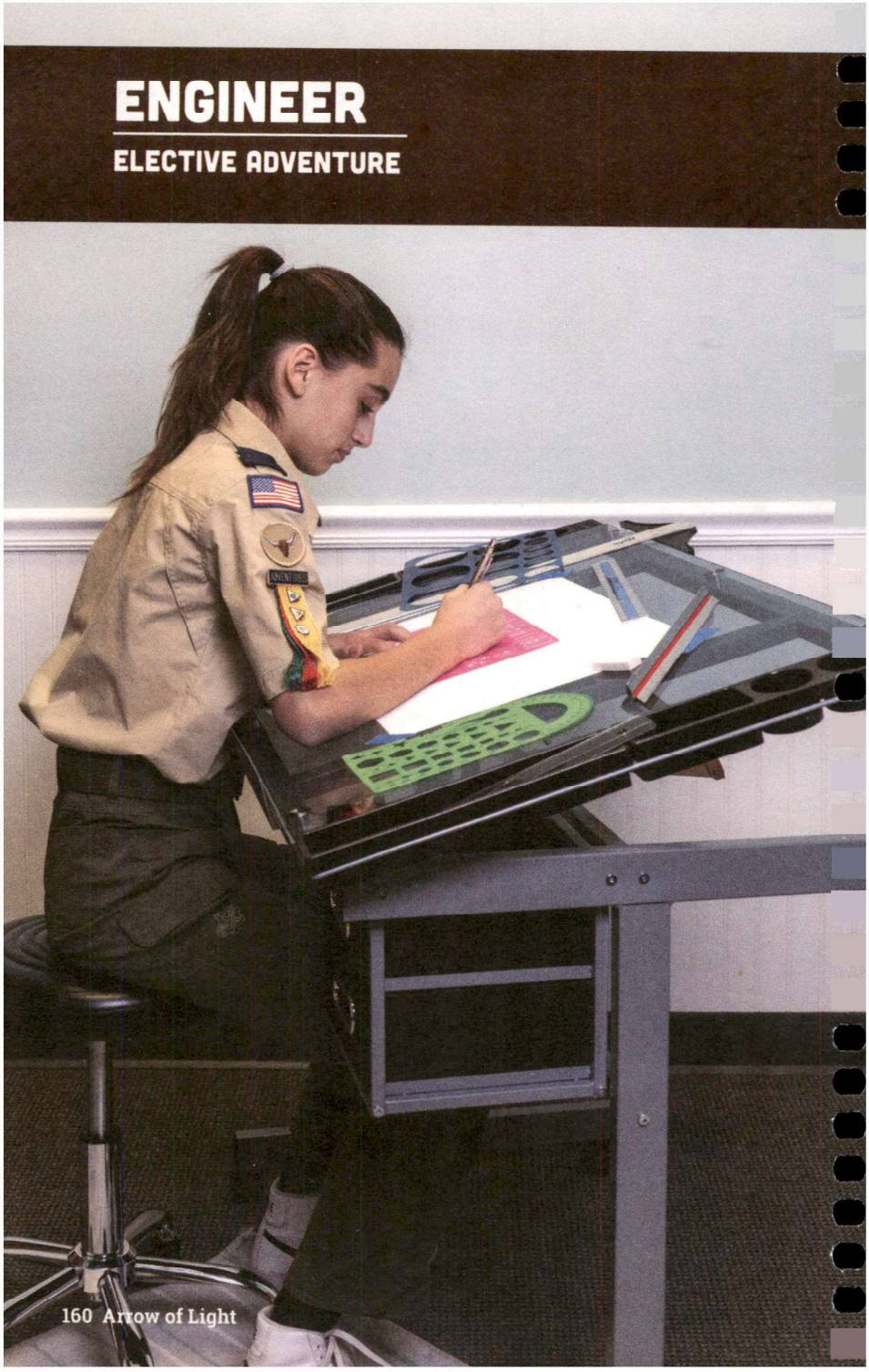
ENGINEER

ELECTIVE ADVENTURE



SNAPSHOT OF ADVENTURE

Lots of people have great ideas: flying to the moon, tunneling under rivers, building robots that walk and talk, or making triple-loop roller coasters. Engineers turn those ideas into reality. They use science, math, and creative thinking to improve people's lives. In this Adventure, you will learn what engineers do. Even better, you can do some engineering projects of your own. So put on your thinking cap and get ready to think like an engineer!

