoting, by giving reference to the source, or by citing the source.
6. End your introduction with the hypothesis of your study.

7. Avoid using First Person writing style. Don't use personal pronouns such as I, we, and they unless absolutely necessary.
8. Write the introduction as if it could be published and written by anyone.

When referring to examples, remember each one has good and bad parts. These are not necessarily perfect examples to follow word for word. You will also find some common problems with introductions based on the article entitled, Guidelines for Preparation and Presentation of Student Research (Martin and Brenstein, 1998). You may also find the guidelines from the Minnesota Academy of Science to be very useful. These are located in the classroom.

What is the purpose for doing this work? If it is simply to get a grade for school, stop now. Get out. You're doing this for the wrong reason. Remember, you should be trying to impress yourself with solving a problem. Don't try to impress your teacher or the judge with your brilliant intelligence. Show a genuine look at a unique problem that you are attempting to solve.

Why is this research important to the world? Why is it important to you? How does this problem fit into everyday living? These are some of the questions that your purpose statement should address. Your purpose should address an ethical project showing a reason that this work is important. It is important to show how this project applies to your life. Refer back to assignment 1 which addresses these ideas.

The purpose statement should be clear and concise. Get to the point. Don't put a lot of fluff in the purpose statement. A good purpose statement should be three to six sentences in length. Give some explanation but keep it brief. Keep all explanations in the body of the introduction section.

ASSIGNMENT 7

1. To develop a sound theoretical/methodological framework for your project.
2. To adequately review the literature available to you regarding your project.
3. To develop a clear purpose statement and hypothesis for use in the paper and on the display board.

ASSIGNMENT 8

1. Revise assignment 7

Assignment 9: BIBLIOGRAPHY

The bibliography is a record of all sources that were cited somewhere in the paper. Most of these will be from the literature search, however some may be procedural or from the discussion section. The bibliography of cited sources will change throughout the process of writing your paper. If you have kept accurate bibliography cards you should be able to copy the entry from the cards.

This is one section that you definitely want to save on your computer and a storage device. It is very important to have a backup. It is tedious to get everything formatted so you don't want to type this part more than one time. If you need to add a source it will be easy to insert as necessary.

You will want to follow the format from the beginning of this step. Remember to alphabetize your sources. Typically the author's last name is first. You can find samples in the back of this book on the CD provided. You may also find samples in the classroom or you can find other examples in writing books (Brooks, 1995; Gibaldi, 1995; Gubanich, 1985; Leahy, 1983; Pechenik, 1997; Turabian, 1987). Ask your teacher, parent, or librarian for help if you are having trouble with formatting. You may also use many different bibliography generators from the internet. We typically use MLA format, although other formats are also acceptable. Refer to the ISEF Student Manual for other formats.

The following guidelines should be followed when word processing a bibliography:

1. single space your bibliography
2. do not number your entries in the bibliography
3. alphabetize your bibliography by author; if there is no author use the title for alphabetizing
4. the author's last name always goes first
5. first line of bibliography is not indented; the second line is indented
6. double space between entries
7. pay attention to punctuation within each entry; be consistent using same style throughout bibliography
8. remember to end each entry with a period
9. underline book, encyclopedia, magazine, and journal titles
10. use quotes around the titles of articles from encyclopedia or journals (Martin and Brenstein, 1998)

ASSIGNMENT 9

18) To develop a bibliography of cited sources used in the body of the paper.

STEP 2 GRADE CRITERIA

E=Excellent S=Satisfactory N=Needs Work

The following grade criteria will be used to assign points for this assignment:

_____ Background sources are authoritative primary and secondary

_____ Research File shows adequate background information

_____ Outline shows logical flow and uses proper format

_____ Introduction explains the relevance of information to your project

_____ The writing is clear and easy to understand

_____ Technical vocabulary is used correctly

_____ Documentation of Sources used

_____ Bibliography in proper format

_____ Minimum of five sources required in Introduction

Format (Grammar, Spelling, Typed, Style) _____

Content (Information, Documented, Reliable, Journal) _____

Creativity/Originality (Ownership of Project, Ingenuity) _____

EXCELLENT WORK: 28-30
SATISFACTORY WORK: 24-27
NEEDS IMPROVEMENT: 21-23

Total Points _____/30 points

Suggestions for Improvement:

STEP 3: DATA COLLECTION

Data collection is, for most students, the most enjoyable part of the project. Most scientists agree that work in the lab is fun. Here you will develop procedures, revise ideas, and collect data. You will have fun in experimentation, however you must document all work by recording everything that was done. Data is anything that we can measure or observe. Data can be placed into two different categories, quantitative and qualitative.

Quantitative data is any observation that is numerical in nature. This data is easily replicable as it is a number measurement. This type of data can be analyzed using a variety of statistical tests. Good quantitative data is something that can be replicated by other research scientists. It is critical that accurate data be recorded for future use and reference. Because quantitative data has a specific measurement, it must have a specific unit of measurement that was used. Be sure to label all quantitative data with the proper unit.

Qualitative data is any written observations that you notice during experimentation. These may include possible problems that you encountered. They may be outside forces that you feel may help explain the quantitative results that are being recorded. Qualitative data are your interpretations of what you are observing. Due to this fact, qualitative data may not be replicable by other research scientists. Most judges will focus their attention on the quantitative data, however good qualitative notes can help you explain this data more clearly. All researchers should keep a good journal documenting both quantitative and qualitative data.

It is imperative that all data is taken and recorded as accurately as possible. A good journal/log book will help you verify your work and adds validity to your study. The data collection sheet is one way to record your data. You may keep this information in a bound journal or on separate sheets compiled together. A well-prepared data collection sheet will help you to identify exactly what you plan to collect. It also forces you to predict other possible data or problems that you may encounter. A well-designed data collection sheet will replace the journal entry during data collection. ISEF strongly suggests a well documented journal as part of the final display. Record keeping can be tedious, but it is critical for developing conclusions about the data collected.

