RESEARCH PLAN: Format and Guidelines

This phase of the project involves finalizing your plan for your experiment, field study or engineering project. The primary purpose of this phase of the project is to explain, in advance, everything you are planning to do.

This phase of the project requires the greatest amount of thought. You must carefully and critically examine all elements of your plan for experimentation.

RESEARCH PLANS SHOULD BE SUBMITTED WITH COMPLETED FORMS 1, 1A, AND 1B (additional forms required for some projects).

1. **TITLE**
2. **PURPOSE STATEMENT**

What real-world question or problem are you trying to solve? You may include a very brief description of description of the relevance of this question of problem.

3. **HYPOTHESIS**

Describe the potential relationship that will be tested in your experiment. Your hypothesis should clearly pinpoint the factors that you are trying to connect or relate to each other. Include a *brief* explanation that supports your reasoning; in other words, explain **WHY** you expect your data to support the proposed relationship. Include a prediction for your experiment in the form of an "If… then…" statement (when possible). Make sure your hypothesis and prediction is ***testable*** and ***measurable***.

4. **VARIABLES**

- **Independent Variable**: Describe the variable that you will be testing in your experiment. (Remember that the independent variable is the "I-change" variable, or the variable I am messing with.) There can only be ONE independent variable, unless you are running multiple experiments simultaneously.
- **Dependent Variable**: Describe the variable(s) that you will be measuring in your experiment. This is the factor that you expect to be influenced/affected by the changes that you make in the independent/test variable.
- **Controlled Variables**: Describe any variables that you will need to control or hold constant so that they do not affect the outcome of your experiment.
    - Explain what you will do to ensure these factors don't affect the results of your experiment.

- ***Uncontrolled Variables****: For SOME projects, you may need to mention factors that you have no way of controlling that could potentially affect the validity of your data/results. Ideally, an experiment would have NO uncontrolled variables. If you have no uncontrolled variables, then you can leave this out of your research plan.*

5. MATERIALS

- Create a detailed LIST (like a detailed shopping list) of the materials that you think you will need to complete your experiment.
- Your materials list should describe the approximate size, quantity, and/or type of material that you intend to use. *This will require prior research!*
- If your experiment involves human test subjects, make sure you include the number of participants you plan to include to insure reliable results.
- If your experiment involves animal test subjects, don't forget the supplies that you will need to house and feed them!
- **It's okay if you end up eventually substituting or adding things not on the list when you conduct your experiment.**

6. SAFETY PROCEDURES

- Provide an exhaustive list of precautions that will be taken to minimize risk to yourself. Precautions should be coming from qualified sources, and included in your bibliography.
- If your experiment involves **humans or animal subjects**, you must include procedures that minimize potential risks and protect the rights of your subjects. (*See more details below*).
- If your experiment involves **potentially hazardous biological agents** and/or **hazardous chemicals, activities, or devices**, you must include any safety and disposal procedures that must be followed. *See more details below*).

7. PROCEDURES

- You MUST provide step-by-step, **numbered** instructions describing the procedure you plan to use in your experiment.
    - *You must conduct thorough research to develop the procedures you intend to use!*
- Include precise measurements, diagrams (if necessary), and instructions for anything that needs to be assembled or constructed in order to conduct your experiment.
- Be sure to include steps that clearly indicate when to use and how to wear any necessary safety equipment.
- Be sure to include clear instructions for each trial of your experiment and how each trial will be varied (if applicable).
    - Be **very careful** about using "economical" phrases in your procedures like *"Repeat steps 5-9."*
    - If your experiment involves a control group, be sure to include any relevant procedures for handling or monitoring this group or population.

8. **BIBLIOGRAPHY**

On the last page of your Research Plan (it should actually be on a *separate page*), you MUST include a list of at least five sources used during your research. Sources used to develop safety procedures are extremely important.

PROJECTS REQUIRING SPECIAL APPROVAL

Projects that will require SRC/IRB approval include those involving: **human subjects, vertebrate animals, potentially hazardous biological agents, and/or hazardous chemical, materials, or devices.**

Look through the sections below and determine which ones (if any) apply to your project. Be sure to carefully and completely address any of these items that apply to your project in the Procedures or Safety Procedures sections of your Research Plan. This will make it easier for the review board to approve your project.

