# Logbook

**Invention Name:** _____

**Invention Category:** _____

| | Name | Grade |
|---|---|---|
| **Inventors:** | _____ | _____ |
| | _____ | _____ |
| | _____ | _____ |
| | _____ | _____ |

**School:** _____

**State/Province:** _____

ANDREWS UNIVERSITY STEM
Science | Technology | Engineering | Math

## Introduction

Math and science can often seem impractical for everyday life. Maybe you've asked your teacher, "Why do I need to learn this?!" In fact, math and science are part of a broader creative problem-solving mindset. Everyday life is full of challenges, which means we all need to solve problems. The goal of this project is to give you practical hands-on experience with solving problems. Engineering and inventing use the tools of math and science to solve real-world problems. Whether or not you decide to pursue a career in STEM (Science, Technology, Engineering, and Math), the problem solving skills you will learn through this project can be applied to almost any challenge. So have fun, be creative, and enjoy this opportunity to learn about STEM in a hands-on collaborative experience!

## About the Logbook

Fun hands-on project? Cool! So why do I need this big document? The Logbook is your record of the steps you will take to create your invention. It contains all your design ideas, iterations, tests, etc. Your team will fill it out together over the course of the project, so it isn't too much all at once.

In addition to the Logbook, each team member will keep a personal record of their progress and goals, either on a provided worksheet or in their own notebook. This is just a quick record of your progress each week to help you stay on track.

The completed Logbook will serve as the proof of what you did as well as a comprehensive project report. It is important to take neat, careful notes for each step. It needs to be clear for other people to read as well as for your future self (further development or improvement). If you decide to patent the invention, this can also serve as the record of your work in case there are questions about your claim to the ideas.

In support of this, it is important that you properly research the ideas and solutions you come up with to be sure they are original. As a matter of professional and academic integrity, we ask that every team member sign the Statement of Originality. This applies to your final design and the prototype you create. Along the way, you may come up with potential solutions that have already been invented. You may not be able to develop those ideas but you should still record them since they were part of your ideation process.

At the end of the project, you will submit your Logbook for grading as well as have it available during your final presentation. The Logbook will also be useful when creating the presentation because it will contain the complete record of the work you did. So do a good job on the Logbook and your presentation will be easy.

# Project Guidelines

## Requirements:

- The teacher must sign off on the project and design before the prototype is built.
- The final design and solution must be completely original or sufficiently different that it can be considered a true innovation and not a copy of existing inventions/products.
  *See the Solution section of the Logbook for more information (pg. 15).*
- All group members must sign the originality statement promising that the design ideas in the Logbook follow the originality requirements.
- The invention prototype does not need to be fully functional, but it should be able show how the final design would operate. If the group can create a functional or partially functional prototype, they should do so.
- If the invention cannot be demonstrated at the final presentation due to size constraints or other considerations, a video must be made demonstrating its use.
- For all presentations, each group will need a Tri-Fold board explaining the project, the signed and completed Logbook, and the prototype. Some or all of these items can be used in the verbal presentation but regardless, they need to be available to show people afterwards.
  *See the Presentation Guidelines handout for more information.*

## Restrictions:

- Animals may not be brought to the final presentation at the invention event. If the design is for animals or uses animals in any way, you must find a way to demonstrate its function without the animal present.
- Inventions may not use wall outlet electricity (110V or higher) unless you are only using unmodified consumer products such as a fan or smartphone charger.
  Battery operated devices are acceptable as long as they use common low voltage batteries (i.e. no car batteries, etc.).
- Inventions may not use any flames or heat sources (lighters, matches, candles, fireworks, heating elements, etc.) or any combustible liquids.
- Inventions may not use biohazards or other dangerous materials.
- Inventions may not be or make use of any weapons such as guns, knives, explosives, stun guns, pepper spray, or blunt weapons.