Assignment 10: DATA COLLECTION SHEET

The data collection sheet is one way that you can keep track of all quantitative and qualitative data. Most students find it will save them time in the long run. The data collection sheet is one piece of paper that will include all of the major experimental information needed for a good journal. If you prepare a place to record your data, then when you are collecting the data it will be much faster. You will eliminate a lot of

repetitive record keeping if you use the data collection sheet. It is very important that you record the data as you collect it. Don't rely on your memory to recall critical data.

The data collection sheet should include, but is not limited to, the following information:

1. Date of data collection
2. Trial number (both control and experimental)
3. Brief procedure with independent variable(s) identified
4. Quantitative data (dependent variable)
5. Qualitative data (observations and notes – these may be very helpful later during conclusion writing and/or data analysis)
6. Constants (include items such as environmental conditions, location, set up, etc. that will stay the same in all testing)
7. Title
8. Your name and/or signature
9. LABEL EVERYTHING WITH UNITS MEASURED!!!!!!!!!!

You do not need to rewrite published procedures. Simply document the published work and you do not need to copy any lengthy procedures. You must describe any modifications that were made to the published procedure.

A poor example of a data collection sheet is shown below. Try to determine why this is a poor example. What is missing? What would make this data easier to understand?

DATA COLLECTION SHEET

Sunday

Green

5	4	4	3	2
5	6	6	7	8

Yellow

5	5	4	5	6
5	5	6	5	4

Data worked perfect!

A better example may look more like this example:

EFFECTS OF DENERVATION ON TRANSPORT MAXIMUM OF PHOSPHATES

Group 2: Saline Control — Ken Mann
Trial # _____ — Date:_____

Initial Mass of Rat:_____grams

Constants: Inulin: 3% at 4.5 ml/hr
Saline: 0.9% at 2.0 ml/hr
Phosphate: 30 mmol at 2 ml/hr
60 mmol at 2 ml/hr
90 mmol at 2 ml/hr

Procedure:

```
        Inulin----------------------------------------------------------------------------------------
        Saline----------------------30mmol Pi--------60mmol Pi--------90mmol Pi----------------
         !                          !                 !                 !
TPTX---!----------------------------!-----------------!-----------------!----------------------
Minute  0       60       120       150     165       185     200       220     235     255
```

	P1	P2	P3	P4
	U1R _____	U2R _____	U3R _____	U4R_____
	U2L _____	U2L _____	U3L _____	U4L_____
Blood Pressure	_____mmHg	_____mmHg	_____mmHg	_____mmHg

Measured Data:

Period	Vu ml/min	In mg%	PO4 mM	Ca++ mM	Na mEq	K mEq	PAH mg%
P1							
P2							
P3							
P4							
U1R							
U1L							
U2R							
U2L							
U3R							
U3L							
U4R							
U4L							

Qualitative Notes:

ASSIGNMENT 10

1. Develop a data collection sheet for record keeping.

Assignment 11: JOURNAL

The journal is an essential part of your science fair project. The journal will document each step in your progress to project completion. The data is very important and should be accurately recorded. A data collection sheet will help you accomplish this. All other aspects of your project can be recorded and documented. You can use a spiral notebook, a bound notebook, or a three ring binder. You may use the sample journal sheets as described in the introduction to this book. The journal will provide verification of when you did your project. It should also document that this is your work. Two items that are important for your journal entries are the date and the signature. This should provide adequate documentation that this is your work. You may also prepare a cover page for your journal. This will help to identify your project. Your teacher can laminate the cover and bind your journal into a final product if you like. You will find sample journals in the classroom.

ASSIGNMENT 11

1. Develop a sample journal to use throughout your project.
2. Develop a cover page to identify your journal.

STEP 3 GRADE CRITERIA

E=Excellent S=Satisfactory N=Needs Work

The following grade criteria will be used to assign points for this task:

_____ data collection sheet shows key experimental plan aspects (title, variables, control, constants)
_____ brief procedure given to help understand how data is being collected

_____ quantitative and qualitative data shown on the data collection sheet

_____ journal cover page

_____ journal entries show date and signature

_____ adequate number of journal entries show project progress

Format (Grammar, Spelling, Typed, Style) _____

Content (Information, Documented, Reliable, Journal)
_____

Creativity/Originality (Ownership of Project, Ingenuity) _____

EXCELLENT WORK: 28 - 30
SATISFACTORY WORK: 24 - 27
NEEDS IMPROVEMENT: 21 - 23

Total Points _____/30 points

Suggestions for Improvement:

STEP 4: DATA ANALYSIS

As soon as the data is completed, it is time to do some type of statistical analysis. If the average data for group A is 12 and the average data for group B is 8, does this mean that the two sets of data are different? Yes, 12 is bigger than 8 – but is it statistically significant? There must be a way that shows that your original hypothesis was supported by the data.

In order to reach a valid scientific conclusion about your hypothesis you must run some type of statistical analysis. There are many different types of statistics to use. In the following pages you will find information about a variety of different ways to analyze data. Your teacher will go over some of these key ideas and help you determine what type of analysis is best for the type of data collected. You may find it necessary to contact a local statistician at a college or university to help you with your specific project.

It is critical that you use the right type of analysis and that you understand what it is that you are doing. Without statistics, you can not say that your data supported or did not support your original hypothesis. The evidence that you obtain about your data will be necessary to adequately form a conclusion about your project. Don't hesitate to ask for help on this step!

You may find from your statistical analysis that more trials are necessary. In all my years of working with science fair projects, I have never had a student collect too much data. A common problem, however, is too little data. Most statisticians agree that thirty trials are necessary for adequate use of many statistical tests.

