Part 2

Work with Machines and Materials

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Machines make our lives easy, and materials are all around us. Projects on Work with Machines and Materials will help you work with different machines and tools to create new things with different kinds of materials, and to repair and maintain things. You can take up projects related to making electronic toys, carpentry products from wood and bamboo, and pottery products (with and without using a wheel), sewing clothes, decorating fabrics, using computers and smartphones to make games and animations, and using waste materials to make toys or even instruments for a school band. It is up to you to imagine all that you can do with your peers.

Two examples of projects are given in this section. You must take up only one project. You can either choose one of these projects or you can design a project of your own choice with the help of your teacher.

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Project 3

Maker Skills

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This project will help you learn about simple machines that make work easier. You will develop skills to create toys from waste using simple machines and then explore the various simple machines used in a bicycle. You will also learn how to maintain and repair these machines to keep your bicycle in a good working condition.

As part of the project, you will be able to:

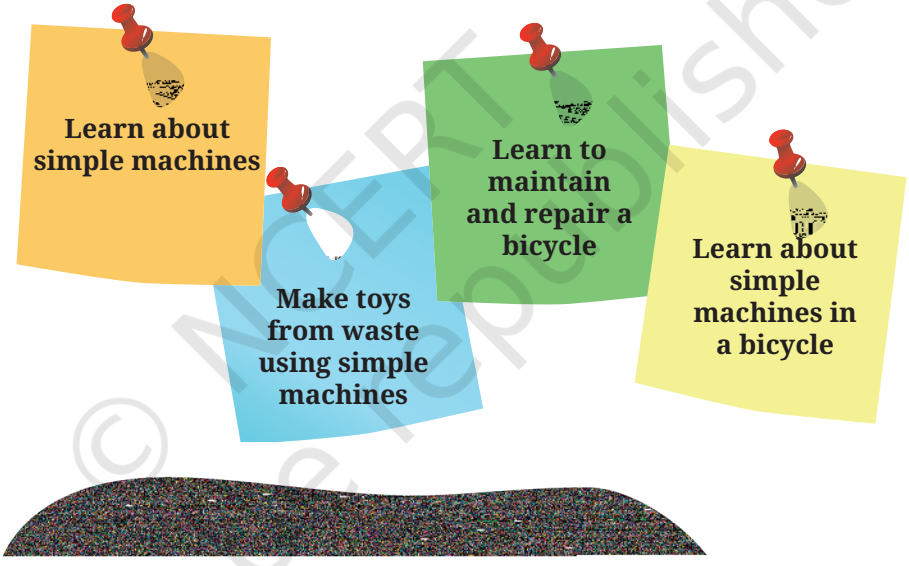

Figure 3.1: *Making things out of waste materials using tools*

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There are many things around us which are complex machines, such as bicycles, toys, buses, cycle rickshaws and autorickshaws. We use doorknobs, and open and close doors and windows without thinking. But how do these things work? All these things have simple machines in them. For example, wheel and axle and pulleys are simple machines.

Simple machines help to make our work easier. They help us to do things beyond our capacity, which are difficult or simply not possible. For example, can we lift heavy loads or break wood with our hands? A cart with wheels and axle can move very heavy objects with less force. Pulleys can lift heavy objects.

Do you know that even a big bus is actually made up of many interconnected small machines? And that the simple machines used in a bus are also used in bicycles and toys, and doors and windows? Yes! It is true that they are made up of simple machines.

Look at Figure 3.2 below and discuss what else simple machines can do.

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Figure 3.2: *Simple machines around us*

In this project, we will first learn how to use simple machines to make simple toys. This will help us understand how these machines work. We will then identify the simple machines in a bicycle and how to keep them functioning well.