*If you have any questions about the project guidelines or feel that the project deserves an exception to the above Requirements & Restrictions, the teacher may contact us at [stemconnect@andrews.edu](mailto:stemconnect@andrews.edu).*

## Statement of Originality

We promise that the ideas and designs in this Logbook are our own. We have researched our solution to verify that it is original or innovative. (all team members must sign)

| **Name** | **Signature** |
| --- | --- |
| | |
| | |
| | |
| | |

**Date:** _____

## Teacher's Signature

I approve of the invention that my students created/will create and agree that it meets the Project Guidelines for safe and acceptable projects.

| **Teacher's Name** | **Signature** |
| --- | --- |
| | |

**Date:** _____

## Important Terms

Become familiar with the following terms and their definitions in the context of this project.

**Invention** – A new and unique solution or device to solve an observed problem

**Innovation** – An improved/enhanced solution or device

**Entrepreneur** – A person who takes the risk of starting a business to develop their product or service

**Engineering** – The application of science to create useful products and systems through careful design, building, testing, and iteration

**Engineering Design Process** – The steps an engineer follows to develop a solution to a problem

**Ideation** – The process of generating ideas through discussion, brainstorming, and research

**Scope** – The extent of the problem or design and the conditions which must be considered

**Criteria** – The important requirements that must be met to achieve a successful design

**Constraint** – A limitation or restriction for the design that must be accounted for

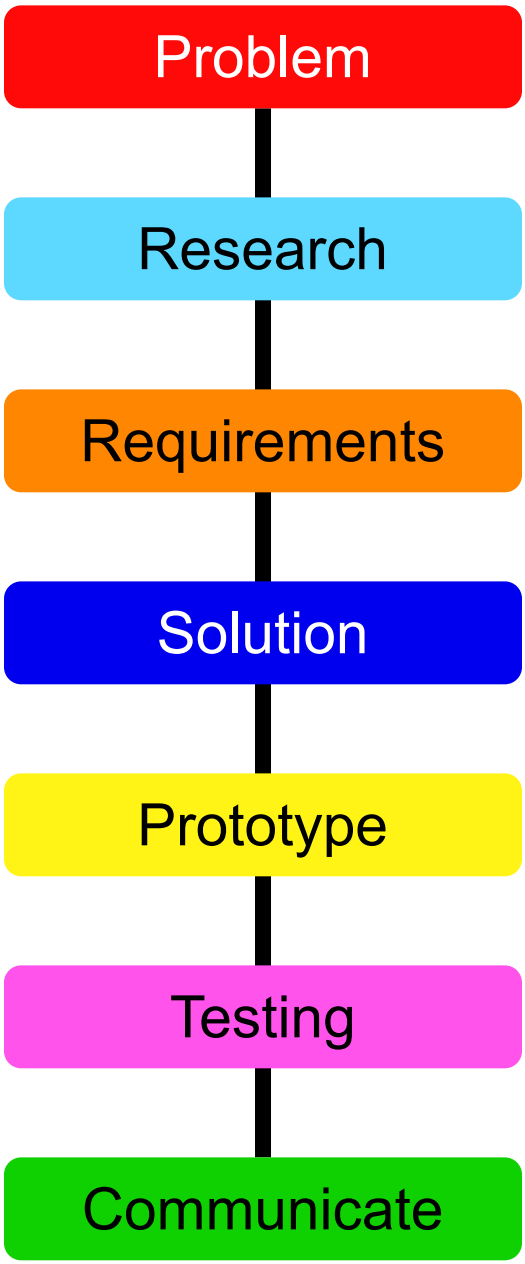
**Prototype** – A model of the design to prove that it works

**Iteration** – Repeated testing and improvement to make the design better

**Patent** – An official document protecting the rights of an inventor so other people cannot steal their invention

## Engineering Design Process

The Engineering Design Process is the technique you will use to design your invention. It is the same process used by professional engineers and is very similar to the Scientific Method. By following these steps, you can take your invention all the way from an idea to a final product. For this project, you do not need to produce a market-ready product. You only need to create a prototype/model. However, you are welcome to continue developing your invention beyond this project. Also note that the order of these steps is somewhat flexible, especially during the testing and redesign stage.




**Identify & Define the Problem**
Observe the problems around you and choose one to solve. Then define the important aspects of the problem.