Human Subjects/Surveys: (requires Human Participants Form (4) and Human Informed Consent Form)

- **Participants**: Describe who will participate in your study (age range, gender, racial/ethnic composition). Identify any vulnerable populations (minors, pregnant women, prisoners, mentally disabled or economically disadvantaged).
- **Recruitment**: Where will you find your participants? How will they be invited to participate?
- **Methods**: Describe any physical or mental activities or procedures involved in your experiment (including physical activities, the ingestion of food or drink, or even filling out a survey). Critically evaluate the potential risks to participants.
    - **Physical Participation:** What will participants be asked to do?
        - Describe the type, duration, and number of repetitions of any exercise or physical activity. What is the frequency and length of time involved for each subject?
        - Describe the ingestion method, amount, and intervals between ingestion of any food or drink, if applicable.
        - Consider and describe any health risks or other potential consequences that might result from these physical activities or the ingestion of the proposed substances.
        - **You MUST attach a complete ingredients list from any item to be ingested.**
        - **You MUST attach complete lyrics sheet for any songs listened to (must be appropriate).**
        - **You MUST attach copies of any images that will be viewed.**
        - **You MUST attach the actual questionnaire/survey when being used in an experiment.**

        - **You MUST identify the rating for any video/movie clips to be viewed. Must be "G" rated.**
        - **You MUST identify any video games to be played. Must be rated "E" for everyone.**

    - **Surveys and Questionnaires**: Will you use any surveys, questionnaires or tests? Include final copies of any surveys or questionnaires that you plan to use and critically evaluate the risk to your subjects.
        - Describe how each question or item on the survey/questionnaire will be used to measure the subject's level of interest (such as behavioral observations, measuring the time required to complete a task, recording the type of response, etc).
        - Consider and describe any emotional stress or other potential consequences that might result from the survey/questionnaire.
        - **You MUST attach the actual questionnaire/survey.**

- **Risk Assessment**: How well you identify, describe and minimize potential risks to participants will largely determine whether your Research Plan get approved.
    - **Risks**: What are the risks or potential discomforts (physical, psychological, time involved, social, legal etc.) to participants? How will you minimize the risks?
    - **Benefits**: List any benefits to society or each participant.
    - See the ISEF Risk Assessment Guide to help with this.
- **Protection of Privacy**: Will any identifiable information (e.g., names, telephone numbers, birthdates, email addresses) be collected? Will data be confidential or anonymous? If anonymous, describe how the data will be collected anonymously. If not anonymous, **what procedures are in place for safeguarding confidentiality**? Where will the data be stored? Who will have access to the data? What will you do with the data at the end of the study?
- **Informed Consent Process**: Remember that you must inform potential human subjects about the voluntary nature of participation and their right to withdraw at any time (Human Informed Consent Form). Describe how you will inform participants about the purpose of the study, what they will be asked to do, that their participation is voluntary and they have the right to stop at any time. You must evaluate and show how you plan to minimize the physical, psychological and privacy risks to your human subjects.
    - **In your bibliography, you MUST include a reference source documenting that you have read about and understand the ethical considerations and basic human rights afforded to any human subjects involved in scientific research.**

Vertebrate Animals: (requires Vertebrate Animal Form (5A)

- **Potential Alternatives**: Can this data be obtained without experimenting on animals? Did you consider or research the potential of using any non-vertebrate organisms? Briefly discuss

POTENTIAL ALTERNATIVES to your experiment and present a detailed justification for use of vertebrate animals in your project.

  - Remember that the use of animals in your experiment must take into account the **ethical** treatment of the subject animals.