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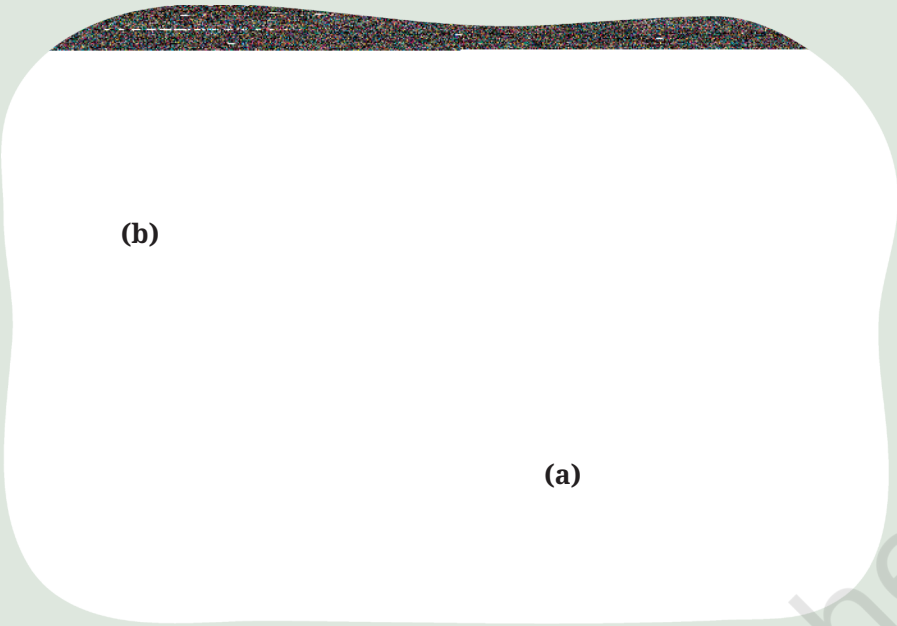

Figure 3.3: *Simple machines have been in use since ages. Ancient people used inclined plane (Figure 3.3a), and pulley (Figure 3.3b) to transport heavy materials.*

Ancient architecture

Huge stone temples in ancient India were constructed using a combination of skilled labour, simple tools and machines and clever engineering techniques. The process often involved quarrying and transporting large stone blocks, carving and shaping them, and then assembling them into the desired structure. Workers used basic tools, like chisels and hammers to carve the stones. They also used various innovative methods for lifting and placing the heavy stones, such as using inclined planes, levers and pulleys. These are all simple machines that we use till today (Figure 3.3).

What will I be able to do?

At the end of the project, you will be able to:

1. Make toys from various materials using simple machines. You can make catapult, robotic arms, elastic band propeller boat, balloon car, rubber band car, and windmill;

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2. Identify the various simple machines that make up a complex machine, like a bicycle;
3. Identify the main parts of a bicycle and their functions; and
4. Identify common problems with bicycles, such as flat tyres, and misaligned brakes and perform necessary maintenance and repair.

What will I need?

For making toys from trash using simple machines

- **Materials required:** Cardboard, plastic pipe, empty plastic bottles, plastic spoon, drinking straws, plastic bottle caps, paper, ice cream sticks, thread, rubber bands, glue, tape, glue gun, cellophane tape, clothes clips, all pin, balloon, colour box, chopsticks (these could be of wood, plastic or metal).
- **Tools required:** Scissors, metre scale, and cutter.

For learning about simple machines in a bicycle

You will need atleast 5–6 bicycles.

- **Materials required:** Oil/grease.
- **Tools required**: Spanner set, wrenches, chain brush, tyre levers and air pump.

You will also have to visit a bicycle shop or request someone who can repair a bicycle to come to the school to teach you.

How do I keep myself and others safe?

- Be careful with cutting tools and other sharp edges.
- Ensure that you clean the area after you finish an activity, and store materials and tools as per the instructions of your teacher.
- While using the toys, ensure that you do not hurt yourself or others.

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What do I need to know before I start?

Can you identify simple machines in your surroundings? Look around, see what you can find.

Activity 1: Simple machines in our surroundings

Identify everything around you that helps you do something. Find out if it is a simple machine or if it is made up of simple machines.

You can ask your teacher or your friends and family for help. Write your observations in table 3.1.

Table 3.1: Simple machines around us

S.No.	Name of simple machine	How is it used?
1.	Knife	Used for cutting vegetables and fruits
2.	Vegetable peeler	Used for removing peels of fruits and vegetables
3.		
4.		
5.		
6.		

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What do I have to do?

First, you will make toys using simple machines and then identify the simple machines in a bicycle. Next, you will learn how to maintain a bicycle.

Learning on the Internet

You can look up the steps to make the toys given in the Activity Book by searching on the Internet with the search keywords: 'DIY + XX (*name of toy*)' (DIY means 'Do It Yourself').

If you want to see videos, you can add the word '*video*' to the search keywords.

Internet safety

Ask your teacher for help while using the Internet, be careful not to upload or download anything, and do not share personal information anywhere.