REQUIREMENTS

Approved by

1. Learn the focus, related sciences, and products of civil, electrical, and mechanical engineers. _____
2. Pick one of the engineering fields from requirement 1 to complete the following requirements. _____
3. Examine a set of blueprints or specifications used by your choice of engineer. _____
4. Identify a project that you would like to build. _____
5. Using the engineering process, build your project. _____

- **Elective Adventure**
- **Scan for this Adventure page**

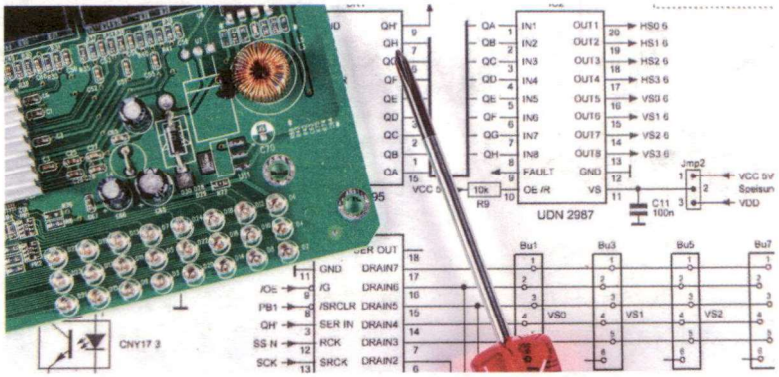
REQUIREMENT 1

Learn the focus, related sciences, and products of civil, electrical, and mechanical engineers.

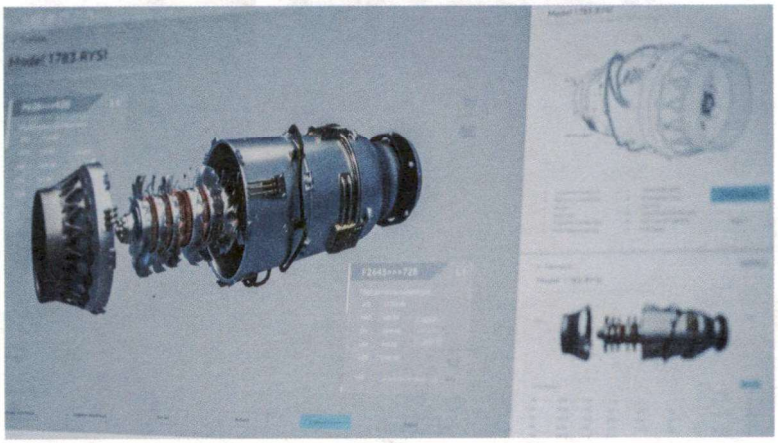
Engineers design everything from tiny materials you can see only through a microscope to spacecraft powerful enough to escape the Earth's gravity. Most engineers work in an area (called a discipline) that focuses on a specific type of project.

Engineers from different disciplines work together on many projects. For example, if you were building a spaceship, you would need aerospace engineers, computer engineers, electrical engineers, mechanical engineers, and several other types of engineers that aren't listed here.

Civil engineers plan, design, construct, maintain, or operate infrastructure — like roads, bridges, and water plants — while protecting the public and environmental health. Civil engineers may also work on improving or repairing existing infrastructure. Highways, bridges, water plants, and other things that civil engineers work on are often owned and operated by the federal, state, or local government.



Electrical engineers design, develop, test, and supervise the manufacture of electrical equipment, such as electric motors, radar and navigation systems, communications systems, or power generation equipment. Electrical engineers also design the electrical systems of automobiles and aircraft.