Assignment 12: STATISTICAL ANALYSIS

Statistical Analysis is not something that you will master in high school. It will be a continual learning experience as you learn more about how statistics can help you as the scientist to show your point. Basically, statistics can be broken down into three categories: descriptive, correlation, and inferential. All projects use descriptive statistics. These include making pictures of your data in the form of graphs and looking at trends of the data. Correlation statistics attempts to look for relationships between data sets to try to make a stronger explanation of what is happening. Inferential statistics uses mathematical principles to show proof that there is a causal relationship between the variables being tested (Blaisdell, 1993). Beginning projects will focus on the descriptive aspects. Intermediate projects should advance to the correlation level, while advanced projects will deal with inferential statistics. It is not recommended that a beginner project use inferential statistics, unless they can explain everything that was done. Parents and mentors should avoid doing the statistics for the student as most judges will be able to identify who completed and understands their own project.

ASSIGNMENT 12

19) To use statistical analysis to determine significance in your data.
20) To write a plan for what type of data you have collected, the type of statistical analysis you will attempt, the type of test to be used, and the level of significance that will be used to draw conclusions on your project. Remember this is a plan for what you hope to accomplish.

Assignment 13: MATERIALS AND METHODS

The materials and methods section is the next part of the paper to be completed. Basically, this section puts your procedures into paragraph form for your paper. This section describes how you conducted your study. It will include materials and equipment used and all procedures completed. This is not a list of steps, everything should be written in sentences placed in paragraph format. NO RESULTS should be included in the methods section. Please refer to Guidelines for Preparation and Presentation of Student Research by Martin and Brenstein (1998) as a guideline.

Samples can be found in the classroom. Sample papers are included at the back of this book. Note that pictures can be very helpful in describing your procedures. The pictures may be in the text or they can be placed in an appendix at the conclusion of the paper. If pictures are included in the paper, you must refer to them at some point in the written form. It is important that you include how data was collected and the number of trials performed. If you are using a published procedure, you simply need to document the source used for the procedure. If a large amount of time was needed to engineer or build your apparatus, you may include this here. In some cases a good labeled sketch is as good as or better than pictures. You may also use a combination of pictures and diagrams.

You may include pilot studies or failed attempts if your paper is not too lengthy. This shows your ability to work through the entire problem. It is not recommended for the advanced project, however, beginners may use this to show how they solved their problem from beginning to end.

Do not use first person writing style. Do not use "I" when writing this section. Instead of saying, "I then performed three tests." Say – "Three tests were then performed." You may need some help from a parent or teacher to help proofread this section. This is not an easy section to complete. Avoid the long and drawn out version which includes every minor detail. However, be sure you include enough detail for the reader so that they could replicate your work.

ASSIGNMENT 13

1. To write your procedures in paragraph form to be used in the body of the paper.

Assignment 14: GRAPHS/TABLES

As you analyze your data, you need to find a way to display your data in a way that judges will understand. A clear table or graph is the easiest way to show a lot of data in a small space. A well-organized result section will make it easier to write your final conclusions.

All data should be displayed in chart or graph form. A data table can show a lot of numbers in a small area. You will want to be selective in the types of graphs and tables chosen and what data to include. For example, if you have 60 individual trials, you will want to include the mean results only. All of the original data will be in your data journal, which will be available at your display for judges to review. Avoid duplicating data in table and graph format unless it is extremely important to your study. In these cases you may want to put the table and graph in the same chart.

The type of graph is very important. For example, a line graph is only used when you have continuous data. Independent data points, which are not found on a continuum, should use a bar or column graph. If you were showing percents or parts of a whole, a pie chart would be best. You can include qualitative observations in a survey format if you used a survey to collect information. Be sure to check with your parent or teacher to be sure you are using the best graphs or charts for the type of data you are displaying. A good source for graphing is Students and Research (Cothron, et al., 1989).

It is recommended that you put your data in a spreadsheet such as Microsoft Excel. The following directions will help you create a chart and graphs using the excel program.

How to Make a Chart and Graph with EXCEL (Mann, 2003)

1. Open Excel by clicking on Excel Icon on Desktop or from hard drive.
2. Click on Excel Workbook to open a blank document.
3. Enter data into cells where you want to enter your data. You can move around the Spreadsheet using the arrow keys or press enter to go to the cell below.
4. To make a column wider or a row higher you can put the cursor on the line between the columns on the top row (between letters) or between the rows on the first column (between numbers). Click and drag cursor when the plus arrow appears.
5. To change the font size, style or alignment simply click on view - toolbars – formatting. This will allow you to change a variety of formatting items.

6. To eliminate numbers and letters in the column or row headings click on file - page setup - sheet - headings or gridlines can be added or deleted.
7. To justify the numbers in the columns click on toolbar - formatting - center, left or right justify.
8. To add a function or statistics click on Fx icon - statistics - type you want (follow prompts)
9. To add a title click on view - header/footer - custom header - type title
10. To print click on file - print preview - page setup - sheet - adjust gridlines, labels, or headings - print

GRAPHING

1. Click on Chart Wizard Symbol
2. Highlight Chart Type - next.
3. Data Range highlights the data you want included (change if it is not correct).
4. Series allows you to change names or add or remove data if necessary.
5. Click on next and then add titles
6. Click next and identify chart location - save as a new sheet to easily modify later
7. Click Finish - Print Preview - Modify or Print
8. To edit graph - double click on location you want changed
   - font change font type or size, bold, color, underline

It is important that all parts of the table or graph are clearly labeled with units used in measurements, as well as a clear title. These tables or graphs should be able to stand-alone and still be clear. These will be used in your paper as well as your display board. You will probably want to print your final copy in color, however, color is not needed in rough draft copies.

ASSIGNMENT 14

1. To construct appropriate tables and graphs to analyze data.

Assignment 15: RESULTS and CONCLUSION/DISCUSSION (PAPER)

Now that you have completed all graphs and tables, you need to write about your results. This section of the paper should be written in paragraph form. You should present your results of your research findings in a logical order. You must refer to tables, charts, or graphs as you discuss the data. Tables and graphs should be numbered separately and include captions and should be placed in an appendix. Numbering will enable you to refer to each graph or table in the text easily. Be sure to give a reference back to the appendix that has the graph or table.

Even though you may present your results in a graphic form, you must explain in text the important features of each table, graph, etc. This is also the appropriate place to

report the results of statistical analysis of your data. Remember to report the type of statistical test used and the p value used to determine significance (usually $p<0.05$).

