Designing an Experiment

In this classroom, you are a scientist. Scientists design experiments to explain in a quantifiable manner why things happen. Today, you will begin designing your procedure for your research project. There are different methods for designing your experiment based on what you are doing. Engineers do iterations, they write steps based off what they will try first, test it, and then revise based off the outcome of their test. A scientist doing a "traditional" experiment will not change their experimental design but will repeat their experiment many times to gather data. A scientist studying humans needs permissions and a committee to review their procedure / survey questions to ensure safety of participants. Data scientists are reviewing other people's research and extracting data that helps them answer their research questions.

This assignment differs based on what your research project is. Go to the section that applies to you. You only do the section that applies to you.

All projects must have a Research Plan written AND approved prior to experimentation. Follow the instructions below to detail the rationale, research question(s), methodology and risk assessment of the proposed research. Much of this you have already done so open up those assignments and copy and paste.

Thoughts for all to think about as you design:

Safety – This is usually where most students must redesign. Safety is important, accidents are usually avoidable by thinking out your procedure and what you have learned about lab safety. One way to help you see potential hazards is to imagine that someone who thinks of worst case scenario is going to read your procedure and deem it safe or not. This means if you are using fire, adult supervision and fire extinguishers need to be in the safety portion of your procedure. If you are making food, how will you test it without using taste testers?

Humans – You must have a human research form risk assessment done and ready to be approved when you submit. Survey questionnaire must be approved and not changed after approval (if revisions required, a second approval is needed).

Pro tips for writing your **METHODS** section:

A **procedure** is a fixed, step-by-step sequence of activities or course of action (with definite start and end points) that must be followed in the same order to correctly perform a task.

- Be specific--imagine instructing someone who has no idea what you did!
- Write the procedure in bullet points and in the **passive voice** ("the fish were fed", not "I fed the fish")
- Don't list your materials separately (this is for babies). Instead, incorporate them into your descriptions of what you DID

What should my methods include?		
Engineering	**Experimental**	**Data Analysis**

• **Sketch** of your design. If you use a **program** (Inventor, Tinkercad) for the prototype, include this.
• Label all **measurements** and **materials** used
	• Sketch of your setup
	• **Step by step description**
	• How many subjects
	  ○ **Sample size n=**
	• **Equipment** used to collect data
	  ○ Include brand name
	• **How the data was analyzed**
	  ○ Averaged? Compared?
	• "The data was analyzed with a _____ statistical test using google sheets. Significance was determined as a p value of <0.05, which indicates..."
		• What **type of data** was used
		• What **website** did the data come from (provide URL)
		• **How the data was analyzed**
		  ○ Correlation analysis? T test?
		• Significance was determined
		  ○ R value (correlation test)
		  ○ P value (all other tests)

From the options below, select your project type to be taken to the correct format to use. You only do one. You can delete the ones that do not apply to you. For example, if you are doing human subjects, delete experimental/data analysis and engineering.

Experimental/Data Analysis

Human

- *Note – If you are collecting data from previously published data, you are doing a data analysis project, use that template.*

Engineering

Human Subject

Question or Problem being addressed - Title
Rationale Brief synopsis of the background that supports your research problem and explain why this research is important scientifically and if applicable, explain any societal impact of your research.
Research Question/Hypothesis/Expected Outcomes
Materials List List of all items used in research. Make sure to include concentrations of all chemicals, source and amount of all living organisms, and all equipment used.
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).
Where will you find your participants?
How will they be invited to participate?
What will participants be **asked to do**?
Will you use any surveys, questionnaires, or tests? If so, briefly describe here and provide a link to all materials that will be used with the human participants.
What is the **frequency and length of time** involved for each subject?

What are the **risks or potential discomforts** (physical, psychological, time involved, social, legal, etc.) to participants?
How will you minimize the risks?
List any **benefits to society or each participant**.
What identifiable information (e.g., names, telephone numbers, birth dates, email addresses) will be collected from the participants?
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, both during and after experimentation?
What will you do with the data at the end of the study?
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.
Hazardous Chemicals, Activities & Devices (Safety): Procedure must include the following items! ● **Describe Risk Assessment process.** ● **Detail chemical concentrations and drug dosages.** ● **Describe safety precautions and procedures to minimize risk.** ● **Specify methods of disposal.**

Procedures (Research Methods) Description in detail of method/procedures. This is a step-by-step list of what you will be doing in the order you will be doing it.

Bibliography

List any references (e.g., science journal articles, books, internet sites) from your article analysis. Please use a **variety of sources**, five sources from the internet will not suffice.

- If you plan on using **human subjects**, one of these references must be from the listing of human subject reference in the ISEF Rules and Guidelines.
- Include MSDS/SDS citation for all **hazardous chemicals** used in experimentation.

Use the chart below to help you keep track of your sources. Anything that you use to help you build a procedure, survey, safety should be included on this chart.

Topic	Article	Author	Link

If you are planning on competing at the Regional Science Fair, you must complete Form 4: Human Participants and Sample Informed Consent (you must incorporate the informed consent into your survey if doing a survey) found at: https://www.societyforscience.org/isef/forms/

Engineering

Question or Problem being addressed

Rationale

Brief synopsis of the background that supports your research problem and explain why this research is important scientifically and if applicable, explain any societal impact of your research.

Engineering Goals/Expected Outcomes

How is this based on the rationale described above?

