Elementary Engineering Problem Identification

Science projects describe, explain, and predict the natural world. Scientist use the scientific method that included a hypothesis. Engineering design projects seek to find solutions to real-world problems. Engineers work towards finding new technologies, devices, or processes that solve these problems. The process engineers use is different from scientists. Sometimes these phases overlap. The next few sections of this form take you through the engineering process you will use.

* Required

1. Email address *

_____

Finding a Topic

The first step is picking a topic that interests you and is a real-world problem you would like to solve. You will have to do research to determine if there is a need for your solution, is the solution testable, are there others out there that exist, what need does it serve, and any science you may need to know to design your solution.

2. What science interests you? *

Check all that apply.

- [ ] Plant Biology - Learning about how plants grow and change
- [ ] Physics - Learning about energy, forces, and light
- [ ] Psychology - Learning about how people and animals think and behave
- [ ] Meteorology - Learning about weather and how it changes
- [ ] Zoology - Learning about different kinds of animals
- [ ] Astronomy - Learning about outer space and our solar system
- [ ] Oceanography - Learning about oceans and other bodies of water
- [ ] Engineering - Learning about how to build, design things, how things work
- [ ] Chemistry - Learning about what matter is made of and how they change
- [ ] Environmental Science - Learning about ecosystems, living and nonliving things
- [ ] Geology - Learning about earth and what it is made of
- [ ] Sports Science - Learning about the physics of games and the biology of athletes
- [ ] Biology - Learning about living things and how they grow and change
- [ ] Computer Science - Learning about how computers and computer software works

3.

Check all that apply.

	Yes	No
Do you wonder about machines, how they work, made, and repaired?	☐	☐
Do you wonder about how plants grow, what is best for them?	☐	☐
Do you wonder about magnetism and gravity?	☐	☐
Do you wonder why people behave in certain ways?	☐	☐
Do you wonder how your computer works or what would be best for playing your video games?	☐	☐
Do you wonder about the natural environment as you hike, fish, camp, bike, hunt, etc.	☐	☐
Do you wonder about forces of nature like volcanoes, earthquakes, and weather phenomena?	☐	☐
Do you wonder how the brain and memory works?	☐	☐
Do you wonder about how different animals grow, change, and live?	☐	☐
Do you wonder about the speed of light and sound?	☐	☐
Do you wonder how environment affects people and animals?	☐	☐
Do you wonder about going into outer space?	☐	☐
Do you wonder about water on earth like oceans, lakes, and rivers?	☐	☐
Do you wonder about chemicals and what happens when you put them together?	☐	☐
Do you wonder about different ways to re-use, re-cycle, or restore stuff?	☐	☐
Do you wonder about rocks and minerals?	☐	☐
Do you wonder about equipment, shoes, and clothing related to sports or other hobbies?	☐	☐
Do you wonder about constructing buildings, roads, bridges, cities, etc?	☐	☐

Do you wonder about products to improve health?	☐	☐

Topic Brainstorm

Using the surveys you just completed, record your ideas. This is the time to be wild with your imagination. Write down anything that comes to mind.

4. What do you like to do outside of school? Be specific, example: play soccer or go to Sam Noble Museum of Natural History. (read, watch tv/video games, play outside, go to museums or the zoo, sports, cook, etc.)

5. What is your favorite thing you have done with science? (examples: experiments, museums, nature centers, YouTube/tv shows)

6. What did your surveys say about your interest? Write down those answers here.

7. Free Write. Write down any other ideas or interests you have.

Narrowing your problem down

The goal of an engineering design project is to create a solution for a real-world problem with either a prototype or a process (order of steps to make something happen). From your Topic Brainstorm page, narrow down your area of interest and problem. Write that idea/problem in the spaces provided. Discuss these ideas with your teacher, parents, friends, and anyone else to gather input or questions they have about your design.