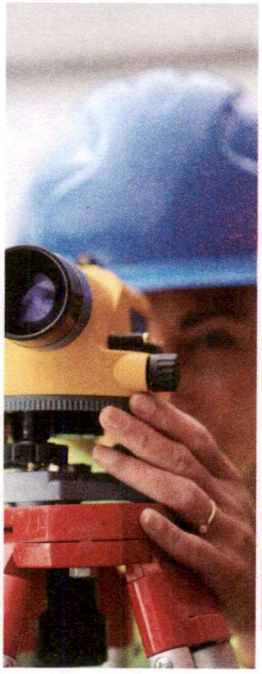
Mechanical engineers plan, design, construct, maintain and/or operate machines that use power, generate power, or involve force or movement. Mechanical engineers may work to improve existing machines, or they may invent new machines. Mechanical engineers often specialize in a specific area like engines, robotics, or even biotechnology.

REQUIREMENT 2

Pick one of the engineering fields from requirement 1 to complete the following requirements.

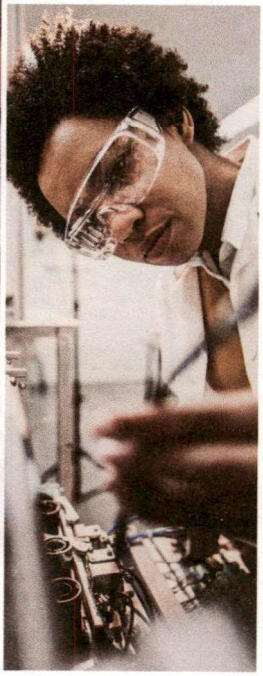
Think about which engineering discipline interests you, and choose from civil, electrical, or mechanical to complete the rest of the requirements.

Civil Engineering



Electrical Engineering

Mechanical Engineering



REQUIREMENT 3

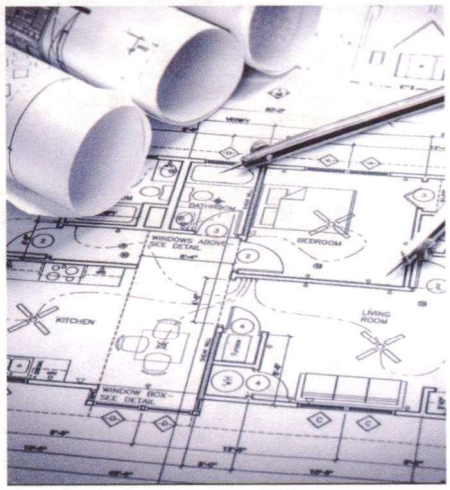
Examine a set of blueprints or specifications used by your choice of engineer.

BLUEPRINTS

A written and/or picture design of a project is called a blueprint. Structural, civil, and electrical engineers are a few of the engineers who use blueprints to assist them with their projects. Why are these designs called blueprints? When they were first introduced in the 19th century, they were made with a process that resulted in white lines on a blue background.

Before you design your own project, look at a set of blueprints. You may use your local library, the internet, or an individual you know who is an engineer or works in the construction field to find blueprints. House plans are good examples because many of the pictures they contain will be familiar to you.

Depending on the project, blueprints can be very complicated. Some include hundreds of pages of information. You will find pictures that show the finished project from every side, measurements of every part of the project, and a list of materials to be used in the project. Blueprints are designed to be so complete that a qualified builder could complete the project without any other information.



REQUIREMENT 4

Identify a project that you would like to build.

Here is a project you might consider building.

Have you ever been on a roller coaster? Constructing a roller coaster requires several types of engineers to work together. Here's a roller coaster you can build, and it won't take a team of engineers. Use the engineering process to design and build your paper roller coaster.

