Logbook

Invention Name: _____

Invention Category: _____

	Name	Grade
Inventors:	_____	_____
	_____	_____
	_____	_____
	_____	_____

School: _____

State/Province: _____

ANDREWS UNIVERSITY STEM
Science | Technology | Engineering | Math

Introduction

Sometimes math and science don't seem useful for everyday life. Maybe you've asked your teacher, "Why do I need to learn this?!" In fact, math and science are simply tools to help you solve problems. Everyday life is full of challenges, which means we all need to solve problems. The goal of this project is to teach you how. Whether or not you decide to become a mathematician, scientist, or engineer, the problem solving skills you will learn from this project can be used almost anywhere. So have fun, be creative, and enjoy this opportunity to learn about STEM by making inventions!

About the Logbook

Fun hands-on project? Cool! So why do I need this big document? The Logbook is your record of how you will create your invention. It contains all your ideas, designs, tests, etc. Your team will fill it out together over the course of the project, so it won't be 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 be the proof of what you did as well as a full project report. It is important to take neat, careful notes for each step so that other people (or your future self) can read it easily. 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 research the ideas 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 is a promise that the invention is your idea and not someone else's.

At the end of the project, you will submit your Logbook for grading as well as have it available during your presentation. The Logbook will also be useful when preparing the presentation because it will contain the complete record of the work you did. So if you do a good job on the Logbook, 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. 12-13).
- 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.

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.

Science – The study of the material world to learn how and why it works

Scientific Method – The process of observing, asking questions, and experimenting to learn about the material world

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

Innovation – An improved/enhanced solution or device

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

Research – To study and learn the important details about a certain topic

Scope – The things which must be considered about a problem/design; how big/small something is

Criteria – The important requirements

Constraint – A restriction for the design

Design – A detailed plan for how something will work and what it will look like

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

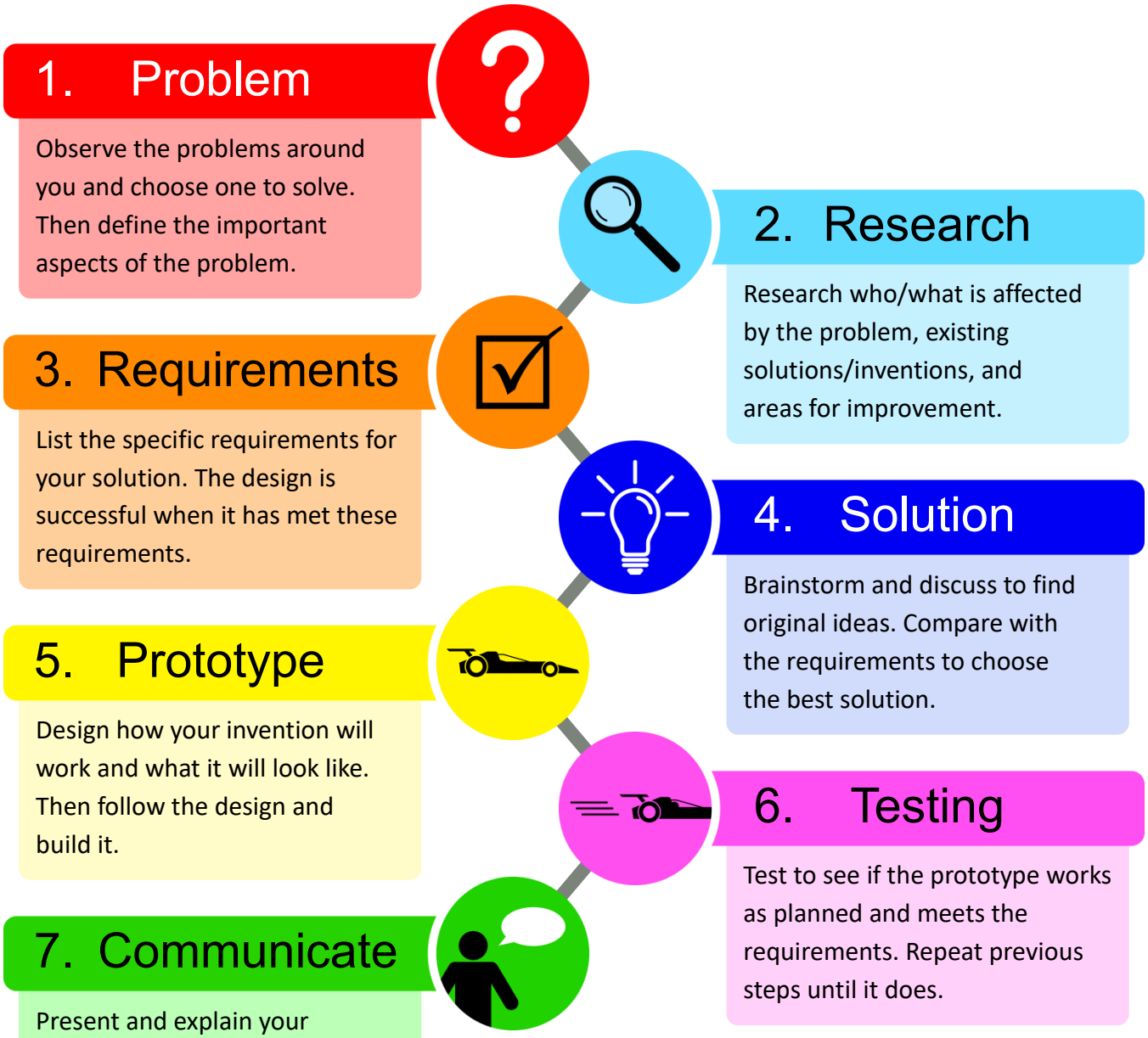
Iteration – Repeated testing and improvement to make the design better