8. Problem 1:

9. What do other people have to say about Problem 1?

10. Problem 2:

11. What do other people have to say about Problem 2?

12. Problem 3:

13. What do other people have to say about Problem 3?

Elementary Engineering - Imagine

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Research

Before you begin your design, you must do some research on your problem. You will need to find out if a solution already exists. If it exists, are there ways you can improve the design? You will also need to research if the need for the solution exists. After you have researched these questions, do you need background information on the science for your design? What are the basic science principles related to your design and problem you are solving?

2. What do you need to learn about your problem before you create your solution? Write down as many questions as you can think of.

3. What do you need to learn about your solution before you create your solution? Write down as many questions as you can think of.

Sources to answer your questions:

It is important to use trusted sources backed from scholarly research.

Good Sources:

- Textbooks and library books
- Professional journals and magazines (National Geographic, Popular Science)
- Teacher or professional
- Online sources with .gov or .edu

Poor Sources: These sources may be interesting, but they may be opinionated and skew views to lean one way or another. The source may help you see perspectives and gain ideas for further research, but should not be used to support your questions.

- Blogs
- Newspaper articles
- .org sites
- Google search page

4. What resources are you going to start with to answer the questions you asked above?

Refining Your Research Questions

What are three three most important questions that you came up with?
Using the boxes below, write each question you need to answer in the space provided. Use the sources you identified to research the answers to those questions. Then, write your answers to these questions using the resources. You may find answers in multiple resources. Finally, write the source of your answer, example: book, journal article, person you interviewed, etc., in the Resource Used box. Have your teacher give you examples of how to reference your resource.

5. Question 1

6. What I learned about question 1 from my resources:

7. Resource(s) used

8. Question 2

9. What I learned about question 2 from my resources:

10. Resource(s) used

11. Question 3

12. What I learned about question 3 from my resources:

13. Resource(s) used

Purpose of your design	What is the purpose of your project? Who might it help? This will help you think of the questions you will later need to answer to conduct your research and plan your design in more detail.

14. What is the problem you are trying to solve?

15. Why is this problem important to solve?

16. What is your idea for a solution?

17. Why is your solution better than others?

18. Who will benefit from your solution and where are they located? (at home? at school? across the city/state/country? In certain parts of the country/world? Around the world?)

19. Where will your solution work best?

20. How will your solution solve the problem?

21. How will you make your solution a reality?

22. Are you designing a prototype or a process?

Mark only one oval.

- Prototype - a model of your solution that the final product will be based off of
- Process - steps that others will follow to solve the problem

Other factors to consider

Brainstorm other factors to consider with your design solution. Use the questions to help you list everything you should consider.

23. What will make it difficult to develop your solution?(What limitations re there? Example: size, cost, location, time, etc.)

24. What are all the materials/resources/tools you may need for your design?

25. Are there other solutions that might solve your problem?

26. What else are you thinking about for your problem or solution?

Elementary Engineering - Plan

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Planning Your Design Goal

Using your Purpose, Other Factors to Consider, and Research, define your design goal in detail. Be specific. Use the box to help you answer each area.

2. Design's Name/Title

3. What is your goal?

4. Who does this benefit?

5. How will you know if your design solves your problem?

6. Size of Design

7. Materials/Resources/Tools. Include costs and where to get them. Don't forget safety equipment.

8. Who do you need to help you with the design?

9. Estimate the length of time it will take to build your design

10. How will you test your design to see if it solves your problem? (Write step by step instructions)

Sketch your design

Create a sketch of your design. Get feedback from at least two people and then adjust your design as needed. Get feedback again and make any changes necessary to your design. Before you build, you will need to have a detailed and labeled sketch of your design.