- **Value**: Explain the potential value, impact, or contribution this research may have. You must justify that your project is worth the potential risks to your animal subjects.
- **Methods**: Describe in detail all procedures to be used involving the care and handling of the animal subjects.
  - Describe the number of animal subjects, including species, strain, sex, age, etc.
  - Include justification for the number of subjects planned for the research.
  - Describe housing and oversight of daily care.
    - **Be sure to justify your animal care techniques by citing a species-specific animal care handbook, as well as consultation with an animal care professional. Both of these resources MUST be included in your bibliography.**
  - Include methods used to minimize potential discomfort, distress, pain and injury to the animals during the course of experimentation.
  - Describe in detail any substances that must be administered to the animal subjects, including special ingredients, chemical concentrations and drug dosages if applicable.
    - Be sure to document that you consulted an animal care professional. **(Requires an official form as well.)**
- **Disposition**: Discuss humane disposition of the animals at the termination of the study. In other words, what will become of the animal subjects after your experiment is over? **Remember to focus on the ethical treatment of the subject animals.**

Microorganisms and Potentially Hazardous Biological Agents: (Requires Form 6A)

- **BSL Classification**: Find out the **biosafety level (BSL)** of ALL organisms you intend to study, or any that you think or expect might be present. Visit the website for the American Biological Safety Association at www.absa.org or the American Type Culture Collection (ATCC) at www.atcc.org to find the BSL classification of your organism.
- **NOTE: As of 2011-12, PROJECTS INVOLVING BSL-2 ORGANISMS MAY NOT BE PERFORMED BY JUNIOR DIVISION (MIDDLE SCHOOL) RESEARCHERS.**
- **BSL Lab Checklist**: Obtain and complete a BSL-1 checklist for the lab that you intend to use. Document that you have completed this checklist in this section of your Research Plan.
- **Biological Source**: Describe the source of the biological agent or the source of specific cell line, etc. (Where are you getting it from?).
- **Safety Methods**: ***Describe in detail*** the safety precautions you will follow and include them in your "Procedures" section where applicable.

- **You MUST provide a detailed description of the aseptic techniques you intend to use to protect yourself and others from PHBAs. These procedures must strictly follow the guidelines for BSL-1 facilities.**
- **Be sure to include a reference in your bibliography that includes standard procedures for handling and working with potentially hazardous biological agents.**
- It may be beneficial to consult a mentor if you have questions regarding these procedures.
- For a description of standard microbiological practices and techniques, see http://www.hawaii.edu/ehso/bio/BSM_part02.htm

- **Disposal**: Discuss the method(s) of disposal you will use.
  - The **ONLY** acceptable methods of disposal are those outlined in the 2012 ISEF rules or an approved use of the institutions biohazard disposal procedure with detailed documentation. These procedures must be thoroughly outlined in the Research Plan AND cited in the Bibliography.
  - The following two methods have recently been approved:
    - Use of 10% household bleach concentration in lieu of 10% concentration of sodium hypochlorite.
    - Use of an approved institution's biohazard disposal procedure with detailed documentation.
- **Unknown Organisms**: Studies involving *unknown* microorganisms present a challenge because the presence, concentration, and pathogenicity of possible agents are unknown. In science fair projects, these studies typically involve the collection and culturing of microorganisms from the environment (e.g. soil, household surfaces, skin, etc.). Research with unknown microorganisms can be treated as a BSL-1 study under the following conditions:
  - Organism is cultured in a plastic Petri dish (or other standard non-breakable container) and sealed. Other acceptable containment include petro film and doubled heavy-duty (2-ply) sealed bags.
  - Experiment involves only procedures in which the Petri dish remains sealed throughout the experiment (i.e. counting presence of organisms or colonies).
  - The sealed Petri dish is disposed of in the appropriate matter under the supervision of the Designated Supervisor.
  - **If a culture is opened for identification, sub-culturing or isolation, it must be treated as a BSL-2 study and involve BSL-2 laboratory procedures. These projects cannot be completed by middle school students.**

Hazardous Chemicals, Activities & Devices: (Requires Risk Assessment Form (3)

- **Risk Assessment**: Conduct a "Risk Assessment" to evaluate the potential dangers associated with your project. See Intel ISEF Guidance for Risk Assessment if you need help with this process.