Once again, avoid the use of first person writing style. Rather than "My data indicates…" you should write, "The data from this study indicates…"

The next section of the paper will be the conclusion section. You need to interpret your results in this section. Begin by restating your hypothesis and explain how your data either supported or rejected your initial research questions. Discuss your research findings in relationship to what is already known about the research problem (this is found reported in your introduction section). You may want to document previous research findings to help strengthen your conclusions. Your conclusions can include relevant, subjective observations or comments however you must state that these are speculation only.

Acknowledge any limitations, which affect the research results. Include major problems encountered. Be careful that these are problems that are out of your control, such as "the plants in the control seemed to die more than group 1". Don't imply that the problems were because you didn't work or try hard enough such as "I didn't read the thermometer correctly all the time."

Include future experimentation plans, which are directly a result of your study. Statistical techniques used to manipulate data may have limitations. Some of the treatment effect might have been caused by a random, uncontrolled intervening variable. Again, acknowledge these limitations and other factors over which you had no control. State how these might have influenced the outcomes of the study. Possibilities for further research suggested by your study might also be presented.

Some excellent strategies for writing conclusions can be found in Students and Research (Cothron et al., 1989), Scientific Writing in Biology (Brooks and Wallace, 1995), and A Short Guide to Writing About Biology (Pechenik, 1997). You may find a variety of sources in your local library which will help you with your writing. Read samples and get an idea of what needs to be addressed in these two sections. Don't hesitate to ask for help from your teacher. This step may involve a number of revisions to get it in its best form.

ASSIGNMENT 15

1. To put your results of your study into paragraph form, which will be used in the final paper.
2. To write a conclusion based on the relationship between the data collected and the original hypothesis.

STEP 4 GRADE CRITERIA

E=Excellent S=Satisfactory N=Needs Work

The following grade rubric will be used to assign points for this assignment:

_____ The experiment was repeated a sufficient number of times

_____ Data table with results clearly marked

_____ Materials and methods are described in enough detail to be replicated

_____ Data are presented in clear and easy to understand graphs and tables

_____ Results section is in paragraph form

_____ All charts, graphs and tables are referenced in the results section

_____ Interpretations accept or reject the original hypothesis

_____ Inconclusive findings and/or limitations of the research are identified (problem analysis)

_____ Implications of results and recommendations for further study are identified

Format (Grammar, Spelling, Typed, Style) _____

Content (Information, Documented, Reliable, Journal) _____

Creativity/Originality (Ownership of Project, Ingenuity) _____

EXCELLENT WORK: 28 - 30
SATISFACTORY WORK: 24 - 27
NEEDS IMPROVEMENT: 21 - 23

Total Points _____/30 points

Suggestions for Improvement:

STEP 5: PRESENTATION OF PROJECT

Now that you are almost completed with your project, you need to think about how you will communicate your project to the judges. You will need to finish the last parts of the written paper, complete your journal, place all materials on a display board, prepare a 12 minute oral presentation, and prepare to speak with judges about your project. The key to these final aspects of your project will be practice, practice, and MORE PRACTICE!!! If you are the expert on your topic, which you should be by now, it should be relatively easy to talk about what you did, why you did it, how you designed it, and what you plan to do in the future. Good luck, all of the hours of work are going to shine through at this time. A colleague once told me, the top ten percent will rise to the top while the bottom ten percent sink to the bottom. The middle eighty percent is a roll of the dice; hopefully the judges will like what you have to say. So where are you with your project? Are you the cream, the middle, or the rocks? There is no substitute for hard work.

Assignment 16: ABSTRACT

It is now time to begin the final piece of the puzzle, the abstract. This is a one-page summary of the entire project. An abstract gives the reader a quick overview of the entire project. The abstract should include parts of the introduction, purpose, hypothesis, procedure, results and conclusions. It should be single-spaced and no more than 200 words. You should use a readable font of 12 so the reader can see the words. Do not try to squeeze extra words by using a small font.

There is no standard way of writing an abstract. The arrangement is up to you. You will probably find that many drafts are required to get it just right. There is no harm asking other students, parents, scientists, or teachers to review your abstract. Some judges will only see this printed form, so make it memorable. For most judges this is the only written paper that they will read. Many will make comments about your project on the abstract sheet as they judge you. They will then refer to this as they assign judge points and ribbon placements.

According to Martin and Brenstein (1998) the abstract should be the summary of principal findings of the paper. It should be a stand-alone document that gives all essential information about your project. They suggest that the abstract should not include headings or include information that is not in the paper. You should not use first person style or include references, figures or tables. Avoid abbreviations and do not emphasize minor details. “While it is difficult to be both concise and descriptive at the same time, that is exactly what you should strive for when writing an abstract. Say only what is essential, using no more words than necessary to convey the meaning. Examine every word carefully.” (Martin and Brenstein, 1998, pg. 4)

The abstract needs to have key information at the top. The title is always typed in all capital letters. The next line includes the student’s last name then first. The third line is the address line. The author recommends that you use the school address here. This is

given so readers may contact the author if necessary. The fourth line should have the school, city and state. Look at examples for spacing specifics. All type should be in font size 12 with a standard font style. The heading information does not usually count in the 200 word count.

Ask your teacher to show you examples from previous ISEF and state fairs to see samples relating to your topic.

ASSIGNMENT 16

21) To prepare an abstract for your project.

Assignment 17: FINAL PAPER

Things will wrap up very quickly in the next few days. The final paper is a compilation of all the steps that you have completed so far in your project. Your science project must be presented in written form so that it can be reviewed and studied by others. Scientists need to share their knowledge so others can learn as well.

As you arrange your paper you need to update any changes that have been made since that step was last evaluated. You want to be sure to write in a past tense mode. Most scientific papers will include the following parts: abstract, title page, table of contents, introduction (includes purpose and hypothesis), procedure, results, conclusions, acknowledgements, sources cited, and appendixes.