Materials List

List of all items used in research. Make sure to include concentrations of all chemicals, source and amount of all living organisms, and all equipment used.

Risk and Safety

Identify any potential **risks** and **safety precautions** needed. Look at the Engineering Project Guide to below to help you.

Procedures

Numbered step by step detail of procedures and experimental design to be used for data collection including proper disposal if needed. See guide below to determine if you need additional approvals

Engineering Projects Guide

Use this information to help determine the requirements of Engineering Projects and potential areas that will require pre-approval and/or extra safety precautions.

Engineering Project Checklist

Consider the answers to the questions below. If the response is yes, then the project may fall under more specific rules and those sections of the International Rules & Guidelines should be consulted.

Hazardous Chemicals, Activities and Devices

Will your project involve any of the following:

- ☐ DEA-controlled Substances
- ☐ Firearms and Explosives
- ☐ Prescription Drugs
- ☐ Alcohol & Tobacco
- ☐ Regulated Drones
- ☐ Radiation

Device Testing with Human Participants

- ☐ Are you going to test your project (device, app, invention, prototype, etc.)? If yes, does it require persons to interact with it other than yourself or adult sponsor/supervisor?
- ☐ Do you intend to gather background knowledge through a survey or interviews to understand the potential use and needs for your project design?
- ☐ Are you going to ask for opinions or suggestions on your project design at any point of the project?
- ☐ Does your project intend to gather personal data/have a health benefit to the user?

Vertebrate Animals

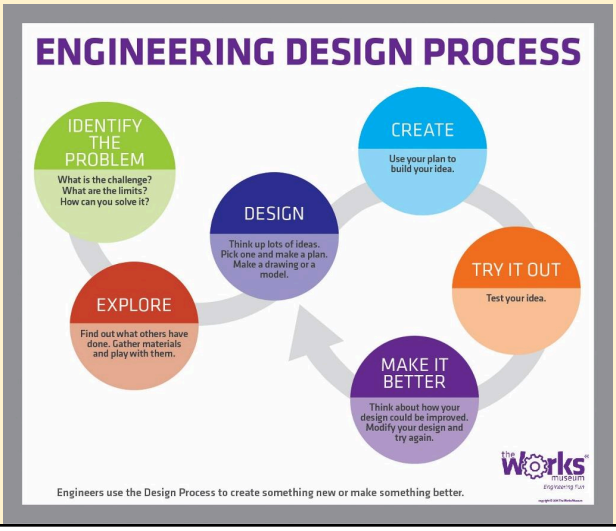
- ☐ Does your project include any interaction with vertebrate animals in any phase of the project? If yes, please refer to the full Vertebrate Animal Rules.

Potentially Hazardous Biological Agents

- ☐ Does your project include any collection, examination or handling of microorganisms, and/or fresh or frozen tissue, primary cell cultures, blood, blood products or body fluids?
- ☐ Are you going to culture or isolate any substance, known or unknown? If yes, please refer to the full Potentially Hazardous Biological Agents Rules.

Step by Step Procedures

Make sure to clarify which procedures were completed by the researcher and which were completed by others
With engineering, you are using the engineering process. You will list the steps you believe will make a product that you can test. You will then test and revise based on the tests. Each iteration (trial) should bring you closer to your desired result.



Data Analysis

Describe the **procedures** you will use to **analyze the data** that determines if the engineering goals were met.

Bibliography

- List any references (e.g., science journal articles, books, internet sites) from your article analysis. Please use a **variety of sources**, five sources from the internet will not suffice.
- If you plan to use **vertebrate animals**, one of these references must be an animal care reference.
- Include MSDS/SDS citation for all **hazardous chemicals** used in experimentation.

Use the chart below to help you keep track of your sources. Anything that you use to help you build a procedure, survey, safety should be included on this chart.

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Experimental/Data Analysis

Question or Problem being addressed

- What are you testing?

Rationale

Brief synopsis of the background that supports your research problem and explain why this research is important scientifically and if applicable, explain any societal impact of your research.

- Why are you testing it?

Research Question/Hypothesis/Engineering Goals/Expected Outcomes

How is this based on the rationale described above?

- What is the reason you are testing?

Materials List

List of all items used in research. Make sure to include concentrations of all chemicals, source and amount of all living organisms, and all equipment used.

- What do you need to conduct this experiment? Be specific.

Risk and Safety

Identify any potential **risks** and **safety precautions** needed.

Potentially Hazardous Biological Agents: Procedure must include the following items!

- Describe **Biosafety Level Assessment process and resultant BSL determination**.
- Complete appropriate Biosafety Form. **Include source of agent, source of specific cell line**, etc.
- **Detail** safety precautions and **specify methods of disposal**.

Hazardous Chemicals, Activities & Devices: Procedure must include the following items!

- Describe **Risk Assessment** process.
- Detail **chemical concentrations and drug dosages**.
- Describe **safety precautions** and procedures to minimize risk.
- Specify methods of **disposal**.

Be detailed. If working with power tools, either state under adult supervision or will be done by adult. Think of the safety precautions that exist in science and can/should you use them.

Procedures Numbered step by step detail of procedures and experimental design to be used for data collection including proper disposal if needed.

If you are planning on competing at the Regional Science Fair and working with vertebrate animals or potentially hazardous biological agents complete those forms found at https://www.societyforscience.org/isef/forms/

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