11. Estimate the length of time it will take to test your design

12. Estimate the length of time it will take to redesign after testing your design

Elementary Engineering - Create & Improve

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Build

You've got your plan. You've got your materials. You are ready to go build, test, and redesign your design solution. Remember to FOLLOW YOUR PLAN! If during your plan, you discover you need to change it, record this. You may have to revise your plan several times and this is okay. It is what engineers go as they are designing solutions. It took the Wright brothers many years of painful unsuccessful attempts before they successfully went airborne. Continue the process until you are certain the prototype is the best solution to your problem.

2. What steps did you follow to build your design?

3. What steps did you follow to test your design?

4. What changes did you make to your plan?

5. What materials did you use to build your prototype?

6. Make sure to create updated sketches of your prototype with labels that define the parts or processes

Test

It may be useful to use SCAMPER during your process. These are a set of questions to ask as yourself as you Build, Test, and Redesign. Remember to record any of these questions and answers you may use during your process.

SCAMPER

Substitute	Can any part be replaced? Can the range be changed? Can a variable be swapped with another? Could you use a different material? Could you change the shape? Can it be used in a different way?
Combine	Are there parts that can be combines? Can this idea merge with another? Can you include some other materials? Can you use someone else's expertise?
Adapt	What else is "like" this, but used for a different purpose? Where else could this be used? What does somebody who has never seen it think it does/is for?
Modify	Can it be made bigger? Can it be made smaller? Could you add something to it? Could you take something away from it? Does it have many parts and need less? Does it have few parts and need more?
Purpose	Why does it exist? Would it have more value used elsewhere? Is there a new need for it that hasn't been considered? Could it by a different set of people to suit a different purpose?
Eliminate	How could it be simplified? What could be minimized? What could be eliminated? Could it be made more compact? What could be removed without ruining function?
Rearrange	Will it work in a different order? Consider it backwards? Could you assemble it a different way? Would it be better/worse or no different? OR work in a completely new way?

7. What steps did you follow to test your design?

8. What data did you collect during each test?

9. Is your data accurate?

Mark only one oval.

- Yes
- No

10. Do you have units of measurement for all your data?

Mark only one oval.

- Yes
- No

11. Have you verified that your calculations (if you have them) are correct?

Mark only one oval.

- Yes
- No

12. Can you summarize and explain your results clearly?

Mark only one oval.

- Yes
- No

13. Do your results support your predictions? (If no, explain why not)

Mark only one oval.

- Yes
- Other: _____

Redesign	After your test(s), make changes to your design and/or prototype until you are satisfied with the results. Remember, it takes most engineers multiple iterations before they are satisfied with their designs. Don't give up!

14. Write down everything that you learned while building your design. What were the results of your tests? What changes did you make and why? Did you changes make your design better? How so?

Elementary Engineering - Reflect

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Conclusions

It's time to reflect upon your experience on building, testing, and redesigning your prototype to solve your problem. Answer the following questions to help you develop 1-3 paragraph summarizing your experience

2. How does this prototype address the need or problem?

3. What did you learn during the design process (testing and evaluating) that informed you of your final design solution?

4. What would you have done differently?

5. How has this brought up new ideas or insights?

6. Why is your design important and how can it be applied to real life?

7. How can your design be improved? What are your next steps?

Acknowledgements

It is important to thank those people who helped you along the way. These people may be teachers, professionals, parents, siblings, or classmates. In the box below write a thank you to each person who helped you during this process and what part they played towards your success.

8. I would like to thank:

9. for

10. I would like to thank:

11. for

12. I would like to thank:

13. for

14. I would like to thank:

15. for

Presentation Checklist

1. Why is your problem important to solve?
2. Who will benefit from your solution?
3. Where will the solution be used and by whom?
4. How does your design solve the problem?
5. What are the limitations to your design? (size, cost, materials)
6. What did you find in your background research?
7. What do your prototypes look like and how many revisions or changes did you make?
8. What is your final prototype design and how or why is it different from your original idea?
9. How could you find out if your prototype is successful? What data would you need to collect and how could you collect it? What evidence would tell you your design solves the problem?
10. What would you do differently next time?