- Projects involving the use of hazardous chemicals, activities, or devices MUST be reviewed by the local SRC prior to experimentation.
- Always research and contact the related state agency for documented permission and legal requirements for any hazardous chemicals, activities, or devices. Document this contact in your project notebook and cite the contact in your bibliography.
- **Hazardous Chemicals**: When doing a risk assessment the type and amount of exposure to a chemical must be considered. For example, an individual's allergic and genetic disposition may have an influence on the overall effect the chemical may have.
    - Describe in detail the chemical concentrations and drug dosages of substances to be used (if applicable).
    - Describe the safety precautions and procedures your plan to implement to minimize risk. In order to do this, the student researcher MUST locate, copy, cite, and refer to **Material Safety Data Sheets (MSDS)** to ensure that proper safety precautions are taken.
        - **MSDS citations MUST be made in the Bibliography for any substance classified by OSHA as a potential health or physical hazard (see the FLINN SCIENTIFIC catalog or www.flinnsci.com).**
        - Have a copy of the MSDS in your Project Folder.
        - Some MSDS sheets rank the degree of hazard associated with a chemical. This rating may assist students, adult sponsors, and designated supervisors in determining risk associated with the use of a chemical.
    - Material Safety and Data Sheets (MSDS) may be collected by your laboratory and should be available from the manufacturer. The internet also has a range of free resources:
        - http://www.flinnsci.com/sections/safety/safety.asp - A directory of MSDS sheets from Flinn Scientific Inc. that includes a ranking of hazard level and disposal methods
        - http://www.ilpi.com/msds/index.html - A listing of numerous sites that have free downloads of MSDS sheets
    - **Chemical terms you may encounter:**
        - Toxicity – the tendency of a chemical to be hazardous to health when inhaled, swallowed, injected or in contact with the skin
        - Reactivity - the tendency of a chemical to undergo chemical change
        - Flammability – the tendency of a chemical to give off vapors which readily ignite when used under normal working conditions
        - Corrosiveness – the tendency of a chemical, upon physical contact, to harm or destroy living tissues or physical equipment.
- **Disposal**: Discuss the methods of disposal you will use to safely and legally dispose of any chemicals, drugs, or devices. If applicable, the student researcher must incorporate in the research plan any disposal procedures required by federal and state guidelines.

ENGINEERING PROJECT RESEARCH PLANS

Engineering projects are different than controlled experiments and should include the following sections:

A. **Defined Need** (instead of problem): What problem are you trying to solve with your design or invention? Define your target user or customer.

B. **Hypothesis/Engineering Goals:** What is/are the primary goal(s) you are trying to achieve? What will you use as the benchmark for success? What exact task or function will you use to "test" the functioning of your design?

C. Methods and Experimental Procedures

- **Design Criteria** (instead of Variables): Design criteria are additional requirements that you, the engineer, must consider when making decisions about how to build the resulting product. They are the real-world factors that limit your design.
    - **Sample list of design criteria:** cost of certain materials, availability of certain supplies, available power source, power output, weight, storage/construction space, timeframe/time available for design and testing, performance goals (what tasks it needs to be able to complete), durability, style/appearance factors, etc.
    - You may use a **bulleted list** to identify your design criteria, but you ***MUST include a brief statement or even a few sentences to describe how each design criterion will influence your design***.
    - For example, you might set out to design a baseball bat that will be easier to swing and reduce arm fatigue. Your engineering goals might call for the design to have the same strength and size as an aluminum bat, but half the weight. These criteria would rule out making the bat from balsa wood (not strong enough) or steel (too heavy). They would lead you to look at materials like carbon fiber composites (very cool stuff, but very expensive). Depending on your budget, some materials that might meet your engineering goals may simply not be practical for you to incorporate into your design due to cost.
- **Materials List:** See earlier description (same as for other projects)!
- **Preliminary Designs** (instead of "Procedures" section): sketches and descriptions of preliminary design ideas, plus step-by-step procedures for any parts of your design that have been borrowed from other sources (cite the sources where you learned to build or construct certain parts of your design).

If you are doing an engineering project and need help, please see:
http://www.sciencebuddies.org/mentoring/project_engineering.shtml