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Activity 2: Using levers to make toys

A lever is a fixed bar or handle that moves around a fixed point, called the *hinge/fulcrum*. A simple example of using a lever is when you use a spoon to open the lid of a tin. The tip of the spoon is fixed under the lid, and you apply force at the other end. Another example is that of a seesaw in the playground.

Some toys you can make using a lever are catapult, lazy tongs and robotic arm scissors. The simple catapult you will make has a single lever while the lazy tongs and robotic arms have multiple levers. Figures 3.4 and 3.5 show the steps for making a catapult and robotic arm, respectively, using waste materials.

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Working Model of Catapult

Materials : You will need ice cream sticks, rubber bands and an ice cream spoon.

Step 1 : Stack about 5–6 ice cream sticks one on top of the other and hold them together with rubber bands — one on each end. Take two other ice cream sticks and hold them together at one end with a rubber band.

Step 2 : Place the two sets of ice cream sticks, as indicated in the figure.

Step 3 : Using a rubber band, attach the ice cream spoon, as shown in the figure.

Your catapult is now ready.

Figure 3.4: *Steps for making a catapult using ice cream sticks and spoon*

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Working Model of Robotic Arm

Materials : You will need ice cream sticks, glue, old bottle caps, toothpicks, and a cutter.

Step 1 : Pierce the ice cream sticks in the centre. Break a toothpick into small pieces and join the ice cream sticks by passing this piece through the holes. Remember to add glue where the sticks are joined.

Step 2 : Join a few more ice cream sticks just like in Step 1. There needs to be a free movement of the ice cream sticks.

Step 3 : Cut out the centres of the bottle caps with the cutter so that you end up with two circular shapes.

Step 4 : Glue the bottle caps to the ends of the first set of ice cream sticks.

Your robotic arm is ready.

Figure 3.5: *Steps for making a robotic arm using ice cream sticks, bottle caps and toothpicks*

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1. Draw a sketch of the toy, giving accurate measurements where different parts are connected. You can paste a photograph of the toy in the space given below:

2. Write down instructions for someone who is using robotic arm for the first time.

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Activity 3: Using a propeller to make toys

A propeller is a wheel with blades. As the wheel moves, the blades help movement by pushing through water or air.

You can make an elastic band boat using a propeller. Figure 3.6 shows the steps for making an elastic band boat using waste materials.

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Working Model of Propeller Boat

Materials : You will need ice cream sticks, glue, straw, bottle caps and rubber bands.

Step 1 : Paste ice cream sticks in the shape as indicated in the figure.

Step 2 : Paste additional ice cream sticks to make a boat shape. Make holes as indicated by the dots in the figure.

Step 3 : Make slits in the bottle caps, cut and paste ice cream sticks to the sides to make a propeller.

Step 4 : Pass a straw through the caps and the holes in the side of the boat as indicated in the figure.

Step 5 : Tie a rubber band at the tip of the boat and to the middle of the straw.

Step 6: Wind up the rubber band using the paddle wheels and place it in water.

Your boat is ready.

Figure 3.6: *Steps for making a propeller boat*

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1. Draw a sketch of the toy giving accurate measurements where different parts are connected. You can paste a photograph of the toy in the space given below.

2. Write down instructions for someone who is using propeller boat for the first time.

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Activity 4: Using a wheel and axle to make toys

Wheel and axle is a simple machine that is made up of wheels held together by a rod so that they move together. In this way, if you have two wheels and axles, they balance each other and can move loads of any sort of shape placed above them. Car wheels are examples of wheel and axle.

Some toys, you can make using two sets of wheel and axle are rubber band car and air balloon car. Figure 3.7 shows the steps for making a rubber band car. Follow the steps to make your rubber band car.

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Rubber Band Car

Materials : You will need clothes clips, straws, chopsticks/toothpick, bottle caps, cellophane tape, scissors, rubber bands and glue.

Step 1 : First cut a straw of length so that you can join the two clothes clips slightly far apart.

Step 2 : Make holes in the exact centres of four bottle caps and attach them to a toothpick/piece of wooden skewer to act as wheels for the clothes clips. Attach one cap, pass it through the straw at each end and then attach the other cap. Remember to use glue to hold the bottle cap and toothpick/ part of wooden skewer together.

Step 3 : Attach a small part of a toothpick/chopsticks between one set of wheels. You will have to glue it to the straw. This is the front of the car. On the other end, loop a rubber band over the straw. This is the back of the car.

Step 4 : Pass the other end of the rubber band over the small piece between the wheels at the back of the car.

Step 5 : Wind up the rubber band at the back of the car and release it on stable ground. Your car is ready to race.

Figure 3.7: *Steps for making a rubber band car*

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Air Balloon Car

Materials : You will need flexible straws, an old plastic bottle, old bottle caps, cellophane tape, a rubber band, chopsticks, balloon and glue.

Step 1 : Tape the chopsticks onto the bottle as shown in the figure.

Step 2 : Make holes in the bottle caps and attach them to the chopsticks as indicated in the figure. Remember to use glue to ensure they stay attached.

Step 3 : Fix the balloon to one end of the straw with a rubber band.

Step 4 : Make a hole in the bottle and insert the straw as indicated in the figure.

Working model 1 : Blow the balloon from the open end of the straw and then press your finger to the straw. Place it on an even surface.

Working model 2 : Release your finger. Your balloon car is ready to move.

Figure 3.8 : *Steps for making an air balloon car*

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1. Paste a photograph of the toy that you created in the space given below.

2. Write down instructions for someone who is using air balloon car for the first time.

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Activity 5: Using more than one simple machine to make toys

A windmill is a machine that generates energy from wind. A real windmill is made up of many parts. But your working model of windmill can be made by using a combination of simple machines like propeller and wheel and axle, along with other parts to make these machines work together. Figure 3.9 shows the steps for making a windmill using various materials.

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Windmill

Materials : You will need pieces of cardboard, chart paper, straws, glue and a cutter.

Step 1 : Make a cardboard box as shown in the figure. Make holes in the centre of the sides and pass the straw through the holes with a circular piece of cardboard passing through it.

Step 2 : Attach another circular piece of cardboard of the same size to the other end of the straw. Stick a small piece of straw to the cardboard circle outside the box.

Step 3 : Repeat step 2 for another side as indicated in the figure except that now you must place the circular pieces of cardboard at the ends of the straw.

Step 4 : Make a cylinder with chart paper as shown. Make a fan with a short piece of straw, circular pieces of cardboard and blades cut out of chart paper.

Step 5 : Assemble the pieces as shown in the figure.

You now have a working windmill.

Figure 3.9: *Steps for making a working model of a windmill*

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1. Draw a sketch of the windmill, with accurate measurements of different parts. You can paste a photograph of the toy in the space given below.

2. Write down instructions for someone who is using the working model of windmill for the first time.

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Using ChatGPT for ideas

ChatGPT is an AI 'chatbot', a smart Intelligent Assistant. This AI tool uses information available on the Internet to answer your questions.

Ask ChatGPT for ideas on using waste material to make fun things. You may be surprised by what it comes up with!

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Activity 6: Simple machines in a bicycle

So far, you have learnt about different forms of simple machines. You will now explore how simple machines are used to create a bigger machine.

A bicycle is made using different simple machines, such as wheels, wheels and axles, levers and pulleys (Figure 3.10). In this activity, you will learn about the parts of a bicycle and how to keep them functioning.

Bicycles have many moving parts that work together to accomplish a task (Table 3.2). All the parts (wheels, gears, pedal, etc.) of a bicycle work together to transform the effort of a rider into motion.

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Figure 3.10: *Parts of a bicycle*

Table 3.2: Parts of a bicycle and their function

Part	Function
Brake Pads	They are placed around wheels and they grab them to resist their motion.
Brakes	They slow down or stop the bicycle. The different types of brakes are rim brakes, disc brakes and drum brakes.
Chain	It transfers power to the rear wheel.

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Chain rings, sprocket	They guide the chain and transmit power from pedal to chain.
Frame	This is the main structure that supports the rider and connects all the parts.
Handlebars	They provide a place to hold and steer the bicycle.
Hubs	These are the central part of the wheel. They allow the wheel to spin around the axle.
Kickstand	It enables the bicycle to stand upright.
Cycle light	It improves visibility and safety.
Pedals	These are the point of contact for the rider's feet to apply force.
Rims	They support the tyres, and provide braking surface (rim brakes).
Saddle	This is where the rider sits.
Seatpost	This connects the saddle to the frame, usually of adjustable height.
Spokes	They connect the rim to the hub and provide strength and stability.
Tyres	They provide traction and cushioning.

Some common problems and solutions related to bicycles are:

1. **Rusting of parts:** You can clean the parts using sandpaper and apply oil or paint, as appropriate.
2. **Loose parts:** You can fix them using the appropriate tools. Ask your teacher which tools are used and write them here.

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3. **Wheels not moving freely:** Oiling of moving parts will help.

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4. **Flat tyres:** Air pressure in tyres should be checked regularly to avoid flat tyres.

Now let us look at each part of the bicycle more closely. As mentioned earlier, the bicycle is made up of different kinds of simple machines. To ensure that it keeps running smoothly, you need to check its parts and maintain them regularly (Figure 3.11). If needed, you can seek help from experts in the bicycle repair shop. Fill table 3.3 with the help of your peers and teacher.

Figure 3.11: *Working on keeping a bicycle in good working condition*

Table 3.3: Fixing parts of a bicycle

Part of bicycle	Function of part	Is the part functioning well? (Yes/No)	Did you do anything to fix the part? (Yes/No)
Brake			
Chain			
Spokes			
Kickstand			
Handlebars			
Tyre			

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Activity 7: Visit to a bicycle repair shop

You must visit a bicycle repair shop to learn from the experts. You can also request your teacher to invite a bicycle mechanic to the school to teach you all about maintaining and repairing a bicycle.

Some questions you can ask the mechanic are given below:

1. Is there anything that should be regularly checked before riding?

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2. Can the saddle height be adjusted? How?

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3. What is the best way to clean a bicycle?

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4. How do you know that the tyres need to be inflated?

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5. How is a punctured tyre repaired?

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6. How often should a bicycle chain be oiled?

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7. How can the squeaking brakes of a bicycle be fixed?

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8. How are the wheels of a bicycle aligned?

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Activity 8: Organise an exhibition of the toys

Planning an exhibition of toys made by you and your peers in a school can be an exciting and enriching experience for all students and visitors. Take the help of your teacher to plan and organise the exhibition. The following are some tips to guide you to organise such an event.

1. Define the purpose of the exhibition. Is it to raise awareness about the toys, showcase creativity, or teach how to make toys using waste materials? For example, during the exhibition, you can demonstrate the skills of making toys.

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2. Decide on a theme for the exhibition (e.g., eco-friendly toys, historical toys, and futuristic toys).
3. Ensure that the toys made by you all align with the chosen theme.
4. Decide on the exhibition space within the school.
5. Plan the layout of the exhibition, ensuring there is enough space for each toy and for visitors to move around. Decorate the venue in line with the theme to create an engaging atmosphere.
6. Send invitations to parents, local artists, and community members.
7. Arrange the toys attractively, ensuring each has a label with the creator's name and a brief description. Ensure all toys are safe to handle and the venue is child-friendly.
8. Have volunteers supervise the exhibition to assist visitors and manage any issue.
9. Collect feedback from visitors, students, and teachers to understand what went well and what could be improved.
10. Take photos and videos to document the event and share highlights through the school's newsletter or website.

What did I learn from others?

1. Name any three things you learnt from your friends while making toys or working models.

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2. Name any three things you learnt from the expert.

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What did I do and how long did it take?

You translate your ideas into actions.

It is important to understand how much time is required for an activity to be completed. Calculate the approximate number of periods you spent on each activity. Mark them on the timeline below. If you did more than the activities suggested in the book, please add the number and time taken.

Activity	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Time taken (Periods)	---	---	---	---	---	---	---	---

What else can I do?

Make a chain reaction machine using different kinds of simple machines made from trash.

You can search on the Internet for ideas using the following search keywords: Simple machine + Chain reaction toy.

Think and Answer

1. What did you enjoy doing?
2. What were the challenges you faced?
3. What would you like to do differently?
4. Design a toy that you can use to help a peer understand a concept related to Mathematics or Science.

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5. Can you estimate the number of times the wheel will rotate when covering a distance of 10 metres?

   Hint: *You can either use the circumference of the rim of the bicycle tyre or observe the movement of the bicycle tyre.*
6. Can using a bicycle make a difference to our health and the environment? If yes, how?
7. What jobs are related to the project? Look around, speak to people and write your answer. A few examples of jobs related to the work, you just did, are bicycle mechanic, toy maker, and engineer.

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