



**KEEP  
UP**

  
Many branches.  
One industry.

The  
**WONDER  
OF  
LUMBER**

**WORKBOOK**

Lesson Plan for Grades 4 to 8



# OVERVIEW

This project aims to teach the younger generations about the lumber industry. The objective of offering it to schools is to generate interest in the industry by showcasing different career paths available and how essential the lumber industry is to these careers.

Trees are the backbone of the lumber industry and one of the most renewable building materials on the planet. They also provide the framework for a variety of creative and innovative industries involving lumber.

**In this project-based lesson plan, we explore different types of wood and how lumber contributes to three industries and career paths: civil engineering, architecture and furniture making.**

# AT A GLANCE



## Lesson Overview:

A comprehensive look at the many career paths that rely on the lumber industry, and how they do so.

## Estimated Time:

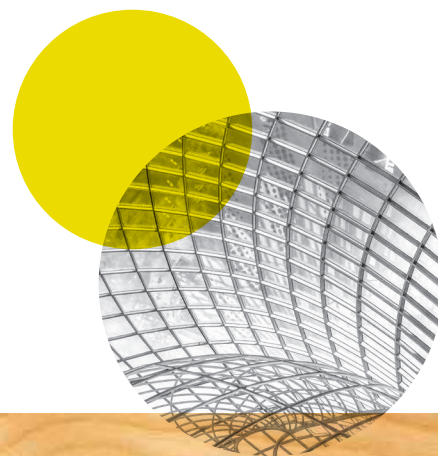
Four to six class periods

## Learning Focuses:

STEM and project-based learning

## Learning Standards:

This program supports math teaching standards in grades 4 to 8.



## math standards

### math standards

#### Measurement and Data – 4.MD

- Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.
- Geometric measurement: understand concepts of angle and measure angles.

#### Geometry – 4.G

- Draw and identify lines and angles, and classify shapes by properties of their lines and angles.

#### Measurement and Data – 5.MD

- Convert like measurement units within a given measurement system.

#### Geometry – 6.G

- Solve real-world and mathematical problems involving area, surface area and volume.

#### Ratios and Proportional Relationships – 7.RP

- Analyze proportional relationships and use them to solve real-world and mathematical problems.

#### Geometry – 7.G

- Draw, construct and describe geometric figures and describe the relationships between them.
- Solve real-life and mathematical problems involving angle measure, area, surface area and volume.

The projects are easily adaptable to include specific grade-level standards.

Examples of modifications include:

- **4th Grade:** Convert your treehouse plans to a  $\frac{1}{4}$ " : 1' scale.
- **6th Grade:** Determine how many cars your bridge can safely accommodate at the same time. Is it a one- or two-lane bridge and how many vehicles can pass across without causing structural damage?
- **7th Grade:** Determine how many square feet your final treehouse plans are.



## learning objectives

### learning objectives

- List several types of wood, their properties and their ideal end uses.
- Explain what each of the following do: civil engineer, architect and furniture maker.

**Civil Engineering Project:** With your team, design a bridge, then choose the wood materials that would be most appropriate for your design, where you would source the wood, and explain why you chose that particular wood.

**Architecture Project:** With your team, design a treehouse, then choose the wood materials that would be most appropriate for your design, where you would source the wood, and explain why you chose that particular wood.

**Furniture Project:** With your team, design bunk beds, then choose the wood materials that would be most appropriate for your design, where you would source the wood, and explain why you chose that particular wood.



## learning enhancement

### learning enhancement

For each of the following projects, have the students actually build replicas using representative materials.

