A Guide for Engineering and Invention Projects

This guide is a series of questions to answer as you plan and execute your project. Links are provided to sections of the International Rules that are pertinent. Understanding that engineering design is iterative, it will be important to check back as your project develops to ensure adherence with the International Rules for your safety and anyone involved in your project.

Getting Started:

The planning stage of a project is often the most critical and time-extensive. It involves goals-setting, project ideation, brainstorming, prototyping, background research (a literature review and/or patent search for prior art), needs assessment, identifying a mentor or supervisor for the project and obtaining any approvals necessary if your project will be working with human participants or vertebrate animals.

Problem to solve

- What is the problem? Why do you think it is a problem?
- What expertise or supervision might you need to explore this problem?
- What is the need? * (If you survey individuals for a needs assessment, work with your school to establish an Institutional Review Board (IRB) as discussed in the ISEF Rule book on page 5 and review and approve the human participant study before you begin.)
- Do you have a potential solution in mind to address your problem or need?
- What is/are the potential benefits(s) or value in addressing this problem or need?

What are similar problems/questions to your own?

- How is your idea similar to other ideas? How are they different?
- What comparisons could you draw?
- What could you learn from similar problems/solutions?

Is your idea novel (new)?

- Does it have utility or function?
- Is it a solution that is "obvious"?
- How can you make it your own?

Have you conducted a patent search?

Design/Methods

Determining the answers to these design/methods questions will help determine additional risk assessments, rules review, supervision required and any pre-review and approval requirements before the experimentation/building phase can begin.

What

- What is your approach? How are you going to solve the problem or address the need? How are you going to answer the question?
    - Will you be building a prototype?
        - Do you have an existing model to work from?
        - Are there standard criteria that you need to be aware of?

- Will you be collecting data?
    - How are you going to collect the data?
    - How can you control variables?
    - Do you need to build something to collect the data?
- Are you going to conduct experiments?
    - How many trials will you need to do?
    - What are elements of the prototype that will need to be tested?
    - How can you tell if it works?

With What Materials?

Material selection is an important element of risk assessment as it may involve hazardous substances or devices that have requirements regarding usage and supervision. Material selection also involves considering environmental concerns as well as those of cost and replicability.

- What are the materials that you will be using?
    - How easy is it to obtain the materials?

What are the costs of the materials?

- What hazards are associated with the materials? (hazard identification/assessment)
    - How do you determine the potential hazards of your materials? (SDS sheet, hazard information databases)
    - Are there human or mammalian health hazards?
    - Are there aquatic hazards?
    - Are there environmental or ecosystem hazards? (i.e., ozone depleting potential, global warming potential, etc.)
- What is the potential for exposure to the hazard? (risk assessment)
    - Hazards x Exposure = Risk
    - What personal protective equipment (PPE) (if any) is required for the materials?
- What alternatives might you consider? (alternatives assessment)
- Consider the lifecycle of the materials:
    - Starting material/Raw materials: Are your materials from renewable or depleting feedstocks? (i.e., biobased versus petroleum)
    - Process: Are there high energy requirements as part of the process? Are there hazardous materials/chemicals used in the process?
    - Product: Are there hazards associated with the final product?
    - End-of-life: Is there waste produced? What happens to the products after use? How will you dispose of unused materials?
        - What is the appropriate/required waste disposal method(s) for the waste?
        - How will unused materials be disposed? (i.e., reused, recycled, biodegraded (composted), disposed)
        - How will the product be disposed of after use? (i.e., reused, recycled, biodegraded (composted), disposed)

Where

The setting of your experimentation (Home, School, Regulated Research Institution, etc.) is an important consideration influenced by the nature of the study, the supervision needed and in some cases the equipment and/or biosafety-level containment available.

- Where do you plan to conduct your research?
- What requirements or constraints exist for where you can operate?
- What equipment will you need?
    - What locations have the equipment for you to use?
    - Do you have permission and proper training to use the needed equipment?
    - What supervision is required (if any).
- What environmental conditions do you need?
    - Do you need to be in a laboratory environment that has the necessary biosafety features and equipment? (BSL-1 or BSL-2)
    - Do you need to have a climate-controlled space?
    - Will your project require being outdoors to allow room (no ceilings or limited space)?

How are you going to test or draw conclusions about your solution/answer?

- Will you be testing your device?
- How many trials you will need to conduct?
    - Have you determined what will need to be measured to confirm that the product solves the problem?
    - Are there multiple measures or elements to consider?

Human Participants - How will humans interact with your product?

Please review all Human Participant rules and the role of an Institutional Review Board (IRB) as discussed on page 5 of the International Rules.

- What safety features and/or instructions will you need to consider so that people use the product safely and for its intended purpose?
- Will you have others (classmates, friends, family, human participants) testing your device?
- Do you need to conduct a survey or questionnaire to get opinions of others?
- Have you considered alternative methods of testing without human participants?

Vertebrate Animals - Does your project involve using animals or testing on animals?

Please consult the Vertebrate Animal section of the International Rules and have review by the Scientific Review Committee (SRC) prior to working with vertebrate animals.

- If yes, have you considered alternatives?
- If working with animals, you will need to consider
    - Where do you obtain the animals?
    - How do you protect the health and well-being of the animals being used?
    - Who will be caring for the animals while they are involved in the project?
    - Have you consulted a Veterinarian?
- What risks are involved to the animals or the student researcher working with the animals
    - Have you gotten the necessary permissions, permits or approvals to work with the animals?
    - What happens to the animals after the project is concluded?