Remember that the symposium rules limit the paper to a total of 20 pages. The computer content should not exceed 1.6mB of space as these will be emailed to judges. Work to say the most that you can in a manageable space.

Three small parts of the paper that still need to be completed are the title page, the acknowledgement section, and the table of contents.

The title page is obviously the cover to your paper. The title page states the title of the research, the category of the research, the student's name and grade in school. The first thing that a judge observes on your project is the title. The title should be well thought out and carefully constructed. The title should catch the eye of the observer without being excessively detailed or over the head of the observer. The title should define your project, giving as much detail as possible. The title should be clear and concise. Don't use a lot of connecting words. The best titles are usually ten words or less. Keep it simple, yet intriguing.

The Junior Science and Humanities Symposium suggest that the following rules be followed:

1. do not write the title as a question

2. do not use abbreviations
3. avoid excess words such as a, an, or the
4. avoid phrases such as a study of or investigations of
5. length of title should be more than 2-3 words but less than 14-15 words (Martin and Brenstein, 1998)

Sample titles are included below. You can also find sample titles in the media center or any science fair project book. (Carnahan and Hartmann, 1988; Hulse and Mc Mullin, 1991; Press, 1998) Abstract books from previous ISEF are located in the classroom.

Title Examples:

Comparing Buffalo Fish Mucus and Synthetic Slime on Racing Swimwear

Concrete Reinforcement Phase III: Strengthening Concrete Beams Using Fiberglass Reinforced Plastic Rods and Carbon Laminates

The Impact of Electronic Tapes on Lesser Snow Goose Harvest Rates

Phase 3: The Effect of Radiation (X-Rays) on Sweet Corn Seeds

The Effects of Metal Hydroxide Sludge on Plant Growth

Automatic Packet Reporting System: Building a Large Scale Geospatial Database

The acknowledgement section allows you to thank and recognize those individuals or groups that significantly helped you with your research. You may want to check with organizations or individuals to be sure that they will allow you to put their name in your paper. Some companies and individuals are not allowed to put their name on your work. This is a nice thank you section for individuals that guided you through the process. **Acknowledgements may be included in the paper but are not allowed to be displayed on the display board.**

The table of contents will help to organize your paper. It will direct the reader to all of the major sections in your paper. Although this may seem like a trivial thing to do, it may mean the difference to advancing to the next level or staying at home. A well-organized paper will be easier to follow for the judges who are reading them.

The research paper that is submitted for competition must be stapled with one staple. No other binding is allowed for competition. NO PLASTIC COVERS, FOLDER, OR THREE-RING BINDER IS ALLOWED FOR JUDGING. You may bind your final paper for display purposes at your project display. No binding is allowed for the paper competition.

The paper is key to advancing to symposium. A strong effort here will be rewarded later in the science fair. You have put so much effort into your project that you don't want this part to be sloppy. An excellent paper should be able to be submitted for publication if everything works out.

ASSIGNMENT 17

1. Compile the entire project into a final paper presentation.
22) To prepare a title page for your paper.
23) To prepare the acknowledgement section for your paper.
24) To prepare the table of contents for the paper.

Assignment 18: BOARD DISPLAY

It is now time to begin the visual display for others to admire your work. Each display must be arranged so that it clearly identifies all aspects of the project. It should tell a story about how you solved your original problem. It should be neat, attractive, and be the focal point for the judges' attention. Your display needs to show the title, purpose or problem, hypothesis, procedure, results, conclusions and abstract. If room permits you may include pictures, display materials, video, etc. Most judges will read from left to right, so it is wise to begin the story on the top left side and end with the conclusion on the bottom right side.

The display size is limited to 76cm (30 inches) deep from front to back, 122cm (48 inches) wide from side to side, and 274cm (108 inches) tall from floor to top. Most tables are 76cm high (30 inches). You will want to refer to the latest copy of the ISEF display rules for the latest rules on what can be displayed.

Normally, power of 110 volt AC, single-phase service with 500 watts per exhibit will be available. Requests for other power needs must be made prior to the fair. Additional power costs will be the responsibility of the participant. The student should provide an adequate extension cord for the project. Power should be used only if necessary to power equipment that is absolutely essential to show the judges. Special effects, such as lights or a laptop, are not recommended unless critical for the judges to see. Remember that judges will cut through the fluff of the display to focus on the project content. If the power is not essential to the project content, avoid using it.

Each student is expected to assemble his or her own exhibit. Help will be limited to packing and unpacking or to situations where the physical size or weight is such that assistance is required. Be sure that you understand how everything fits together. You will need to bring the tools necessary to assemble your project. Check with your school or fair director to see if they provide basic tools. ISEF has a hub set up for tools and supplies that can be checked out by the presenter.

Perhaps the most important part of the display is lettering, so it should be done with great care. Stencils, pre-made letters, or computer signs may all be used. Focus on color combinations which will enhance your project. Be sure they are easy to read and bring focus to the key parts of your project. Size of the lettering is important. Titles should be at least 2 inches tall, while subtitles should be at least 1 inch letters. Paragraph writing should not be smaller than font size 20. Judges should be able to be read the display from a distance of four to five feet away. The display should be a summary of key ideas. It does not have to be in paragraph form. Bullets and short phrases are acceptable, and some judges prefer to not have to read lengthy paragraphs on the display. At ISEF, the judges read through the displays without the presenter present, prior to judging. Be sure the display is easy to follow without the presenter explaining everything. The author has found that most judges do not like the display if it is a copy of the written paper put on display. The paper should be available at the display for the judges to read if they want. Most display judging will only be 10 – 15 minutes in length. Be sure the judge is able to see all of the key ideas of your display and also have adequate questions answered.

Several types of arrangements can be used for your display. Avoid copy cat displays. Make your display unique to your project. It should be neat and well organized. AVOID CLUTTER! You will find that good pictures of your equipment may be more effective than a clutter of equipment. You will find several examples of display arrangements and pictures of displays in the Science room. The author has several pictures on a CD from previous ISEF fairs. Ask your teacher or parents if you need supplies to put your display together. Be creative and put together a fun display. Judges will remember unique displays; however the key always comes back to your knowledge and project content.

Please make sure your project display meets all ISEF rules. Here are some pointers. The following is taken directly from the ISEF web site display and safety page. The bolded underlined items are the most common violations we have at the state science fair. Please do everything you can to abide by these rules. Remember pictures say a thousand words! Instead of bringing in items, **TAKE PICTURES!**

Not Allowed at Project or in Booth

1) Living organisms, **including plants and fruit flies!**

2) **Taxidermy** specimens or parts

3) **Preserved** vertebrate or **invertebrate animals**

4) Human or animal food **including popcorn**

5) Human/animal parts or body fluids (for example, blood, urine) (**Exceptions:** teeth, hair, nails, dried animal bones, histological dry mount sections, and completely sealed wet mount tissue slides)

6) Plant materials (living, dead or preserved) usually which were part of the scientific experimentation and which are in their raw, unprocessed, or non-manufactured state (Exception: manufactured construction materials used in building the project or display)

7) **Laboratory/household chemicals including water** (Exceptions: water integral to an enclosed apparatus or water supplied by the Display and Safety Committee) **Please note this includes bottles with residue and toothpaste!**

8) Poisons, drugs, controlled substances, hazardous substances or devices (for example, firearms, weapons, **ammunition**, reloading devices)

9) Dry ice or other sublimating solids

10) Sharp items (for example, **syringes, needles, pipettes**, knives)

11) Flames or highly flammable materials

12) Batteries with open-top cells

13) Awards, medals, business cards, flags, **acknowledgements (this means you can not say "Thank you to Dr. Jones on your display"; an acknowledgement can be made in the paper)** etc. (Exception: The current year Intel ISEF medal may be worn at all times.)

14) Photographs or other visual presentations depicting vertebrate animals in surgical techniques, dissections, necropsies, or other lab procedures

15) Active Internet or e-mail connections as part of displaying or operating the project at the Intel ISEF

Allowed at Project or in Booth, BUT **with the Restrictions** Indicated

1) Soil or waste samples **if permanently sealed in a slab of acrylic**

2) Postal, Web and e-mail addresses, telephone and fax numbers **of finalist only**

3) Only photographs (that is, visual depictions) of the Finalist, the Finalist's family, photographs taken by the Finalist, and/or photographs for which **credit** is displayed (such as from magazines, newspapers, journals, etc.) **if not deemed offensive** by the Scientific Review Committee, The Display and Safety Committee or Science Service

4) Any apparatus with unshielded belts, pulleys, chains, or moving parts with tension or pinch points **if for display only and not operated**

5) Class II lasers **if**:

a) Operated only by the Finalist.

b) Operated only during Display and Safety inspection and during judging

c) Labeled with a sign reading "Laser Radiation: Do Not Stare into Beam."

d) Enclosed in protective housing that prevents physical and visual access to beam.

e) Disconnected when not operating.

7) Class III and IV lasers **if for display and not operated**

8) Large vacuum tubes or dangerous ray-generating devices **if properly shielded**.

9) Pressurized tanks that contained non-combustibles **if properly secured**.

10) Any apparatus producing temperatures that will cause physical burns **if adequately insulated**

Electrical Regulations at the Intel ISEF

1) Finalists requiring 120 or 220 Volt A.C. electrical circuits must provide a UL-listed 3-wire extension cord which is appropriate for the load and equipment.

2) Electrical power supplied to projects and, therefore, the maximums allowed for projects is 120 or 220 Volt, A.C., single phase, 60 cycle. Maximum circuit amperage/wattage available is determined by the electrical circuit capacities of the exhibit hall and may be adjusted on-site by the Display and Safety Committee. For all electrical regulations, "120 Volt A.C." or "220 Volt A.C." is intended to encompass the corresponding range of voltage as supplied by the facility in which the Intel ISEF is being held.

3) All electrical work must conform to the National Electrical Code or exhibit hall regulations. The guidelines presented here are general ones, and other rules may apply to specific configurations. The on-site electrician may be requested to review electrical work on any project.

4) All electrical connectors, wiring, switches, extension cords, fuses, etc. must be UL-listed and must be appropriate for the load and equipment. Connections must be soldered or made with UL-listed connectors. Wiring, switches, and metal parts must have adequate insulation and over current safety devices (such as fuses) and must be inaccessible to anyone but the Finalist. Exposed electrical equipment or metal that is liable to be energized must be grounded or shielded with a non-

conducting material or with a grounded metal box or cage to prevent accidental contact.

5) Wiring which is not part of a commercially available UL-listed appliance or piece of equipment must have a fuse or circuit breaker on the supply side of the power source and prior to any project equipment.

6) There must be an accessible, clearly visible on/off switch or other means of disconnect from the 120 or 220 volt power source.

Maximum Size of Project at the Intel ISEF

30 inches (76 centimeters) deep

48 inches (122 centimeters) wide

108 inches (274 centimeters) high including table

ASSIGNMENT 18

1) To prepare a display board which meet the needs of your project.

Assignment 19: ORAL PRESENTATION (PAPER COMPETITION)

The regional science fair has two types of competitions. The project competition is similar to the local science fair. Your display board is judged and you talk with 3-4 judges about your project. Each project judge will spend 10-15 minutes talking with you and asking questions. Don't spend a lot of time talking. Know your key points and allow the judge to ask you a lot of questions. The second competition is paper judging.

The paper is sent to the regional committee to be read by three different judges on the written aspects of your project. At the regional fair you are then judged by 3-6 judges in an oral presentation. The oral presentation is limited to 12 minutes for you followed by 6 minutes for judges to ask you questions.

The oral presentation should involve some visual items, however the project board display is not allowed. You may use posters, slides, video, computer slide presentation, or overhead slides. You want to pick the media that you feel comfortable working with. Work with your teacher to pick the appropriate style that fits you. If using PowerPoint presentations there are a few precautions. Be sure to create your slide show on the same computer that you plan to present it on. There is very little set up time for your presentation, so you can not afford computer problems. Be very careful that your disk or storage device is compatible with the presentation computer. From past experience this

can be a big problem. Be sure to practice on the computer to be used at presentation to avoid any problems.

Avoid mixing too many media types within your presentation. It is difficult for a judge to shift from overheads to video to posters. Practice with your materials so you are very comfortable with your presentation. The paper presentation should be prepared to use all of the time available, while the project presentation is less prepared as each judge will ask different questions. Both require hard work in preparing for responses to questions that the judges may ask.

When presenting, begin by introducing yourself to the judges. Talk directly to your judges while maintaining good eye contact. Stand to the side of your visual so that you don't block the judges' view. Use a pointer to point out details that you are discussing. Avoid opening your presentation with, "My project is about…". When answering questions, be specific and honest. Don't try to make up an answer; the judge probably knows the correct answer. They are testing you to see how much you know about your topic. Be honest and say you don't know an answer: the judges will appreciate your honesty. Avoid using note cards for your presentation. Practice many times to have your responses to questions well prepared. Avoid a memorized approach, as this can be very robotic. Be flexible. If you have spent 100-200 hours on this project, you will have no problem talking for 12 minutes. Remember that you will be stopped at 12 minutes. PRACTICE, PRACTICE, PRACTICE. Do you get the feeling that there is a key theme to presenting?

Be enthusiastic, friendly, calm and in control. Always thank the audience for their attention and ask if they have any more questions. Remember that practice will be extremely important in how well you do on your oral presentation.

ASSIGNMENT 19

1. Complete an in class mini symposium and practice judging.

ASSIGNMENT 20: SCIENCE FAIR COMPETITIONS

You are now ready for competition. The science fair begins with the local science fair(usually held at the end of January or early in February). This is optional although it is good practice working with judges, especially if this is your first science fair. All projects are able to advance to the regional fair. The placing at local fair is simply a preliminary look at your project.

The second level of competition is the regional science fair. This fair is usually held at the end of February. For the SE Minnesota Regional Fair it typically alternates between Winona State University and St. Mary's University in Winona. This fair is the

springboard for all future competitions. You must be selected to advance to a higher level competition. Winners can advance to the State Science Fair or the International Science and Engineering Fair. The Minnesota State Fair is a three day event in St. Paul, typically at the end of March. The International Science Fair is held in various cities, usually the second week in May. There are many special awards at all levels of competition.

The paper competition begins at the regional science fair. Top papers advance to the Northcentral Regional Science and Humanities Symposium. This involves top papers from Minnesota, North Dakota, and South Dakota. This competition is usually the day before the MN State Science Fair in St. Paul. The top 5 papers from this competition advance to the National Symposium. This is usually at the end of April and is located in different cities around the US. The top papers from National advance to the European Symposium in London. This is usually held the end of July.

Although winning awards should not be your only motivation, it is a great reward for the hours of hard work that you have put into your project. Most of the travel awards are paid by the regional or state competition. Awards vary at each science fair, but can be a financially fun experience. Scientists enjoy talking to young scientists. Have fun and share what you have discovered.

STEP 5 GRADE CRITERIA

E=Excellent S=Satisfactory N=Needs Work

The following grade rubric will be used to assign points for this task:

_____ Abstract clearly displays key aspects of the project.

_____ Key background information is well-documented throughout paper.

_____ Data collection methods precisely summarized.

_____ Results of statistical analysis are clearly presented.

_____ Graphs and tables clearly presented.

_____ Interpretations and conclusions addressed including problems, related scientific work, and implications for further study.

_____ Board display

_____ Oral Presentation

Format (Grammar, Spelling, Typed, Style) _____

Content (Information, Documented, Reliable, Journal) _____

Creativity/Originality (Ownership of Project, Ingenuity) _____

EXCELLENT WORK: 28 - 30
SATISFACTORY WORK: 24 - 27
NEEDS IMPROVEMENT: 21 - 23

Total Points _____/30 points

Suggestions for Improvement:

Bibliography of Cited Sources

Blaisdell, Ernest A. Statistics in Practice. Elizabethtown, Pennsylvania: Saunders College Publishing, 1993.

Brandwein, Paul F. and A. Harry Passow, editors. Gifted Young in Science: Potential Through Performance. Washington, D.C.: National Science Teachers Association, 1988.

Brooks, William S. and Robert L. Wallace. Scientific Writing in Biology. Ripon College Department of Biology, 1995.

Carnahan, Peggy S. and Marjie Hartmann. Science Fair Manual: An Independent Research Guide. Englewood Cliff, New Jersey: Prentice-Hall Publishing, 1988.

Cothron, Julia H., et al. Students and Research: Practical Strategies for Science Classrooms and Competitions. Dubuque Iowa: Kendall/Hunt Publishing Company, 1989.

Dispezio, Michael A. Giant Book of Challenging Thinking Puzzles. New York: Sterling Publishing Company, Inc., 1999.

Gibaldi, Joseph. MLA Handbook for Writers of Research Papers. 4th Edition, New York: The Modern Language Association of America, 1995.

Gubanich, Alan A. A Student's Guide to Writing A Scientific Paper. Dubuque, Iowa: Kendall/Hunt Publishing Company, 1985.

Hulse, Karlyn and Terry McMullin. Prentice Hall Science Fair Manual: A Step-by-Step Approach. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1991.

Lawson, Anton E. Biology: A Critical-Thinking Approach. Dubuque, Iowa: Kendall/Hunt Publishing Company, 1996.

Leahy, William. Fundamentals of the Research Paper. St. Petersburg, Florida: Kenneth Publishing Company, 1983.

Llewellyn, Douglas. Inquire Within: Implementing Inquiry-Based Science Standards. Thousand Oaks, California: Corwin Press, Inc., 2002.

Mann, Ken. "How to Make a Graph With Excel. Winona Area Public Schools, 2003.