PAPER ROLLER COASTER

Materials

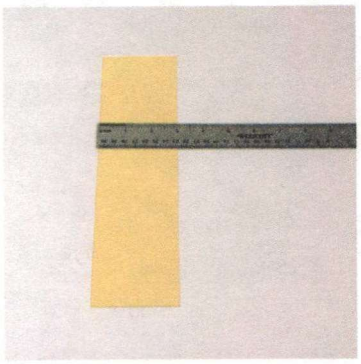
- ☐ Sturdy square of cardboard for a base
- ☐ Construction paper or cardstock (it needs to be flexible)
- ☐ Pencil
- ☐ Ruler
- ☐ Tape
- ☐ Scissors
- ☐ Marbles

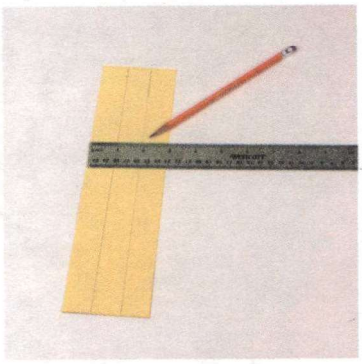
Instructions

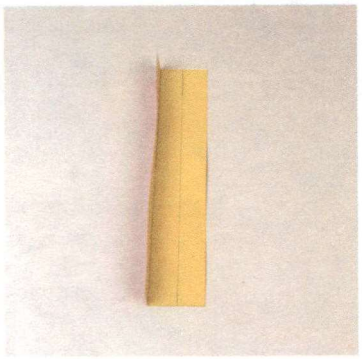
Before you try building an entire roller coaster, practice building the individual track segments. Follow the instructions to draw with a pencil and ruler and cut out each segment. You can always use your segments in your final construction; this will also help you when you design your coaster.

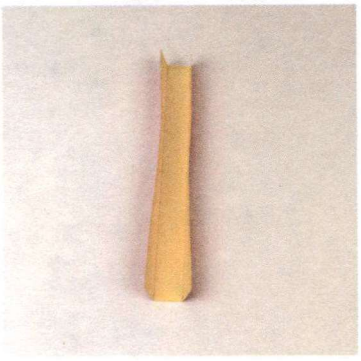
To build a straight segment:

1. Cut a 3-inch-wide strip of paper.
2. Draw two parallel lines that divide it into three 1-inch-wide strips.
3. Fold the two sides up 90 degrees along those lines to form walls.



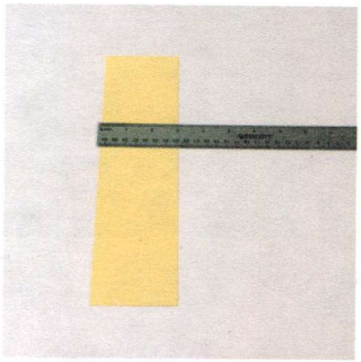


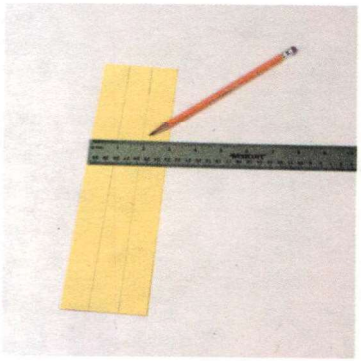


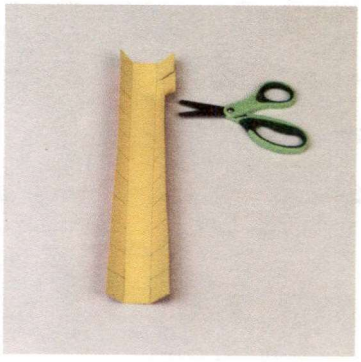


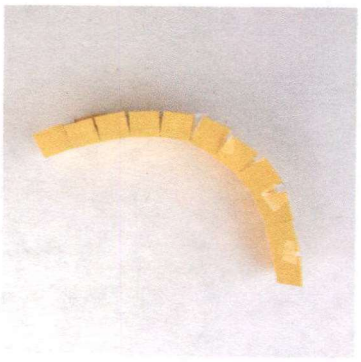
To build a loop or a hill:

1. Cut a 3-inch-wide strip of paper.
2. Draw two parallel lines that divide it into three 1-inch-wide strips.
3. Make marks every 1 inch along the long edges of the paper.
4. Cut 1 inch inward from these marks to form tabs.
5. Fold the tabs up 90 degrees.
6. Bend the track into the shape you want and tape the tabs together to hold it in place. This step is easier with two people, one to hold the track in place and one to do the taping.