Testing – Experiments and measurements to see how well something works

Collaboration – Working with other people to accomplish a goal

Engineering Design Process

The Engineering Design Process is the set of steps used by professional engineers to solve problems and create products. For this project, you will be using it to create your invention. Unlike engineers, you only need to create a prototype/model of your invention, rather than a market-ready product, but you are certainly welcome to keep working on your invention beyond this project.



Find a Problem

Your first step is finding a problem to solve. This can seem difficult if you try to come up with ideas on the spot, but if you observe the world around you, talk to people, and pay attention to the challenges of everyday life, you are certain to find inspiration for your invention.

Try these techniques to find 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**.
- Ask your **parents**, **grandparents**, **friends**, **neighbors**, **teachers**, or **community members**.
- Notice when **people complain about or struggle** with a problem.
- Notice things 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.
- **Brainstorm** with your team. Discuss everyone's ideas and consider new ideas as they come up.

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 everything you know about the problem. Be as detailed as possible.

- 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.

Define the Problem

Describe your problem below. Be as detailed as possible. Include drawings or pictures if you need to.

Brief Description:

Important Details:

-
-
-
-
-
-
-
-
-
-

Research the Problem

Research is important for the engineering design process because it helps you learn what you need to solve the problem. Use books, websites, videos, surveys, interviews, etc. to answer the following questions. There will also be other things to research later in the project.

Save Your Sources!
Write the source name/title and page number (if applicable) where you use the information and list all your sources in the Sources section at the end of the Logbook.

1. **Who or what is affected by this problem?**
   One person, several people, a community, a region, an entire population, a state/country, an industry, the environment, etc.?

Source:

2. **What solutions already exist (inventions or products that already solve this problem)?**

Source:

3. **Are there areas for improvement (ways you could solve the problem better or differently)?**

Source:

Solution Requirements

After you define and research the problem, you need to list the requirements for your solution (criteria and constraints). These are the things your invention must fulfill to solve the problem.
Whenever possible, these requirements should be things you can test and measure. You know you have succeeded when your invention meets 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
- It must reduce his falls
- It must be easy to use
- If the invention attaches to the bike, it must be easily removable
- It must work with all common bicycles

Other things 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 “serious injury” instead of “any injury” and “reduce his falls” instead of “prevent his falls”. You should make your invention as good as possible, but you won’t be able to plan for everything. Instead you need to describe the situations where your invention is intended work.