**Research the Problem**
Research who/what is affected by the problem, existing solutions/inventions, and areas for improvement.

**Specify Solution Requirements**
List the specific requirements for your solution. The design is successful when it has met these requirements.

**Identify Options & Choose the Best Solution**
Brainstorm and discuss to identify original ideas. Compare with the requirements to choose the best solution.

**Design & Build the Prototype**
Determine how your invention will work and what it will look like. Then follow the design and build it.

**Test the Prototype**
Test to see if the prototype works as intended and meets the requirements. Repeat previous steps until it does.

**Communicate Your Solution**
Present and explain your problem, the research, the process you followed, and the invention you created.

## Find a Problem

This first step is often the hardest. Finding a good problem to solve can be difficult but it doesn't need to be. Rather than sitting down and trying to come up with an idea on the spot, observe as you go through your day, talk to others, discuss and brainstorm. As you observe and talk with others, you will find that there are problems all around.

Try these techniques to identify a problem you can solve with an invention.
Come up with as many ideas as you can.

- Observe problems/challenges in your **home**, **school**, **church**, **community**, and the **environment**.
- Notice when **people complain about or struggle** with a problem.
- Ask your **parents**, **grandparents**, **friends**, **neighbors**, **teachers**, or **community members** what problems they have.
- Notice things or tasks that are **difficult or inconvenient** (invent a new or improved way to do it).
- Check the **news** (newspaper, magazine, online) for problems in your community and beyond.
- **Discuss/brainstorm** ideas with your team. Talk about the ideas each of you have and consider new ideas as they come up. This process can generate new ideas very quickly.

## Define the Problem

Once you've chosen a problem to solve, you need to define it. Defining a problem means you need to list and describe all the important aspects of the problem. Simply put, you are listing everything you know about the problem.

- Think about the problem from different angles
- Discuss it in your group
- Talk to other people about it
- Research to learn more (also part of the next step)

**Example:**
Suppose your little brother keeps falling off his bike. If you define the problem as "My little brother keeps falling off his bike.", that is not enough detail. Instead, you should give his age, how tall he is, how heavy he is, how long he's been riding, whether he uses training wheels or not, how he falls off, how fast he's going when he falls, whether he rides on soft or hard surfaces, what kind of injuries he gets when he falls, etc. The more details you give now, the easier it will be later.

Describe your problem on the next page. Remember to be as detailed as possible.
Add drawings or include pictures if applicable.

## Define the Problem

**Brief Description:**

**Important Details:**

## Research the Problem

Research is an important part of the engineering design process and something you may need to do throughout the process. At this stage, there are several key aspects to research.

1. **Who or what is affected by this problem?**
    a. Is this a local issue or does it affect a larger audience or setting?
    b. Does it affect an individual, a few people, a single community, a small region, etc.?
    c. Does it affect an entire population or user group, a state/country, an industry, a large region, the environment, etc.?
2. **What solutions already exist?**
    a. Are there existing inventions or products that solve this problem? (search for similar products or systems, look in stores or on shopping websites)
    b. Are there areas for improvement where your invention could do it better than existing inventions?
    c. Are there different ways of solving the problem that have not been done before?

Keep in mind that as you research the problem and learn more about it, you may need to go back and revise your problem definition. You will find throughout this project that iteration is a big part of the process. You will often need to loop back to previous steps and do things out of order.

**Save Your Sources!**

Be sure to keep a record of your sources. This is an important part of any professional or academic project involving research. It is up to you and your teacher how you format and record the sources but be sure to save the following information at a minimum:

- Source name/title (author's name, website title, video title, interviewee's name, etc.)
- Source location (website URL, book title, interview, etc.)
- What information you collected from each source

Record your research findings on the next page and add additional pages as needed.
Also make a source list at the end of your Logbook.

## Research the Problem

## Solution Requirements

After you define and research the problem, you need to specify the requirements (criteria and constraints) for your solution. You need to list out *in detail* the important things that your solution must satisfy to be a successful design. This is similar to the problem definition step, except instead of describing the problem, you are listing the requirements for the solution. Whenever possible, these requirements should be quantifiable/measureable benchmarks that you can test to judge the design. You know you have succeeded when you have met all the requirements.