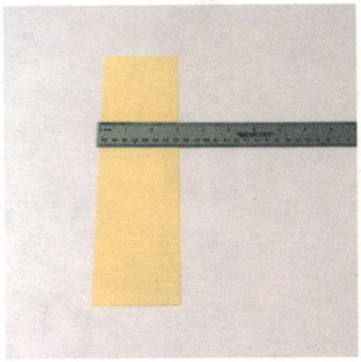


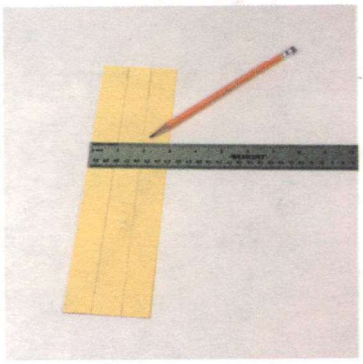


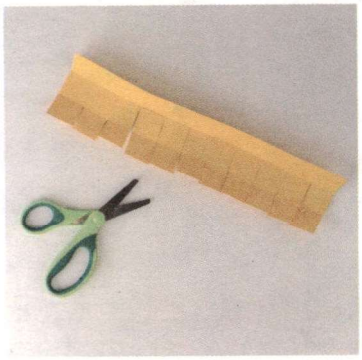


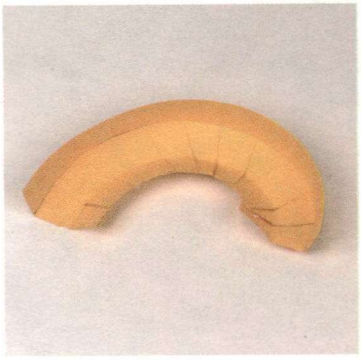
To build a curve:

1. Cut a 3-inch-wide strip of paper.
2. Draw two parallel lines that divide it into three 1-inch-wide strips.
3. Make marks every 1 inch along one long edge of the paper.
4. Cut inward 2 inches from these marks.
5. Fold up the uncut side of the paper 90 degrees to form a wall.
6. Fold up the tabs on the other side to form the other wall.
7. Since the bottom portion of the track is cut into segments, you can bend it horizontally to form a curve. Tape the tabs together to hold the curve in place.





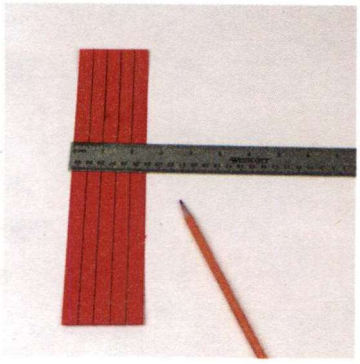


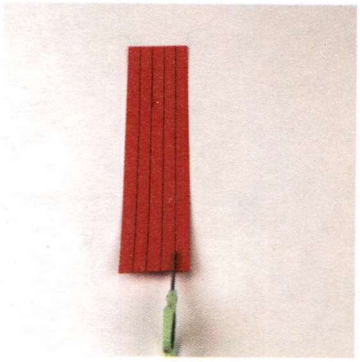


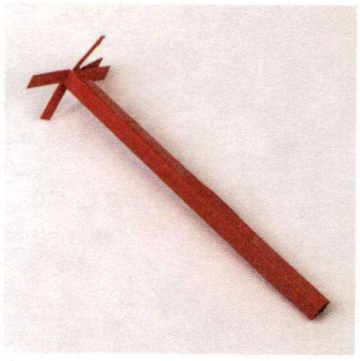
To build a support strut:

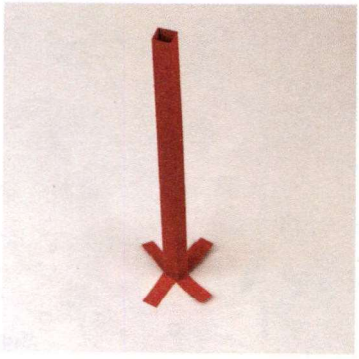
1. Cut a 2.5-inch-wide strip of paper.
2. Draw four parallel lines that divide it into five 0.5-inch-wide strips.
3. Cut 1 inch inward along these lines from one edge.
4. Fold along the lines to form a square shape (so two of the segments overlap) and use tape to hold in place.

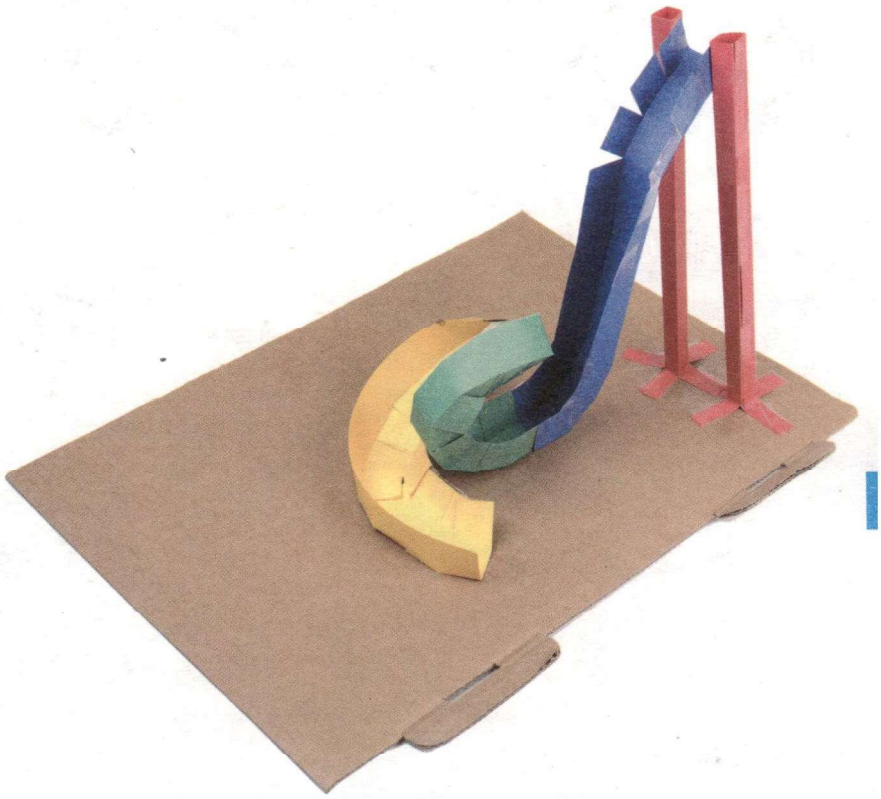
Fold the tabs you cut at the end outward. This will allow you to tape the tabs flat to a piece of cardboard so your strut can stand upright.











Before putting all the pieces together for your marble roller coaster, make a simple drawing of what you want your roller coaster to look like. It is best to keep your first design simple. Look at your design and figure out how many of each of the pieces listed above you need to make to build your design.

Keep in mind that the marble will need to start high. Gravity makes the marble move through the track. If you make the track too long, the marble will not have enough momentum to complete the track.

REQUIREMENT 5

Using the engineering process, build your project.

THE ENGINEERING PROCESS

To understand how an engineer might approach a project, let's look at the engineering process. After an engineer becomes aware of a need, they gather information, and then make a design. The building phase begins after that.