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

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. The checkboxes are for later.

Meets Requirements? ☐ **Safe & Acceptable?** ☐ **Time & Resources?** ☐ **Original?** ☐

Meets Requirements? ☐ **Safe & Acceptable?** ☐ **Time & Resources?** ☐ **Original?** ☐

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 check the corresponding boxes for 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?

If your idea has passed the first three questions, there is only one more to answer.

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. 10):
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 suggestions* to find out if your idea is original. Remember to cite your sources.

Tip: Think of several **keywords** that describe your idea and use these in your research.

- Internet
  - Search 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, add a new page and describe it like you did before.

Originality

Answer the following questions about your chosen solution. Find **at least 4 sources**.

Where did you search to see if your idea was original? Describe what you found from each source.

1.

2.

3.

4.

Did you find any similar inventions/products? Describe them and explain how yours will be different.

Before you can 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 separate steps, they often overlap and repeat. As you build and test the prototype, you will find things to change and improve.

This kind of iteration is an important part of the engineering design process. Every time you make a change in the design, document those changes – make new drawings, record test results, and explain why a change was necessary. You may need to repeat these steps several times before you finish.

Design the Prototype

On the next page, sketch your design, add notes to the drawing, and describe how it will work.
Consider the following questions as you create your design.

- How will your invention work? (moving parts, electronics, power sources, etc.)
- What materials will you use?
- What will it look like?
- How will you build it? (tools, space, adult help, etc.)

Tip: It might help to try things as you go. Grab some cardboard, paper, or any other material to quickly test your ideas and make sure you are on the right track. This can help you design it faster.

Build the Prototype

Once you have a design, you are ready to build it. Since this is a prototype, you don't need to make it with final materials. For example, if your design calls for a plastic box with metal hinges, you could model it with cardboard and tape. Cheap and easy materials are great for building a prototype like this.

Test the Prototype

Testing is necessary to see if your prototype works as planned and meets the requirements.
Test your prototype to see how well it works. Record the results for each test.

Questions to consider when testing:

- Does it work as expected?
- Does it solve the original problem?
- Does it meet the requirements?
- Changes or improvements?

Redesign:
If you need to make big changes to your design or create an entirely new design, start another design page and give it a new version number (design version #2, design version #3, etc.).
Continue to use this new version number until you change the design again.

Design the Prototype

Draw your invention design and describe how it will work. Include as much detail as possible. Number the design version (#1, #2, #3, etc.) and write the date.

Design Version #	**Date:**

Build the Prototype

Take notes about your prototype as you build it. Describe any interesting challenges or breakthroughs you encounter. Include the design version and today's date.

Design Version #
Date:

Design Version #
Date:

Design Version #
Date:

Test the Prototype

Conduct a test to see how well your prototype works. Describe what you tested and how you tested it. If you measured anything for the test or collected number data, record this below (lists, tables, graphs, calculations, etc.). Include the design version, test number (#1, #2, #3, etc.), and today's date.

Design Version #	**Test #**	**Date:**

1. Describe your test. What did you try?

2. What were the results? Include any numbers or graphs from your test.

Test the Prototype

Design Version #	Test #	Date:

3. Did it work as you expected?

4. Does it meet all your requirements?

5. Does it solve the original problem?

6. Do you need to change or improve the design? (different materials, build it differently, etc.)

If your prototype doesn't work, don't worry! Engineers don't usually get it right the first time either. They keep fixing and improving their design until it works.

If you need to change your design,

1. Add a new Design the Prototype page.
2. Give it a new version number (design version #2, design version #3, etc.)
3. Design, build, test, and repeat until your invention works!

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 is to tell others about what you created. For an engineer, this could mean writing a report, describing and demonstrating the prototype, or talking to a client. For you, it will mean explaining and demonstrating the invention to your teacher, classmates, and judges.
It is important to communicate your results so that your hard work can be appreciated.

Steps to prepare for your presentation:

1. **Name your Invention**
   Find a creative and catchy name for your invention. 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

Name/Title: _____

Source Location: _____

Name/Title: _____

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