**Example (continued from pg. 7):**
For the little brother falling off his bike, you might list requirements such as…

- It must protect my brother from serious injury when he is riding on level ground
- It must reduce his falls by at least 70%
- It must be easy to use (positive user experience)
- If the invention attaches to the bike, it must be secured temporarily so the user can remove it when no longer needed
- It must be compatible with all common bicycle designs without modification

Other criteria/constraints you should consider are size, weight, durability, time, cost, etc.

You might notice that some of these requirements limit the scope of the design to "riding on level ground" instead of "riding anywhere" and "reduce his falls by at least 70%" instead of "prevent his falls". This is an important distinction for your requirements. You want the design to be as robust as possible, but no matter how good it is, you can't design for every scenario. Instead, you have to limit the scope by specifying that it must work under certain reasonable conditions. Later on, you may be able to expand the scope and push those boundaries, but at the beginning it is important to define the operating conditions under which your design must work.

List your requirements on the next page. Add additional pages if necessary.

**Tip:** It may help to look at similar products to see what sort of things they had to design for.

## Solution Requirements

## Find Solutions

Think of different ways you might solve your problem. Don't worry about finding the perfect solution. Just write down every idea you come up with. Even a weird idea may help you think of something better. Try to think of new solutions or find ways to improve existing solutions. Describe how the solution will work, what it will look like, and draw a picture of it. Add additional pages as needed.

As you discuss, compare your ideas to the list of requirements. Remember that your solution will need to fulfill all the requirements, so start checking to see if they work. However, do not prematurely dismiss an idea just because it doesn't meet all the requirements. If you foresee that one of the requirements won't be met, you might be able to combine ideas or find a workaround.

## Find Solutions

## Choose the Best Solution

Once you have a good list of ideas, talk about them, compare them, and choose the best solution. Use the following questions to help you decide and mark the answers by each idea.

1. Does it **meet all your requirements**?
   If not, maybe you can change or combine ideas to make it work.
2. Is it **safe and acceptable**? Check the Restrictions on pg. 3.
3. Will you have enough **time and resources** to complete the project?
4. Is it an **original solution**? Have other people thought of it or built it already?
   If it is not original, can you change or improve on it (innovation)?

**Example (continued from pg. 11):**
With the little brother and his bike, you couldn't just invent a padded box for his head or small pillows for his knees because helmets and knee pads already exist (he should be using those anyway). Instead, you would need to find an original solution or make a helmet and pads that are significantly different or better than current ones.

Use the following research suggestions* to find out if your idea is original.
Document your findings and remember to cite your sources.

- Internet
  - Search various keywords about your idea, how it works, similar solutions, etc.
- Stores
  - Check online or in-store for similar products (Amazon, BestBuy, Target, Walmart, etc.)
- Books about your topic(s)
  - Libraries (ask a librarian for advice or use a digital index)
  - Book stores (Barnes & Noble, Amazon, etc.)
- Trade and Industry Publications (each industry has magazines and websites)
- United States Patent and Trademark Office
  - Visit www.uspto.gov to search for patents and trademarks related to your idea.
- Domain Registrars
  - Search domain registration sites for your product name to see if anyone made a website with that name. (www.GoDaddy.com, www.domain.com, https://domains.google, etc.)

*Research suggestions compiled from the 2020 Invention Convention Logbook

After you choose the best solution, go back and mark it on your list (label it, add a checkmark, etc.). If you modified or combined ideas, describe it like you did before.

**Before you start designing and building the prototype, your teacher must sign off on the solution you have chosen (pg. 4). Discuss it with them and get their signature before proceeding.**

## Design, Build, & Test the Prototype

The next few steps are designing, building, and testing your prototype. The prototype is a model that proves your solution works. Even though designing, building, and testing are distinct steps in the process, in practice they often overlap or repeat. As you build and test the prototype, you will find things to change in your design. Once you change the design, you will need to implement those changes and run new tests.