Here is how you might use that process to construct a small item for your bedroom:

1. Determine your need.

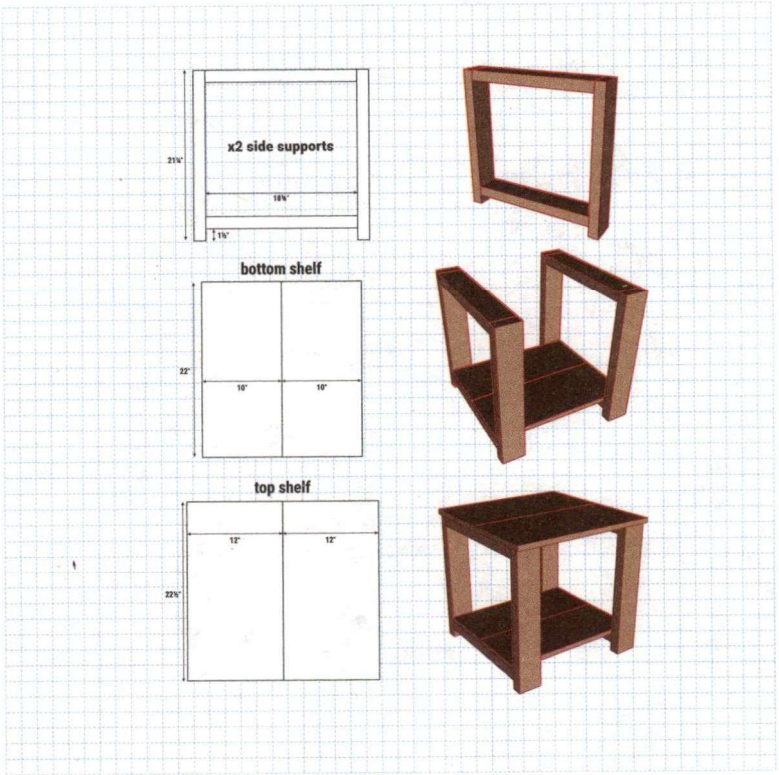
Let's say you don't have anything next to your bed to set your books and alarm clock on. You need a small table.

2. Gather information.

Of course, tables come in all sorts of shapes and styles. You could ask questions like these to refine your idea:

- What will I put on the table? How much do the items weigh? You need to know how sturdy your table needs to be.
- What building materials should I use? Now that you know your weight requirements, you can pick materials that will be strong enough to handle the weight of the items.
- Will the materials be expensive if I have to purchase them? Can I recycle materials I already have? Engineers have to make sure their designs are cost-effective.

- What is the best design I can use? Should it have two, three, or four legs? Should it have a square, round, or rectangular top? How tall should it be? These questions will guide you to the right design based on your table's location and use.
- Will it help if I draw pictures of the design before I begin? These drawings can help start your blueprint!



3. Prepare instructions.

The information you gathered should help you better understand the planning process and your needs. Now you can create a plan for building your table. Because of the process you followed, you'll be able to build a better table than if you just

started nailing boards together without a plan. By drawing your blueprint on graph paper, you can easily keep the drawing to scale. For example, one grid on the paper could equal 1 inch on the finished product.

Be sure to make notes on your drawing about all dimensions and materials. Remember that another person should be able to create your project from the blueprint you have made. You might also want to make a small-scale model of your project. Heavy cardboard, toothpicks, craft sticks, and tape are some materials you could use.

4. Build your project.

Once you have prepared your design and your blueprint, you're ready to build your table. Here you'll discover if your design ideas work and if your blueprints have clear instructions and good information. It's a good idea to take notes and pictures as you go along so you remember what worked and what didn't.

5. Evaluate your project.

After you build your table, you should test it to make sure it meets your needs. Testing and evaluation are also important parts of the engineering process. On major projects, engineers build models and run computer simulations before starting actual construction. These steps can save time and money if the design needs to be changed.

You can also ask yourself questions like these:

- Did the project turn out as I expected?
- How much did it cost to build the project?
- What would I do differently next time?
- What three things did I learn when I designed and built my project?
- What am I most proud of about my project?