Mann, Kenneth J. et al. "Renal Denervation Enhances the Phosphaturic Effect of Parathyroid Hormone", Mineral and Electrolyte Metabolism. 17:16-20, 1991.

Mann, Kenneth J. et al. "Acute Renal Denervation Decreases Tubular Phosphate Reabsorption", Mineral and Electrolyte Metabolism. 18: 354-358, 1992.

Pechenik, Jan A. A Short Guide to Writing About Biology. 3rd Edition, New York: Addison Wesley Longman, Inc., 1997.

Pellegrini, Barbara J. and Karen A. Olson. Students as Scientists. October, 2000.

Press, H. J. Giant Book of Science Experiments. New York: Sterling Publishing Co., Inc. 1998.

Turabian, Kate L. A Manual for Writers of Term Papers, Theses, and Dissertations. 5th Edition Revised and Expanded by Bonnie Birtwistle Honigsblum, Chicago: The University of Chicago Press, 1987.

www.sciencenewsforkids.org

http://www.societyforscience.org/index.html

Abstract Sample #1

TESTING THE EFFECTS OF BLADE TWIST ON A WIND TURBINE GENERATOR

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Winona Senior High School, Winona, MN

The consumption and pollution of fossil fuels and other nonrenewable resources has led to a search for alternative sources of energy. The wind, though intermittent, could be bettered to supply the world with a renewable solution to this crisis. The purpose of this research was to determine whether a twist in the blade shape of a wind turbine would produce greater amounts of wattage compared to a straight bladed turbine. It was hypothesized that the wind turbine with twisted blades would produce greater amounts of wattage compared to a straight bladed turbine. Data was collected by testing both turbines on a generator at all three fan settings. The amount of voltage and amperage produced by the turbines was recorded and multiplied together to discover the wattage outputs of the turbines. Drag and Lift tests were conducted in a wind tunnel to determine the lift to drag ratios of the turbine blades. A relatively high lift to drag ratio is the prime objective in wind turbine design. The lift to drag ratio for the twisted blade (877/283) was higher than that for the straight blade (397/209). The turbine with the twisted blades produced the greatest amount of wattage at all three wind speeds (setting 1: 12.5; setting 2: 67.5; setting 3: 263) compared to the straight bladed turbine (setting 1: 8.01; setting 2: 29.8; setting 3: 78.7) thus supporting the original hypothesis. This was thought to have happened because the angle of attack was less at the tip of the twisted blade than at the base of it which caused the tip to produce less drag as it rotated around the hub of the turbine allowing the turbine to rotate faster, thus producing greater amounts of wattage.

Abstract Sample #2

NITROGEN AND SEDIMENT LOADING TO THE UPPER MISSISSIPPI RIVER: ASSESSMENTS OF 27 WATERSHEDS IN MINNESOTA AND WISCONSIN

Last Name, First Name
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This study was designed to test the hypothesis that Southeastern Minnesota and West Central Wisconsin tributaries are contributing disproportionately more sediments and nutrients to pools 5-8 of the Upper Mississippi River during summer, and that these pools would be retaining sediments and exporting nutrients. Turbidity and nitrates were measured monthly at each of 25 tributaries and Lock and Dams 4-8. Discharges were measured at 21 tributaries, whereas discharges at four tributaries and the Lock and Dams were obtained online. GIS watershed and land use data were used to determine percentage row crops in each watershed, and then compared to sediment and nitrate loads to determine if row crop agriculture increased sediment and nitrate stream loads. Tributary drainages comprised 11.8% of the watershed area upstream of Lock and Dam 8, but contributed 22.1% of sediments and 12.4% of nitrates delivered to Lock and Dam 8. When percentages of row crops per watershed were compared to sediment and nitrate loads, no significant ($P>0.40$) correlations were found either on a monthly or total summer basis. Pools 5-8 were exporting sediments, with output (107 metric kilotons) exceeding inputs (100 metric kilotons). Nitrates also were exported, with outputs (17.9 metric kilotons) equaling inputs (17.9 metric kilotons). Disproportionate contributions of sediments and nitrates from the Southeastern Minnesota and West Central Wisconsin tributaries to pools 5-8 of the Mississippi River are degrading the river environment by increasing sediment load and contributing additional nutrients to the Gulf of Mexico Dead Zone.

Abstract Sample #3

THE IMPACT OF GRASS HEIGHT AND DENSITY ON DUCK NESTING SUCCESS

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The Prairie Pothole Region of the United States and Canada is North America's single most important waterfowl breeding area. Dotted with millions of shallow wetlands formed by glaciers 10,000 years ago, the Prairie Pothole Region encompasses over 250,000 square miles and supports more than 50% of the continent's ducks. In some portions of the region, potholes and their associated prairie uplands support over 100 breeding pairs of ducks per square mile. The purpose of this study was to determine the impact of grass height and density on duck nesting success. Duck nests are greatly affected by predation. Mammalian and avian predators are destroying thousands of duck eggs each year (Ducks Unlimited). It was hypothesized that duck nests in denser and taller habitat will be more effective. It is believed to be so because in a denser habitat, the hen can hide in the grass and predators will be less likely to find her and her eggs. All data was collected between June 9, 2003 and June 30, 2003. The Long Lake and Beck Game Production areas, consisting of 3,160 acres were located in the counties of Codington and Brookings, South Dakota. Thirty-five nests were located on the Game Production Areas by either using a 6-foot willow switch or a 25-foot chain (Vaa, 2003). Grass height (cm) and density (stalks per $10cm^2$) were measured. A comparison was made, examining the success of nests in different grass heights, and the nest distance to water. The odds of a nest being successful in high grass height (above 60 cm) were eight times more likely than in low grass. This was statistically significant at .03, using a logistics regression test. The standard p value (.05) was used in this study. Duck nests in high grass height were more successful than nests in low grass height. This is probably due to the fact that visibility is restricted in high grass height. In a high-density situation, nests were more likely to be depredated, than in a low density. The majority of the data collected did support the original hypothesis.