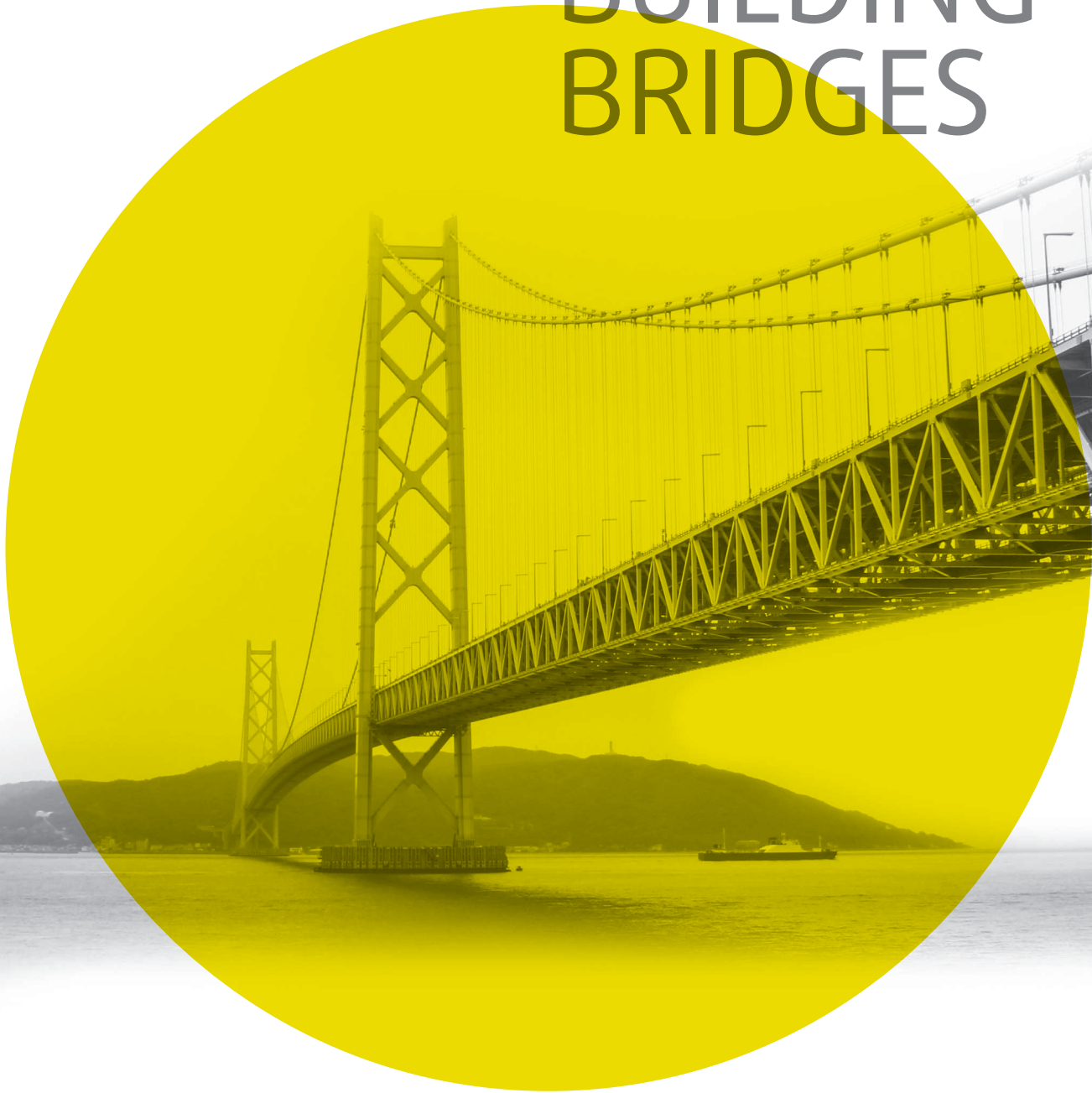
#### Possible materials List:

- Construction paper or thick paper stock
- Fabric in varying colors and patterns
- Magnetic pieces
- Marshmallows
- Popsicle sticks
- Rubber bands
- Smaller sheets, slabs and pieces of lumber if available
- Straws
- Tinfoil
- Toilet paper rolls
- Tongue depressors
- Toothpicks



project 1

# BUILDING BRIDGES





# HARDWOODS

1

Begin with a discussion of hardwoods, as these are most often used in finishing, e.g., doors, frames, furniture, mouldings, cabinetry. Not so much in large infrastructure construction.

# HARDWOODS

ash



Characteristics



Environment



Renewability

ash

Ash is a relatively lightweight wood for its strength, stiffness and resistance to shock. It's also notably flexible and can take stains and polishes well.

Ash trees like cool and warm climates and a lot of direct sunlight. This type of tree is native to eastern and central North America.

Highly renewable

beech



Characteristics



Environment



Renewability

beech

Typically reddish-brown in color, Beech wood is known to demonstrate a fine, even texture. It is easy to work with and has a high crush strength, medium stiffness and resistance to shock.

Young Beech trees can survive in partially shaded areas, but as they get older and taller (and they do get tall – 80 to 100 feet high!), they require direct sunlight. They typically grow in northern parts of Europe and Asia as well as eastern North America all the way to Wisconsin and south to eastern Texas and northern Florida.

Its slow to medium growth rate makes Beech less renewable than its hardwood counterparts.

mahogany



Characteristics



Environment



Renewability

mahogany

Mahogany is perhaps best known for its rich reddish-brown color. It is straight-grained, very strong and highly durable, ranking about six on a hardness scale of one to 10. Its unique color makes it a popular choice for furniture.

Mahogany trees love warm climates. Within the United States, they are native to South Florida, and are also commonly grown in the Bahamas and the Caribbean.

For such a large tree, Mahoganies grow relatively fast; however, one should avoid sourcing and using Brazilian Mahogany given the country's resistance to reforestation.

# HARDWOODS

oak



Characteristics



Environment



Renewability

**oak**

A workhorse of a tree, Oak is incredibly strong, heavy and durable, and typically resistant to pests and disease. These features contributed to Oak being a common choice for Viking longships!

Oak trees thrive in a variety of climates. They grow well in Mediterranean-type climates with dry summers and wet winters, as well as arid regions. In the United States, Oak trees can grow in almost all of the planting zones.

Oak is a slow-growing tree, so harvesting must be done responsibly in order to make it sustainable.

balsa



Characteristics



Environment



Renewability

**balsa**

Balsa wood has a straight grain with a medium to coarse texture. It's light but strong, so it offers a good weight-to-strength ratio. It is typically very easy to work with; however, it does not hold nails well, so glue is the preferred joining method.

This type of wood is grown in tropical regions of the Americas.

While Balsa wood can be responsibly grown on plantations, saving native forests from harvesting, it is frequently used to make wind turbines. Given a recent uptick in wind farms, its availability is expected to become limited in coming years.





# CIVIL ENGINEERING

2

Discuss what a civil engineer does and common projects with which they are involved.

# CIVIL ENGINEERING

- Roads
- Public buildings
- Airports
- Tunnels
- Dams
- Water supply systems
- And bridges!



## project

### project

#### Description

You and your team (three to five students) are civil engineers based in Virginia. Your company was just awarded a contract to build a new bridge that spans a large creek that runs through a historic town. Given the town's rich history, the local government would like to adhere to a traditional design aesthetic, incorporating at least 40% wood into your design.

#### Tasks

- 1 Design a bridge that can span a 12-foot-wide creek, with flat road access on both sides.
- 2 Make sure that your design is at least 40% wood (additional materials can be steel and concrete pilings).
- 3 Present your bridge and explain the following:
  - Which wood type(s) did your team choose and why?
  - How and where did you source your wood?

# CIVIL ENGINEERING

## Vocabulary

### Abutment

A support that touches and directly receives thrust or pressure of a bridge

### Cantilever

A projecting horizontal beam only fixed at one end

### Grain

The lengthwise patterns of wood fibers

### Infrastructure

The basic facilities required for the functioning of a country, e.g. roads, bridges, aqueducts, etc.

### Plasticity

A wood's ability to retain its shape when bent

### Rings

New wood formed by the annual growth of a tree

### Seasoning

The reduction of wood's moisture content through drying

### Toughness

A wood's ability to bend without breaking

## Tree Trivia

Did you know that both the largest and tallest trees live in the United States? The largest is a giant sequoia (known as General Sherman) in Sequoia National Park in California and the tallest is aptly named Hyperion (after one of the Titans of Greek mythology), located in Redwood National Park, also in California.



## Engineering Info

The Great Pyramid at Giza is one of the earliest examples of civil engineering. Just as they were then, civil engineers today are essential to the infrastructure and safety of our day-to-day lives. Did you know that until modern times, there was no distinction between civil engineering and architecture? The term "civil engineering" came into use in the 18th century, and refers to engineering work performed by civilians for nonmilitary purposes.





project 2

# TREES FOR TREEHOUSES







# SOFTWOODS

- 1 Begin with a discussion of softwoods and their uses.



# SOFTWOODS

larch



Characteristics



Environment



Renewability

## larch

Larch timber ranges in color from yellow to reddish-brown with a grain that is generally straight. It is moderately durable and commonly used for veneer, particle board, construction beams and flooring.

Larch trees are native to Northern Europe and Asia as well as northern parts of North America. This type of tree thrives in colder climates and mountainous areas with plenty of moisture.

Highly renewable

pine



Characteristics



Environment



Renewability

## pine

There is a large variety of pine trees. Soft pines are typically defined by even grain. The three main types of soft pines are Sugar Pine, Western White Pine and Eastern White Pine.

Pine trees grow almost exclusively in the Northern Hemisphere, and have one of the largest footprints of any conifer family. They prefer cool temperate forest climates.

Highly renewable, and some scientists are even working to turn pine needles into a renewable plastic!

spruce



Characteristics



Environment



Renewability

## spruce

Spruce has a fine, even texture and reliably straight grain. While it's easy to work with as long as the lumber is knot-free, Spruce is not particularly resistant to decay and it doesn't take stains or varnishes as well as other lumber choices. For the musically inclined, Spruce is very commonly used in soundboards and for many musical instruments, including guitars, mandolins, cellos and violins.

Spruce trees thrive in the northern temperate regions of North America, including parts of New England and a large portion of Canada.

Highly renewable



# ARCHITECTS

2

Who designs our buildings? Discuss what an architect does, his or her process, and some of the technical and aesthetic concepts they must consider when building.

# ARCHITECTS



## 1. Concept

In architecture, the concept is the initial idea that works as the roadmap or foundation for the project. Think of it as the thesis statement for your building; it should be detailed enough that you and your team are able to use it as a point of reference and direction throughout the process.

## 2. Building envelope or building enclosure

Think of this as the outer shell of your structure. It can be divided into three subcategories: support (how your structure supports weight), control (how it facilitates the flow of energy of all types), and finish (the aesthetic, or how you want the finished product to look).

## 3. Context

Would you build a brick building in the middle of the forest? Alternatively, would you put a Swiss-style ski chalet in downtown Brooklyn? Probably not. When architects design a building or structure, they must consider the context or situation or environment in which that structure will be built.

## 4. Interior versus exterior design

Architects get to consider all elements of a structure's aesthetic, or how it will look. This includes both exterior design, such as materials, windows, solar panels, chimneys, etc., as well as interior design, including window placement and how it affects light, lighting fixtures themselves, where the fridge is in relation to the stove, etc.

## 5. Board and batten

There are a lot of different ways to style the exterior siding on a building. One of the more popular styles is board and batten. This style alternates wide boards with narrow wooden strips, called *battens*.



# ARCHITECTS



## 6. Dormer

A *dormer* is a window that projects vertically from a sloped roofline. Think of the ghost in your favorite ghost story, looking out from a peaked window perch in the attic, or the roofline of a farmhouse, with multiple “mini rooflines” built up from the main, or dominant, roofline. Dormers allow for more light and ceiling height in the top level of a building.

## 7. Eaves

The eave is the part of the roof that hangs over the walls of a building.

## 8. Load

Technically, within the realm of physics, structural loads are forces applied to your structure. There are a few different classifications of load:

- **Dead load** (terrible name, right?), but all this means is that the load is constant over time, for example the weight of the structure itself.
- **Live load**, imposed loads or transient load refer to temporary stresses on a structure, such as someone walking on a floor, or installing a new fridge in your kitchen.
- **Environmental loads**, as the name suggests, are loads created by natural forces, including wind, rain, snow, earthquakes, frost and flooding, as examples.

## 9. Sway

Buildings must always take gravity into consideration, but there’s also the horizontal force of wind. Ever seen a palm tree swaying in the wind? Most tall structures must do the same thing, at least to a small extent, in order to accommodate horizontal forces without toppling over.

# ARCHITECTS

## project

### project

#### Description

You and your team (three to five students) have been tasked with building a neighbor's treehouse for his three sons, ages 4 to 10. Despite their different ages, the boys all share a love of nature and adventure.

#### Tasks

- 1 Design a treehouse that meets the neighbor's following requirements:
  - Must have a solid, safe floor
  - Three-foot-tall walls (if not taller)
  - At least one window on each wall
  - A roof
  - A door (which doesn't necessarily have to be a traditional door – think trap doors, secret doors, etc.)
  - A safe and sturdy ladder to get up
  - A fun way to get down
- 2 The majority of the structure should be wood – although you can mix hard and soft woods based on use – augmented with window materials, rope, steel and other materials as needed.
- 3 Present your treehouse and explain the following:
  - Your treehouse design and the architectural elements you incorporated
  - How the design meets the needs of your "client" (the neighbor)





# ARCHITECTS

## Vocabulary

**Eave:** The edges of a roof that hang over an exterior wall.

**Dormer:** An opening for windows at the roof level.

**Facade:** The primary exterior face or front of a building.

**Floor plan:** The layout and arrangement of different levels of a building showing the location of important aspects of the structure, e.g. walls, stairs, chimneys, rooms, doors, etc.

**Masonry:** Construction that uses tile, brick, stone or concrete with a mortar.

**Sway:** To move or incline to one side or in a particular direction.

**Temperate:** Moderate temperature that does not experience extremes of hot or cold weather.



**Bonus:** Name some of the trees that grow in North American temperate climates.

**Veneer:** A thin layer of wood for facing or inlaying.

## TREE TRIVIA

Wood is a favorite building material, at least in the United States, because of its efficiency, durability and renewability. Not only are many trees easy to regenerate (and make sure you're building with those!), the amount of energy needed to produce wood products is much less than other popular building materials. Additionally, wood is unique in its ability to vastly reduce carbon in the form of forests.



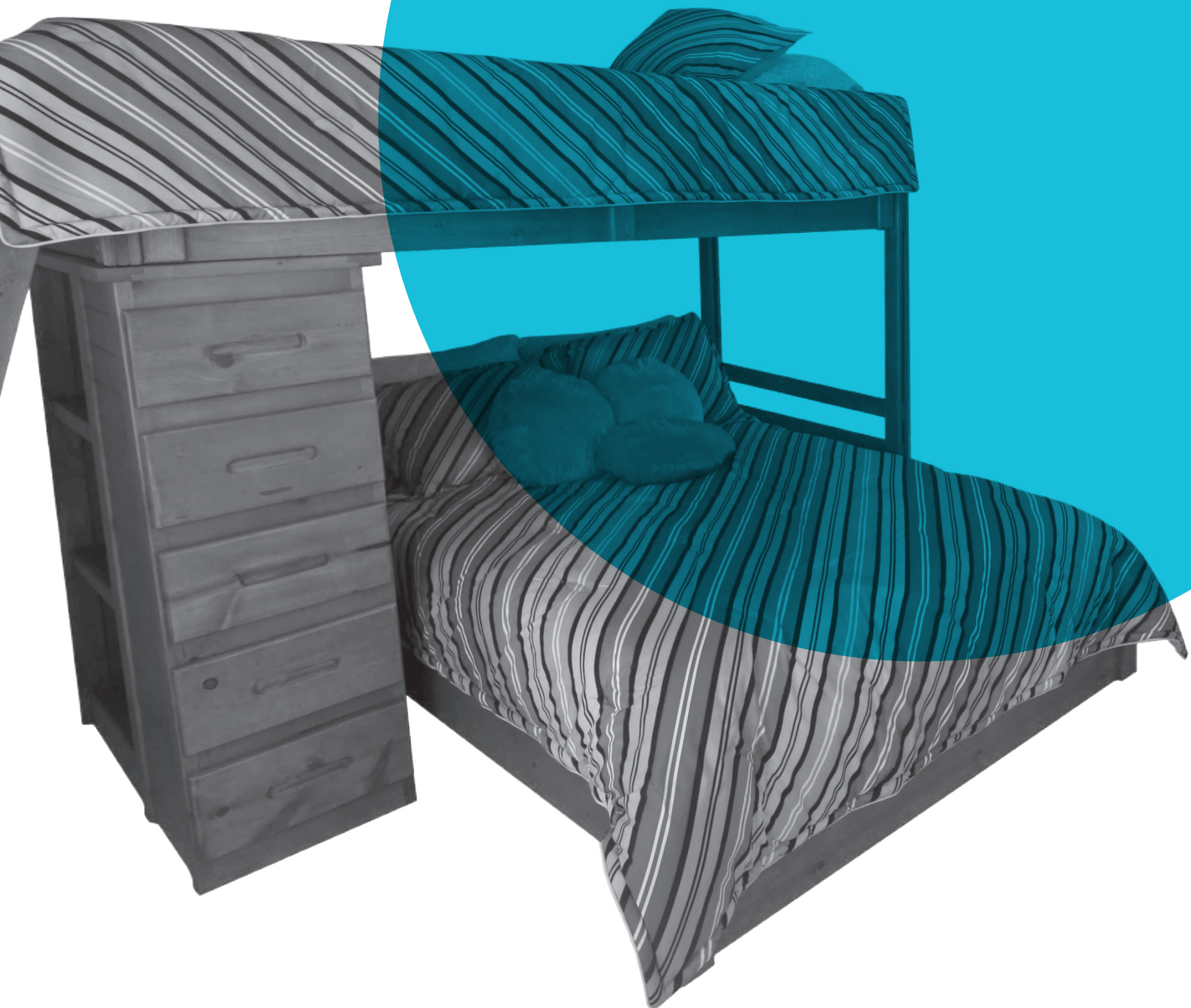
## ARCHITECTURE TIDBIT

Architecture was once an Olympic sport. That's right! During the first 40 years of the modern Olympic Games, more than 150 medals were awarded for music, painting, sculpture, literature and — you guessed it! — architecture.



project 3

# BUNKBED CHALLENGE





# MANUFACTURED WOOD PRODUCTS

- 1 Begin with a discussion of manufactured boards and their uses.

# MANUFACTURED WOOD PRODUCTS

fiberboard



Characteristics



How it's made



Renewability

## fiberboard

Fiberboard is a type of engineered wood product. This means it is created from wood fibers instead of whole timbers. Fiberboard comes in low-density, medium-density and high-density varieties, each varying in strength.

Fiberboard is a product of — you guessed it! — wood fibers. Either fresh or recycled wood is chipped into much smaller pieces, then, depending on its density and end use, the fibers are compressed into a piece of usable sheet or board.

Assuming fiberboard is a product of recycled, highly renewable or repurposed wood, it can be considered a highly renewable resource.

plywood



Characteristics



How it's made



Renewability

## plywood

As its name suggests, plywood is created by pressing multiple thin layers, or veneers, of wood together into a strong, rigid panel. Plywood is a very strong, low-cost option for construction and furniture making.

A log is typically steam-softened and then mounted on a lathe (a machine used to shape wood, metal or other materials), then cut into veneers. Several layers of veneers are then stacked together with alternating wood grain directions. Finally, the stack is heated and pressed into a usable piece of plywood.

Like all manufactured wood products, Plywood's renewability depends on the type of lumber from which it originates.

particle board



Characteristics



How it's made



Renewability

## particle board

Particle board is made from some of the smallest wood filaments, including wood chips, sawmill shavings and sawdust.

The wood particles are bound together with a synthetic binding, such as resin, before it is pressed and shaped.

Highly renewable based on initial wood byproduct ingredients.



# RECONSIDERING FURNITURE

2

We often take furniture for granted, not stopping to think about how it's designed, made and the materials that go into our favorite pieces.



# RECONSIDERING FURNITURE

Discuss the art and process of furniture making, including the following concepts:

1. Furniture design as it relates to end use
2. Furniture design as it relates to aesthetics and materials
3. Measure twice, cut once

This old adage applies to both furniture building and life. It emphasizes the importance of doing all of your due diligence and planning before you begin actually building your project.

- Make sure you double-check all measurements before making any cuts or permanent marks.
- Consider how all of the materials will look together once the project is finished. Does the textile you've chosen go with the wood? Do you want to apply a stain, paint or finish, or leave the wood untreated? Will the final piece of furniture fit in the desired space within your home or patio?

4. Natural joints versus adhesives, nails and other ways of securing corners and edges

Historically, furniture makers did not always have access to more modern adhesives such as wood glue or nails, so they had to use wood to connect other pieces of wood.

- **Traditional Joints:**

**Dowel joints** use small dowels fitted into same-size holes in separate pieces of wood to hold them together.

**Box joints** look a lot like a game of Tetris, with interlocking square fingers that fit together and receive pressure from two directions.

**Mortise and tenon joints** work like a key fitting into a lock, with a stub (tenon) that fits tightly into a hole cut exactly for it (mortise). This type of joint is a traditional method framing doors, windows and cabinets.

