Part 2

Work with Machines and Materials

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, which are Working with Wood and Bamboo and Home Automation. 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.

Project 3

Working with Wood and Bamboo

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You can do many things with natural materials like wood and bamboo. You can cut these materials according to a design, assemble the parts and convert them into useful products. This project is about working with wood and bamboo to make useful objects.

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

- Learn about working with wood and bamboo
- Use basic carpentry tools
- Build a prototype as per design
- Make useful products using soft wood and bamboo

Figure 3.1: *Making useful products with wood*

Have you ever noticed that wood and bamboo are indispensable to our lives? From the wooden doors of our homes to fruit and vegetable carts, from school benches to cricket bats, wood baskets, fences, jewellery and toys—they are everywhere (Figure 3.1). They are also seen in the handles of our kitchen tools, bookshelves and even fishermen's boats and oars.

India is known for its ancient buildings and architectures. These buildings have stood the test of time. Most were built of wood, stone and other naturally occurring materials. From the *Hidimba Temple* in Manali, *Rumtek Monastery* in Sikkim and *Vishrambaagh Wada* in Pune—these buildings are renowned for their architecture and intricate decorative woodwork. Another example is the *Padmanabhapuram Palace* in Tamil Nadu, one of Asia's largest wooden palaces (Figure 3.2). It was built four hundred years ago and is spread over 6.5 acres.

Figure 3.2: *Padmanabhapuram Palace*

Wood is used as fuel in some parts of the country. It is also used as construction material for making houses, tools, weapons, furniture, packaging, artworks, and paper.

Craftsmen and carpenters have shaped wood into beautiful and functional objects for generations. Think of the carved wooden pillars in old temples, the sturdy bullock carts that travel through villages, or even the simple wooden ladle used to stir *daal* and curries. Humans have used this material in many imaginative ways for their benefits.

Even when many different materials are available, wood is still used in many ways. Wood and bamboo are increasingly preferred over concrete and bricks for building houses and schools as they keep rooms cooler in summer and warmer in winter (Figure 3.3). Sports like cricket, badminton and hockey rely on strong wooden materials. In some places, even bridges and equipment in playgrounds are made from these materials because they are strong and last long.

Since trees can be planted to replace the ones that have been cut, wood is considered a renewable resource. However, its use is not sustainable if its consumption exceeds the number of new trees planted. It must be noted that there are certain areas, such as those at high altitudes in the Himalayas, where trees do not grow easily. Once cut, entire forests disappear. Therefore, wood must be used judiciously. Ideally, the wood of a tree should be used after it has completed its lifecycle on earth—this is a sustainable approach compared to cutting off younger trees for wood.

This approach is in alignment with our culture and traditions. While using natural resources, our ancestors used to pray to the earth. For example, the *Atharva Veda* says, "Whatever we dig out from you, O Earth! May that have quick regeneration. May we not damage our vital habitat and earth."

Figure 3.3: *A traditional south Indian house with wood used for building roofs, doors, windows and pillars*

Substitutes like engineered wood or bamboo can be used instead of wood. Examples of engineered wood around you include plywood and Medium Density Fibreboard (MDF). Engineered wood is usually made using recycled wood, sawdust (fine particles or dust produced when wood goes through different processes in the production of objects), tiny wood particles, and wooden fibre.

Bamboo, on the contrary, is a perennial grass and grows back when cut (Figure 3.4). There are several species of bamboo in India, and these are grown in many parts of the country, with the maximum amount being grown in the north-eastern part of India.

Figure 3.4: *Bamboo grows in almost all parts of India, except for the extremely hot and cold desert regions of Rajasthan and Ladakh, respectively*

In this project, you will make products using either wood or bamboo. Adult supervision is required since you will be doing hands-on carpentry, including shaping, joining and sanding. You should **collaborate with a carpentry instructor or a local carpenter** to understand proper tool handling and safety measures.

What will I be able to do?

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

1. Safely use tools, like a hammer and saw, to cut, join and assemble materials.
2. Design a product and make a prototype.
3. Build a functional object using basic carpentry hand tools and materials.
4. Apply finishing techniques to make objects durable and attractive.

What will I need?

Tools required: Tri-square, hand saw, wood file, plane, claw hammer, measuring tape, steel ruler, bench vice, brush, clamps, hand drill, and cutter.

Figure 3.5: *Tools used for woodworking*

Materials required: Nails, screws, pencil or chalk, wood glue, sandpaper, varnish, softwood and/or bamboo, cardboard, synthetic resin adhesive, and cellophane tape (Figure 3.5).

How do I keep myself and others safe?

- **Handling tools:** Use all the cutting tools carefully. Learn the proper techniques to hold and use tools. Use masks and safety goggles to protect your eyes from wood dust.
- **Workplace safety:** Keep the workspace organised and free from any unnecessary dust and wood cuttings. Keep tools in their proper place after use.

Internet safety: Ask your teacher for help while using the Internet. Be careful not to upload or download anything without checking. Do not share your personal information with anyone.

What do I need to know before I start?

Natural wood is available in hard and softwood, depending on the kind of tree. Wood from different trees is used for different purposes. For example, hardwood from *babool* and mango trees is used for construction (making houses, bridges, window frames, flooring, etc.), while the jackfruit tree is used for making furniture and small objects, like *pooja* stands, handicrafts, etc. Softwood from pine and *deodar* is used for making lightweight furniture, shelves and packing boxes, while eucalyptus (*Nilgiri*) is used for making paper. Wood from the teak (*Sagawan*) tree is used for building ships and outdoor furniture.

As you may have guessed from its name, hardwood can be challenging to work with, requiring stronger tools and specific techniques. Softwood is easier to cut, shape and finish, making it more suitable for you to work with. Bamboo is also easy to work with. You can even use plywood or recycled wood from old wooden furniture or objects.

Look at the wooden objects around you and check if they are made of soft or hardwood using the fingernail test.

The test is simple–press your thumbnail against a wooden surface and pull it along. If it leaves a scratch mark, it's softwood; if not, it's hardwood.

Activity 1: Visit a Local Woodworking/Bamboo Workshop

Have you ever wondered how raw wood or bamboo becomes useful, like a chair or a table? What is the first step in turning a simple piece of wood or bamboo into a finished product?

By visiting a carpenter's workshop, you will discover how carpenters take decisions at each stage—from choosing the right materials to designing, shaping, cutting, and assembling the final product. Think about what you want to ask the carpenter(s) about their process of creating products and the things they take care of at every stage.

Record of the Visit to the Carpenter's Workshop

Name of the carpenter .....

Number of persons employed in the workshop (if applicable) .....

Qualification of the carpenter and other persons in the workshop .....

.....

Follow the checklist in Table 3.1 to observe, ask and document key details about the carpenter's work. Add or remove questions as suitable.

Table 3.1: Record of details about the Carpenter's work

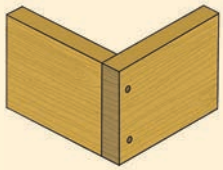
S. No.	Questions	Observation
1.	What kind of carpentry work is done in the workshop (e.g., furniture making, house construction and repairs)?	
2.	What types of wood are used to make different products?	
3.	How do you decide the type of wood to use for a particular purpose?	
4.	What tools and machines do you use to make products?	
5.	What are the basic techniques used to make products from wood? For example, measurement, drawing a design on wood, cutting, and joining.	
6.	What safety precautions do you take while working?	

Activity 2: Understanding Bamboo or Wooden Products

Look at the objects made up of wood/bamboo around you and pick any one of them.

You will find that different parts of a wooden object are joined in various ways. Any wooden object is generally made of different parts 'assembled' (or joined) together. Thus, joints are essential in making any wooden or bamboo product.

Figure 3.6 shows common joints used in wooden products. Of course, there are other ways of joining parts of an object, for example, with nails, screws, wood glue or with bamboo string (also known as twine).



Butt Joint

What it is: Joints in which straight edges join at the corners.

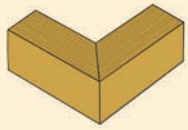
When used: For simple connections where strength is not a major concern.

Applications: Basic furniture like small tables or picture frames.

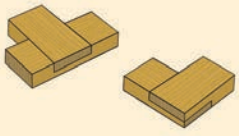
What it is: Joints in which pieces come together at a 45° angle.

When used: For simple connections where strength is not a major concern.

Applications: Basic furniture like small tables or picture frames.



Mitre Joint



Lap Joint

What it is: Pieces overlap each other with one piece sitting on top of the other.

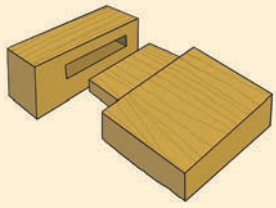
When used: For joining two pieces of wood that need extra surface contact for strength.

Applications: Shelves, simple boxes, and frames where durability is needed.

What it is: A joint where a protruding tenon on one wood piece fits into a mortise, a corresponding slot, on another piece.

When used: Ideal for strong, durable connections in areas needing to support heavy loads.

Applications: Common in making doors, window frames, furniture like tables, chairs, and bookshelves, and in building timber frames.



Mortise and Tenon Joint

Figure 3.6: *Common joints used in wooden products*

Joining parts using nails and screws

Nails, screws, nuts, and bolts are also called fasteners. They are used to join parts—nails are fixed using a hammer, and screws are fixed using screwdrivers. You need to make a small dent in the wood to place the screw tip. Using a screwdriver will help. Different types and sizes of nails and screws are used in woodwork.

Besides nails and screws, nuts and bolts are also used—these are fastened through a hole drilled with a hand or power drill.

Joining moving parts

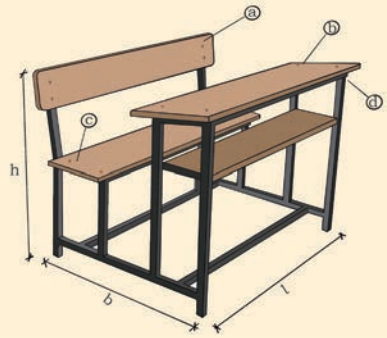
In some objects, the parts move, like windows, doors, cupboards, chests, and similar objects. Hinges join these moving parts. Hinges are used for smooth movement and allowing parts like doors or lids to open and close easily. This provides durability to wooden objects, so that they last a long time. Different hinges are suited for various purposes depending on the use, as shown in Figure 3.7.

Figure 3.7: *Hinges allow movement while ensuring the durability of wooden objects*

Record observations for the object you selected below:

1. Which object did you select?
   .....
   .....
2. What is it made of (for example, wood, bamboo, etc.)?
   .....
   .....

Table 3.2: Understanding the dimensions of an object

Sketch the object. Label each part and indicate the kind of joint used. For example: School bench.  	Draw a sketch of the object selected by you.
What type of material is it made of? For example: The bench is made of hardwood.	.....
Is it made of a single piece of wood or bamboo? If not, how many parts can you count? For example: The school bench. There are four different parts and a metal frame on which they are fixed; the parts are joined using nuts and bolts.	....
Did you see any of the joints shown in Figure 3.6? No, there are no wooden joints–metal and wood are joined together using nuts and bolts.	....

Activity 3: Making a Prototype of a desired object or product

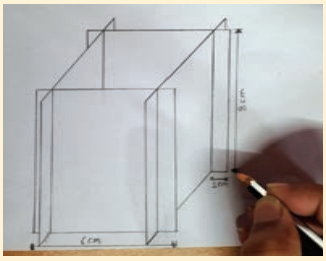
Figure 3.8: *Simple objects for making prototypes*

You have observed different carpentry tools at the workshop and studied wooden/bamboo objects or products. Now, decide on the product you want to make (Figure 3.8).

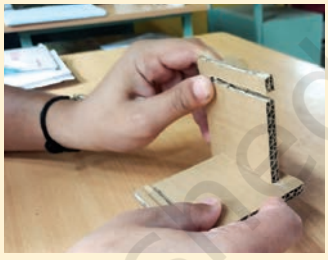
Since you are doing it for the first time, it is better to make a prototype of the object. A prototype is the first model of the product for checking your design. Since you are working with wood/bamboo for the first time, use cardboard or waste softwood

to make a small model of your chosen object. Remember, use the cardboard/softwood wisely, with minimum wastage.

Figure 3.9 shows the steps in making the prototype of an object or product.



Step 1: Sketch a three-dimensional object with dimensions.



Step 2: Collect material (cardboard/waste softwood, cutter, pencil, scale) and carefully mark the design on it. Ensure that the design is as per the sketch. Cut the material as per dimensions.

Step 3: Assemble the project using glue and see whether it has come out as per your original design.

Figure 3.9 : *Basic steps for making a prototype of an object*

Prototyping is an integral part of working with materials. It has many advantages—a few of them are listed below:

1. With the selected material, you can get an idea whether the design is appropriate or (while good on paper) unrealistic to make in three dimensions.
2. It reduces the chances of making errors while making the actual object.
3. You can modify the design at a low cost since you used cardboard or waste wood.

Hint: You can use glue instead of nails while working with cardboard, or you can also use cellophane tape. You can make hinges by piercing pieces of old wire into the cardboard (Figure 3.10).

Figure 3.10 : *Prototype of a hinge*

Review your process and respond to the following questions:

1. Were you able to measure and cut the material accurately? If not, what would you do differently next time?

   .....

   .....

   .....

2. How did you join the parts? Any difficulty in joining them? What would you do differently next time?

   .....

   .....

   .....

3. Were you able to recreate your sketch in three-dimension (3D)?

   .....

   .....

   .....

4. Show your model to your peers. What feedback did you get?

   .....

   .....

   .....

Activity 4: Making a product from wood

Now, you can make your own product using wood.

Select suitable wood. You can use scrap wood pieces. For your first product, you should choose softwood or plywood.

Start with something simple yet functional, like a wooden coaster (Figure 3.11). A coaster is a small flat piece of wood used to place cups or glasses to protect surfaces from heat or liquid.

You can also make different objects, like a wall hanging, key chain, key holder, chalk duster for your classroom, a phone stand to keep your mobile upright, a nameplate for your desk or door, a small wooden toy or something else (Figure 3.12).

Figure 3.11 : *Wooden coasters*

Remember, how you made the prototype in Activity 3. Whatever you decide to make, first sketch the object and make a prototype. You can look at similar objects to get an idea of the dimensions and parts, and how they can be joined, or you can get help from an expert.

Figure 3.12: *Designs that you can use for making coasters*

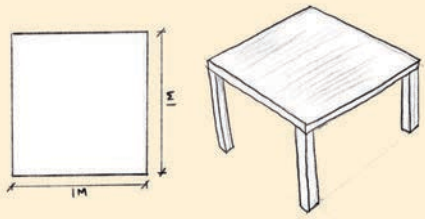
Through this activity, you will learn basic carpentry skills like measuring, cutting, sawing, sanding, and finishing, which will help you make other wooden objects.

Basic skills for working with Wood

Figure 3.13 shows basic skills for working with wood/bamboo. You will practice these skills as you build your product.

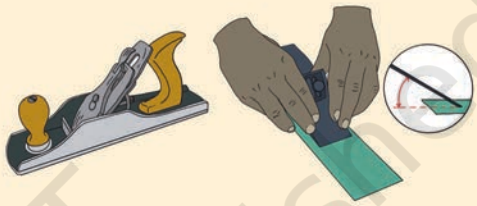
Remember to ask an expert or search for information through books or the Internet in case you need any support.

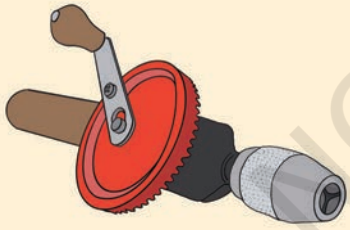
Sketching and planning: Sketch the object you will make (you can draw a simple outline on paper). Collect required materials and tools.



Measuring and marking: Use a measuring tape and pencil to mark where to cut.

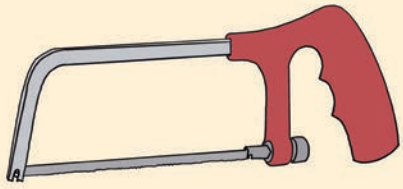
Planing (smoothening the wood): Plane is a tool to shave thin and uneven strips from wood surface. It creates a smooth surface by removing high spots. It also evens out any rough edges. Use a plane to smoothen the surface of wood.





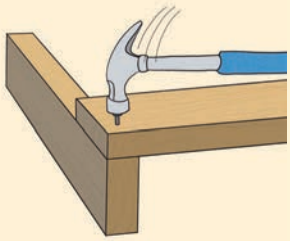
Drilling: Drills are used to create holes in wood to fix screw, nails, etc., using a hand drill. Keep the drill perpendicular to the wood where you want to make the hole for fixing pieces. Select the right type of tool, ensuring that it is fixed in the tool holder.

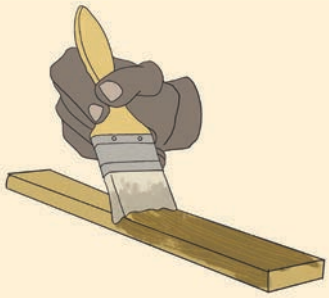
Cutting: Hacksaw is an important tool used to cut wood. Before you start cutting the wood, ensure that the piece is secured tightly in the bench vice. Mark a line to cut and make a small cut at the point the line begins. Check if the line is straight, else do necessary corrections.



Sanding: Sanding is done to smoothen the surface or smoothen the edges using sandpaper for a polished finish.

Assembly: Join the parts as per the sketch. You can press fit the joints made for the purpose. You can also use nails or nuts, bolts, and screws to join different parts.





Varnishing/Painting: Varnish is a solution of resins, oil and solvents. It is applied to form a protective layer on the wood surface. It becomes scratch resistant and also enhances appearance and durability.

You can decorate the object to make it look attractive, if you wish.

Figure 3.13 : *Steps for making products from wood*

Once you have practised the processes, respond to the following questions:

1. Which object are you going to make?

   .....

   .....

2. Sketch the object you plan to make with dimensions.

3. Write down the process you followed in making your object. Which tools did you use to make your object?

.....

.....

4. Did you face any difficulties while making it, and how did you overcome them?

.....

.....

5. What did you do to make the product look attractive?

.....

.....

Now, you have learned various steps in making wooden objects. The more you practice, the more you will master making them.

You can be creative when designing a small item (Figure 3.14). Here are few examples:
i. Bird house; ii. Mobile phone holder; iii. Name plate; iv. Wooden toy; and v. Keychains.

Figure 3.14: *Small items that you can make out of wood*

Activity 5: Make a bamboo product

As you read earlier, bamboo is a strong, lightweight, eco-friendly and readily available material that you can use to create many valuable items. Since you have already made a wooden coaster, you can make some other creative bamboo products.

The most striking feature of a bamboo plant is the stem, which emerges from the ground as a tender shoot and grows quickly into a tall and woody culm. The culm is a hollow cylinder tapering towards the top. It is the most commonly used part of the bamboo plant. A bamboo plant system consists of many culms. The stem is covered with a sheath (leaf-like structures that protect the developing plant) and has multiple nodes, as indicated in Figure 3.15.

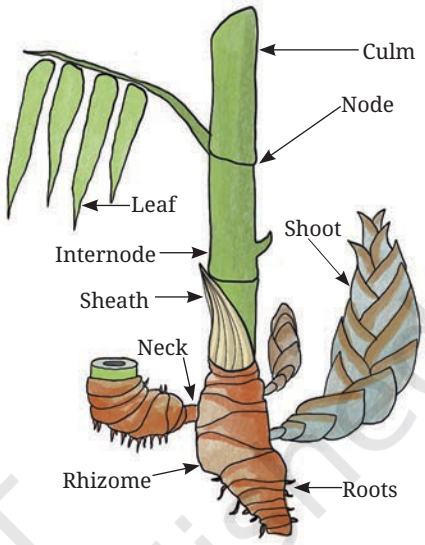


Figure 3.15: *Structure of bamboo*

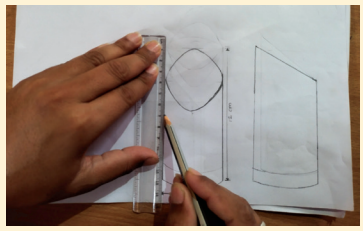
The culm is the part of the bamboo plant generally used for making products (Figure 3.16). It is a hollow cylinder segmented by solid nodes. Culms with smooth texture are used for making handicrafts and bamboo utensils.

Figure 3.16: *Objects made of bamboo*

Once you have decided on the object you want to make, the steps listed in Figure 3.17 will guide you to move from raw material to the final product.

Remember to ask an expert or search for information through books or the Internet if you need any support.

Sketching and planing: Sketch the object you will make (you can draw a simple outline on paper). Remember to label important measurements (width, height, thickness). Collect required materials and tools.



Measuring and marking: Use a measuring tape and marker to mark where to cut.

Cutting the piece you want: Cut the internodes from a length of bamboo using a hacksaw, and then cut the parts required according to the sketch. Remember to use a bench vice.

Smoothening: Scrape off the outer skin and smoothen **the surface area** of the bamboo piece.

Assembly: Join the parts as per the sketch. You can use a hand drill. You can also use nails or nuts and bolts, or screws to join the different parts.

Sanding: Sanding is done to smoothen the surface or smoothen the edges of the product using sandpaper for a polished finish.

Varnishing/Painting: Varnish is a solution of resins, oil and solvents. It is applied to form a protective layer on the surface. It is scratch resistant and also enhances the product's appearance and durability.

Figure 3.17: *Steps for making products from bamboo*

Reflect on your learnings

1. Which object are you going to make?

   .....

2. Sketch the object you are going to make with dimensions.

3. Write down the process you followed in making your object. Which tools did you use to make your object?

   .....
   .....
   .....

4. Did you face any difficulties, and how did you overcome them?

   .....
   .....
   .....

5. What did you do to make the product look attractive?

   .....
   .....
   .....

Activity 6: Costing — How much did you spend?

To decide the selling price of the product, we need to calculate the costs incurred in manufacturing the product. Please list all the materials and tools (in case the school purchased/rented them), and the cost incurred in Table 3.3.

Next, think of your labour—the time you spent making the object. Estimate the number of hours you spent making the product.

Table 3.3: Estimate of cost of making product

Materials	Quantity	Cost per Item (₹)	Total Cost (₹)
Wood/bamboo		₹	₹
Nails		₹	₹
Paint/Varnish		₹	₹
Sandpaper		₹	₹
Other materials		₹	₹
Total Cost			

Try to find out the price of a similar product in the market. (You may check with a local market or an online marketing platform).

Activity 7: Basic repairs Around the School

Like other objects, wooden objects also need maintenance. Most routine maintenance include tightening nuts, nailing the loose part, or painting the object. Some wooden objects may need sanding of worn-out parts. If objects are not maintained in time, their life gets reduced. Use your carpentry skills to repair wooden items in your school or home, such as benches, cupboards, and desks. One example is given in Table 3.4; add the details of what you did.

Table 3.4: Record of repair and maintenance work

Repair task	Was it fixed properly? How?	Does it feel strong? (Yes/ No)	Any final improvements needed?
The wooden top of a school bench	Yes, the screws were tightened	Yes	Smoothen the edges of the wood by sanding, which is done by using sand paper

What did I learn from others?

1. Name three things you learned from the carpenter/experts/ teachers during the project.

   .....

   .....

   .....

2. What was the most difficult step in making your product? How did speaking to others (e.g., peers, teachers, experts, family, community members, etc.) help?

   .....

   .....

   .....

What did I do and how long did it take?

It is important to understand how much time is required for an activity to be completed.

Calculate the approximate number of hours 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***
Time taken (Periods)	---	---	---	---	---	---	---

What else can I do?

Create a mini orchestra using simple handmade wooden instruments, like an *Ektara*, a wooden shaker (filled with seeds or beads), a clapper made from two pieces of flatwood, or a mini drum using a wooden container and cloth (Figure 3.18).

Make Your Own *Ektara* and Explore Other Musical Instruments

An *ektara* is a simple, one-stringed musical instrument used widely across India. It is easy to make using everyday materials, like bamboo, coconut shell, or hollow cylinders.

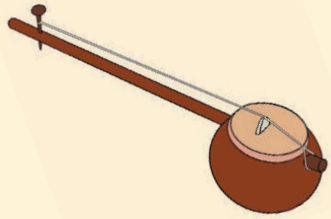


Figure 3.18: *Making an Ektara*

Other Musical Instruments You Can Make

Bamboo Flute: Use a hollow bamboo piece, drill small holes for notes, and blow across the opening.

***Damaru* (Hand Drum):** Use two small wooden bowls joined together with a string and beads to create rhythmic sounds.

***Chipli/Ghungroo Salangai/Ghunghur* (Bells):** Attach small bells to a piece of wood to create a musical instrument.

You can reuse old wood to make something new, like turning a broken drawer into a shelf or using small scraps to create art, gifts, or other fun objects. Look around your home or school for waste wood and try building or fixing things. This way, you can help the planet while having fun.

Think and Answer

1. Did you enjoy doing this project?
2. What did you like, and what would you do differently next time?
3. Wood has been a part of human civilisation, and part of the life of humans. It is present in almost every moment and every step of human life. Find out whether it is mentioned in literature and scriptures. Quote the words that talk of wood and provide translation, if needed.
4. Some examples of jobs related to your work are carpentry, interior design, etc. What other jobs are related to the project? Look around, speak to people, and write your answer.