This process of iteration is a normal and important part of the engineering design process. Every time you make a change in your design, document those changes – sketch new design drawings, take pictures, record test results, describe why a change was necessary. It is important to keep a record of past mistakes because each iteration shows how you arrived at the final result.

## Design

You must decide how the invention will work (mechanisms, power sources, etc.), what materials it will be made of, what it will look like, how to build it, and ensure that it will meet all the specified requirements. Sketch a design drawing, add notes to the drawing, and describe the important aspects of the design. It might also help to try things out as you go. Grab some cardboard, paper, or any other random object or material to quickly test your idea and make sure you are on the right track. Quick "pre-prototyping" like this can help you solidify your ideas and arrive at the design faster.

## Build

Once you have a design, you are ready to build it. Since this is a prototype, you don't need to construct it with final materials. For example, if your design calls for a plastic enclosure with metal hinges, you might model it with cardboard and tape. Cheap and easy materials are great for building a prototype like this. If you worked for a big company with an entire design team, the latest software, and the coolest machines, you could model it on the computer and 3D print or laser cut the perfect model. However, you don't need fancy tools to make a good design, and often creating something from cardboard or paper, testing it, and then quickly making changes can actually be faster. You are welcome to use the tools at your disposal but don't dismiss the value of simple and cheap materials.

## Test

Testing is necessary to see if your prototype works as intended and meets the specified requirements. Plan and perform tests on your prototype throughout the process and at the end to ensure it achieves the desired goals. Document the test results and repeat previous design steps until you succeed.

- Does it operate as designed?
- Does it solve the original problem?
- Does it meet the requirements?
- Changes or improvements?

## Design, Build, & Test the Prototype

Describe and draw the design. Label and annotate drawings, include design changes, minor revisions, and the materials list. Describe tests performed and write the results (tables, graphs, etc.). Number the design version (#1, #2, #3, etc.) and write the date. Also write the date for each step along the way. For each significant change/new design, increase the version number (#2, #3, etc.). Add pages as needed.

| **Design Version #** | **Date:** |
|---|---|

## Conclusion

Summarize the results of your invention project. Did your invention solve the original problem? What was the biggest challenge you encountered? What changes or improvements could you make in the future? What impact did it have or could it have in the future?

**Biblical Connection:**

What spiritual lesson did you learn from this project? Does it connect with any Bible principles, stories, characters, or lessons? How does this spiritual lesson apply to your life?

## Communicate the Solution

The last step of the engineering design process is communicating your solution. In the professional workplace, this might mean writing a report, describing and demonstrating the prototype to a supervisor/manager, explaining your work to the manufacturing team, or giving a progress report to a client. For you, it will mean explaining and demonstrating the invention to your teacher, classmates, and judges. It is important to effectively communicate your results so that your hard work can be appreciated. Others can learn from your experience, you can receive feedback from your audience, and it may lead to opportunities for further development. So look back through this Logbook and organize the information into a presentation.

**Steps to prepare for your presentation:**

1. **Name your Invention**
   Finding a creative and catchy name for your invention is a good way to get people's attention. Name it something that describes or hints at its function. You might use fun words, alternate spellings, numbers, or rhyming. Once you pick a good name, write it on the cover page of the Logbook and include it in your presentation.
2. **Select an Invention Category**
   Select the category that best describes your invention.
   Write it on the Logbook cover below the invention name.
   *See the Invention Categories handout for more information.*
3. **Make a Tri-Fold Presentation Board**
   Layout and decorate a presentation board that describes the original problem, research, requirements, proposed solutions, design, building, testing (include the test results), and conclusions. Show off your final invention and highlight how it works. Include pictures/drawings of your design along the way. The Logbook will be especially helpful as an outline.
   *See the Presentation Guidelines handout for more information.*
4. **Plan and Present a Verbal Presentation**
   This presentation will include the same material as your tri-fold board. You need to explain to the audience your original problem and the engineering design steps you took to solve that problem. If possible, demonstrate your prototype and talk about how it works and how it can be used. You could also talk about any future improvements or plans.
   *See the Presentation Guidelines handout for more information.*

## Sources

List research sources here: