

Bentwood Boxes, Volume and Surface Area



Goals: Students will become acquainted with the art of making bentwood boxes from cedar, while also performing the necessary math functions to solve a real-world mathematical problem involving volume of cylinders and cones. Students will also look at maps to see how the lands of the Natives changed since Time Immemorial and post contact with the Europeans and signing various treaties.

Oregon Common Core Standards:

- 8.G.C.9 Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

Oregon Social Sciences Academic Content Standards:

- Historical Thinking 8.9 Construct or evaluate a written historical argument demonstrating an understanding of primary and secondary sources.

Objectives:

- Students will be able to identify which formula to use for the volume of a rectangular prism.
- Students will be able to identify which formula to use for the volume of a cylinder.
- Students will be able to use the surface area of a rectangular prism to solve a mathematical problem.
- Students will be able to construct the appropriate size bentwood box in order to hold the drum with a given radius and height.
- Students will be able to describe the steps for making a bentwood box from cedar.
- Students will be able to explain to a partner what Native people used bentwood boxes for.

LESSON PLAN

Unit: Grand Ronde Tribal History

Lesson Title: Bentwood Boxes, Volume and Surface Area

Rational: This lesson will introduce students to the art of making bentwood boxes from cedar, which was a practice used by Natives from the Pacific Northwest coast, specifically the Chinook people. Students will also need to use their math skills and recall the formulas for volumes of cones, cylinders, and spheres in order to solve the problem given.

Goals: Students will become acquainted with the art of making bentwood boxes from cedar, while also performing the necessary math functions to solve a real-world mathematical problem involving volume of cylinders and prisms. Students will also be presented with a primary and secondary source regarding bentwood boxes and will need to evaluate both.

Oregon Common Core Standards:

- 8.G.C.9 Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

Oregon Social Sciences Academic Content Standards:

- Historical Thinking 8.9 Construct or evaluate a written historical argument demonstrating an understanding of primary and secondary sources.

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- Students will be able to describe the steps for making a bentwood box from cedar.
- Students will be able to explain to a partner what Native people used bentwood boxes for.

Materials Needed:

- | | |
|---|----------------------------|
| ✓ Bentwood box gift worksheet | ✓ Formula sheet (optional) |
| ✓ Bentwood box gift answer key | ✓ Vocabulary sheet |
| ✓ Hilary Stewart, <i>Cedar</i> , read aloud | ✓ Exit cards (index cards) |
| ✓ Bentwood box read aloud | |
| ✓ Calculators (optional) | |



LESSON PLAN

Time: Two class periods

Anticipatory Set: Begin the lesson by asking the students to put themselves back in time before European contact or since time immemorial; a time when just Native Americans occupied the land. Ask student to think about the materials they could use to make a box based on the resources they had around them. Describe a piece of land to the students that will help them visualize the types of resources that grow in nature, such as cedar trees, wapato and juncus plants. Tell them that there were no stores around to buy things back then and that the Indians had to use what was around them to make things that they needed. Explain to the students that they need to make a box in order to protect a drum that was made. Tell the students that the drum is shaped like a cylinder. Ask students what kinds of materials they think they could use to make a box. Write down their ideas on the board. Ask students if they have ever heard of anyone using steam to bend wood.

➤ **Lesson Steps:**

1. Present to students a read aloud page that is provided along with the lesson. This can be done a few different ways. The teacher can read the page aloud or give students an individual copy and the teacher can call on students to read a paragraph at a time.
2. Before reading the read aloud text, go over vocabulary with students.
3. While reading the read aloud page, ask students to think about how making one of these boxes relates to math. What kind of vocabulary do they hear that makes them think of math?
4. After reading the steps it takes to make a bentwood box direct the student's attention to the pictures of bentwood boxes and the diagrams that show how to make a bentwood box. Point out to students that the sides are all one piece, but that the top and bottom are two separate pieces.
5. After finishing both read aloud page, ask students to tell a partner what kinds of things the bentwood boxes were used for.
6. Have student's think-pair-share regarding the steps they would have to take in order to make a bentwood box.
7. Ask students which source is a primary source and which source is a secondary source. Explain to students that the excerpt written by Albert Buell Lewis is a primary source because it is an original record of a specific historical period. Explain to students that the excerpt from Hilary Steward is a secondary source because she had to reference primary sources to get her information to write her document.
8. Pose the question: Based on the two readings given, does one reading pose the thought that only one tribe made bentwood boxes and not any others?
9. Pass out the Bentwood Box worksheet.



LESSON PLAN

10. Allow students to work on the worksheet. Provided with this lesson are the different volume formulas needed in order to solve the math problem. Teacher can use this sheet at their own discretion.
11. During the lesson ask students questions like: how do you know you have designed the smallest bentwood box possible to fit the drum? Would there be other size boxes that are possible to design that would hold the drum?
12. To close the lesson, have students fill out an exit card answering the question: How does the art of making bentwood boxes relate to math?

Differentiation: Students can get individual copies of the read aloud and vocabulary sheet. Post volume formulas for students on overhead or give copies of the formula sheet provided with this lesson. Students can work in pairs on the worksheet.

Early Finisher Activity: Students who finish early can create a design they'd put on their own bentwood box if they were to make one.

Assessment:

	Yes	No	Notes
Student was able to identify the formula needed in order to find the volume of a prism and a cylinder and correctly use the formulas.			
Student was able to correctly use the formula to find the surface area of a prism.			
Student was able to list reasons why Natives used bentwood boxes			
Student was able to correctly describe the steps for making a bentwood box.			



LESSON PLAN

Notes/Other: To show students how a bentwood box is made teachers may show students the following YouTube video:

<https://www.youtube.com/watch?v=astU3VQwWx0>

To extend the lesson teachers can have students work on other questions such as:

- If Beaver made a drum that was twice as tall as the original, how will the volume of the drum change?
- How will the larger drum affect the surface area of the bentwood box?
- How will the larger drum affect the volume of the bentwood box?

This lesson works well when it is split into two separate class periods so that students can first work on volume and then a second day working on surface area. Prior knowledge is needed for both areas.

Attachments:

- ✓ Bentwood box worksheet
- ✓ Bentwood box answer key
- ✓ Formula sheet
- ✓ Vocabulary sheet
- ✓ Bentwood box read aloud text
- ✓ Hilary Stewart, *Cedar*, read aloud





Vocabulary

Bentwood Boxes

Chinook

Kwakiutl

Plank

Kerf

Dulse

Permeated

Cedar bark

Paraphernalia

Mordant

Definitions:

Chinook: The Chinook people lived in the Northwest along the banks of the Columbia River and the coast of the Pacific Ocean.

Kwakiutl- the Kwakiutl (kwah-kee-oo-tl) Indians lived in the Pacific Northwest Coast, which is now known as British Columbia.

Plank- a long, flat piece of timber, thicker than a board. (In this case, the planks were made from cedar.)

Kerf- a cut or incision.

Dulse- a coarse, edible, red seaweed, *Rhodymenia palmata*.

Permeated- to pass into or through every part of.

Cedar bark- the outer layer of the cedar tree that is harvested in long sections and pounded and softened to be used for making Grand Ronde baskets. Cedar bark was also harvested whole and used to waterproof the roofs of plank houses. Chinookan people made waterproof clothing from cedar bark and cedar hats. Cedar bark was also used to make cordage (also known as rope). Cedar bark was a valuable resource to the Grand Ronde Tribe.

Paraphernalia- equipment, apparatus, or furnishing used in or necessary for a particular activity.

Mordant- having the property of fixing colors, as in dyeing.

Bentwood Boxes

Cedar was a very valuable resource to the Grand Ronde people. They used cedar to make anything from houses and canoes to clothing, rope and boxes. Special boxes made by the Chinookan people were bentwood boxes. To find out whether the local tribes made bentwood boxes, we looked for clues



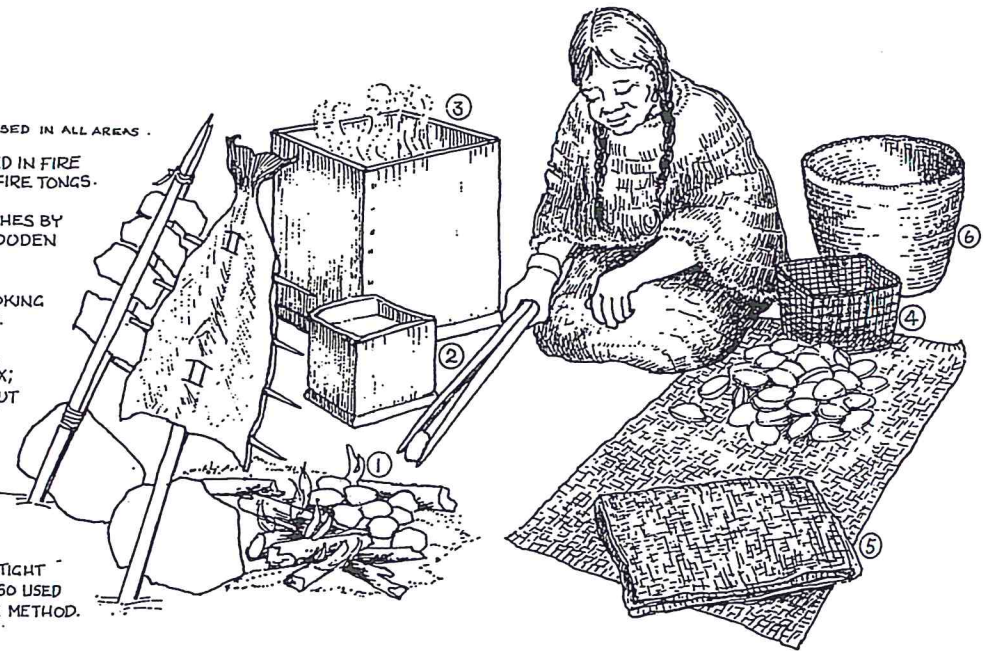
wherever we could find them.

Attached to this read aloud page is an excerpt from Albert Buell Lewis's article, *Tribes of the Columbia Valley and the Coast of Washington and Oregon*. In the article Henry Thompson recorded a journal on his journey through the lower Columbia River during 1813-1814 and stated "that the Chinook in 1814 had wooden

boxes with covers, some of which they made themselves, but does not tell how they were made" (as cited in Swanton, 1906, p. 161). Albert Buell Lewis also states, "boxes made out of boards, in much the same way as among the more northerly Indians, where manufactured by the natives around Puget Sound" (Swanton, 1906, p. 161). There is little record regarding the bentwood boxes made by Chinook people, but with this journal entry we can assume that the Chinookan people practiced the art of making bentwood boxes.

BOX COOKING — USED IN ALL AREAS .

- ① BOILING STONES, HEATED IN FIRE REMOVED WITH SMALL FIRE TONGS.
- ② STONES RINSED OF ASHES BY DIPPING INTO SMALL WOODEN BOX OF WATER.
- ③ STONES PUT INTO COOKING BOX WITH WATER IN IT.
- ④ WHEN WATER BOILED, FOOD WAS PUT INTO BOX; SMALL ITEMS OFTEN PUT IN OPENWORK BASKET AND LOWERED INTO WATER.
- ⑤ CEDAR BARK MAT PLACED OVER BOX TO CONTAIN STEAM.
- ⑥ INSTEAD OF BOX, WATERTIGHT CEDAR ROOT BASKET ALSO USED FOR COOKING BY SAME METHOD.



occasions, either on a pole in front of the house or high on the gable as a proud statement of self worth. In another way of declaring his superiority, a chief might erect a ridicule pole or figure that showed a rival chief in some belittling attitude. A shame pole would be displayed to show contempt for a rival's misdeeds or an unfulfilled social obligation: the carving represented some aspect of the event, and if it did not shame the person into paying the debt, fulfilling the promise or otherwise making good his shortcomings, it stood as a reminder of his disgrace for all to see.

Some carved figures held great spiritual significance. A Coast Salish shaman who took part in the spirit canoe ceremony had a carved representation of his spirit assistant planted in the ground beside him, and a Tlingit shaman's guard figure watched over him while he slept. Very small carved figures were part of many a shaman's medicine bundle, a powerful means of helping to cure the sick. Guard figures watched over a shaman's grave and that of others, too: the Coast Salish often placed one or more standing figures at a grave, and northerners frequently placed a carved crest animal at the site.

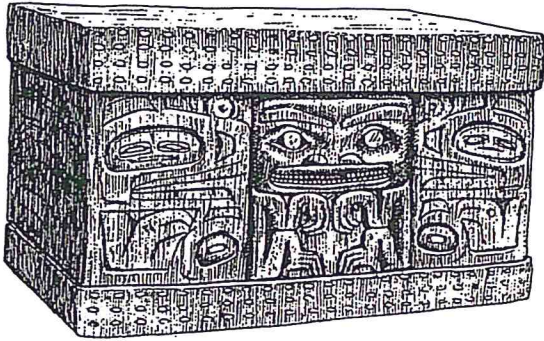
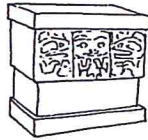
On the west coast of Vancouver Island, certain shamans of villages that did not have access to migrating whales built special shrines of cedar planks and posts. Set

apart from the village, these shrines housed human skulls and simply carved human effigies that were used in association with the whaling cult that sought to call whales ashore.

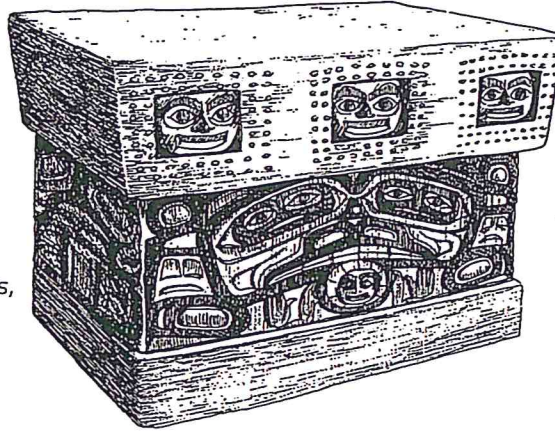
STEAMBENT WOOD One of the most outstanding items manufactured by Northwest Coast woodworkers must surely be the bentwood (or bent-corner) container. No other people in the world devised a large wooden container by kerfing and steambending a single plank to form four sides. The Inuit did make containers using a bentwood technique but seldom used kerfs and lacked a supply of suitable wood for making large storage boxes.

Boxes and Chests Bentwood containers with a height greater than the width are termed boxes, while those with a length greater than their height are referred to as chests. Boxes varied in size from small to quite large. Some were undecorated; others were either carved or painted, sometimes both. The undecorated cooking box, made in varied sizes, sat beside the fire, partly filled with water. A woman dropped heated stones into the box to bring the water to a boil for cooking food. If food required longer boiling, she replaced the cooled stones with freshly heated ones.

TELESCOPING CHEST
LID FIT COMPLETELY
OVER THE SIDES.



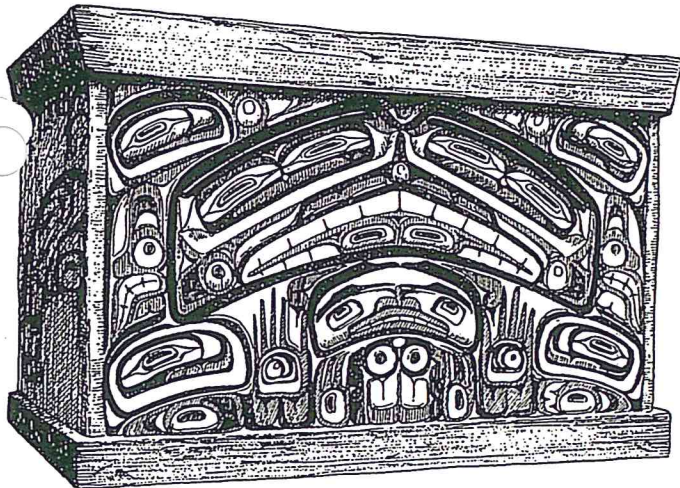
TELESCOPING CHEST, CARVED WITH FIGURES OF THREE BEARS,
GENEROUSLY INLAID WITH OPERCULA OF RED TURBAN SNAIL.
50.1 cm [19 $\frac{3}{4}$ "] HIGH. TL 20