- **Non-traditional Joints:**

**Glues and fasteners**

**Pocket-hole joinery** uses a hidden screw driven into a joint at an angle to attach two pieces of wood.



# RECONSIDERING FURNITURE

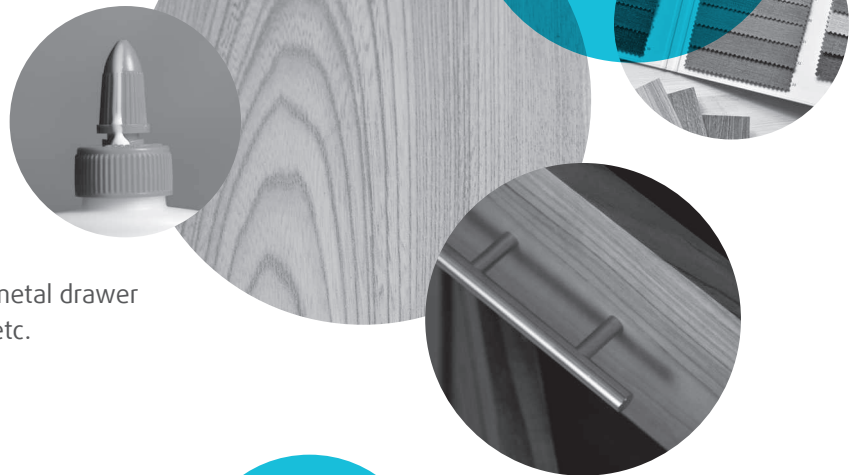
## 5. Tools

- **Handsaw:** Traditional and modern handheld tools used to cut and shape wood
- **Table saw:** This tool is used to cut larger pieces of wood
- **Jigsaw:** This fun tool can cut curves in wood
- **Tape measure**
- **Power drill**
- **Chisel:** A hand tool used to carve into wood
- **Hammer**
- **Screwdriver**
- **Pencil** to mark measurements on wood
- **Clamps:** These can be helpful when trying to fit pieces together or glue pieces together



## 6. Materials

- Different types of soft, hard and manufactured wood
- Textiles
- Glues and adhesives
- Complementing materials such as metal drawer pulls, steel chair legs, bed frames, etc.



## 7. Finishes

- **Paint**
- **Stain:** This specific type of paint is used to color and protect wood.
- **Varnish:** This is typically a transparent hard protective finish or film used when wood's natural texture and grain are intended to show through.



# RECONSIDERING FURNITURE

## project

### project

#### Description

Every year, your local home design store hosts a furniture building competition. The goal this year? Design a creative, sleek and functional set of bunk beds.

#### Tasks

1

Your bunk beds must meet the following requirements:

- While the bunks do not necessarily need to be the same size, they do need to fit standard mattresses, e.g. twin, full, queen.
- There needs to be a safe way for children as young as 4 to get from the top bunk to the floor.
- The distance between the top of the bottom bunk and the bottom of the top bunk needs to be at least 36".

2

Your design needs to be made entirely of wood products, although you can use adhesives, nails and screws if needed. Wood products can range from sustainable hard and soft woods to manufactured slabs and planks.

3

Present your design and explain the following:

- Your design concept, why you chose it and how it's unique.
- The type(s) of wood you chose to work with and why.
- Any additional design elements, such as paints, stains, special joints, etc.



# RECONSIDERING FURNITURE

## VOCABULARY:

**Density:** The mass contained in a unit of volume of wood.

**Lathe:** A common piece of woodworking machinery designed to hold a section of material to be carved, cut or shaped.

**Joint:** The junction at which two pieces of wood come together to form or make a closure.

**Hinge:** A moveable joint or mechanism on which two adjacent, connected pieces open and close.

**Dowel:** A round, grooved pin or peg that is fitted to holes in two pieces of wood in order to hold the two pieces together.

**Modular:** Furniture constructed in different units that can be arranged in varying configurations.

**Palette:** A range, quality or use of color.

**Particle Board:** Engineered wood product manufactured from wood chips and a synthetic resin or other suitable binder, which is pressed and extruded.



**Bonus:** What are some of the wood byproducts that can make up particle board?

## TREE TRIVIA

Plywood actually dates back centuries to ancient Egypt and China, where artisans glued multiple layers of veneer together when more desirable timbers were in short supply. How do we know? The wood was used to make furniture later found in the tombs of ancient Egyptian and Chinese emperors.



## FURNITURE FUN FACT:

The oldest known chairs were used as ceremonial furniture in Ancient Egypt over 5,000 years ago. And have you ever wondered why royalty sit on thrones? In early society, chairs or thrones were typically used by higher society, while lower- and middle-class citizens had to opt for stools.







**Many branches.  
One industry.**

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