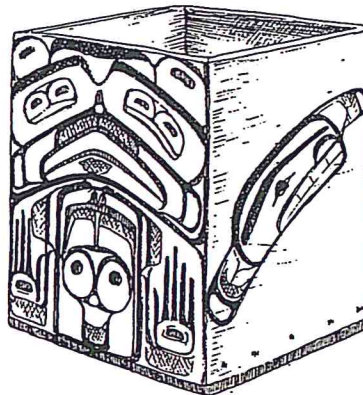
STORAGE CHEST, WITH LID UNUSUAL FOR ITS
PROPORTIONS AND CARVING - INLAID WITH 182
OPERCULA EACH SIDE. 66 cm [26"] TL 28



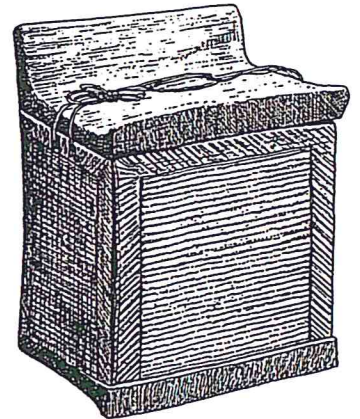
STORAGE BOX WITH PAINTED DESIGN
CENTRED ON ONE CORNER. ENTIRE
BOX OF CEDAR WOOD, OPERCULA
INLAID ON LID. 55.8 cm [22"] TL 21



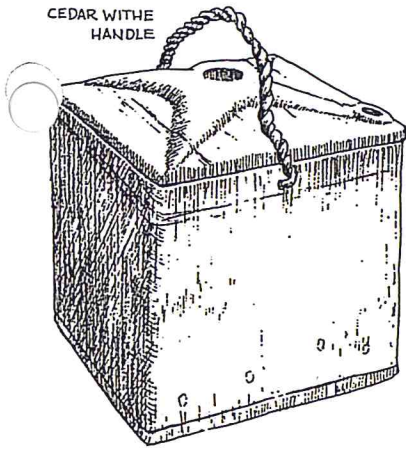
SUPERB CARVED AND PAINTED CHEST - VALUABLE PROPERTY OF
WEALTHY PERSON, USED FOR STORING CEREMONIAL REGALIA AND
WEALTH ITEMS. 99 cm [39"] TL 12



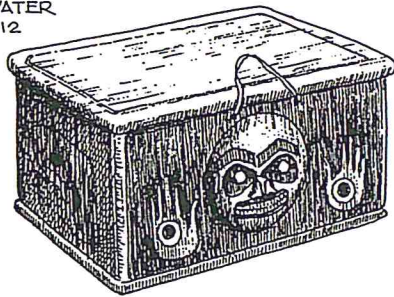
BENTWOOD BOX OF CEDAR BEARING
CLASSIC BLACK AND RED DESIGNS ON
FRONT AND SIDES. 39.3 cm [15 $\frac{1}{2}$ "] TS 20



FOOD STORAGE BOX, DECORATED
WITH ROWS OF FINELY CHISELLED
GROOVES. CORD TIED LID ON. 27.3 cm
[10 $\frac{3}{4}$ "] WC 21



WATER BUCKET - USED ON CANOE JOURNEYS. LARGE OPENING FOR FILLING; SMALL HOLE FOR DRINKING, USING A HOLLOW TUBE - PLUGS IN BOTH PREVENTED WATER SPILLING. 22.8 cm [9"] HIGH. MK 12



SHAMAN'S BOX WITH CARVED FRONT
52 cm [20 1/2"] TS 2

Very large cooking boxes used for preparing large quantities of food for a number of guests at a big feast were also brought into service to render oil from eulachon by boiling the pre-rotted fish. The oil floated to the top and was scooped up and poured into smaller bentwood boxes. Eulachon oil was regarded as a valuable trade item, as well as a symbol of wealth by those who lavished it upon the food of their guests. Boxes containing foods or oil for trade were made in standard sizes to simplify trading calculations. The large boxes containing oil were particularly strong and could hold 45.3 kg (100 lbs.).

Domestic boxes, plain or fluted, provided storage for foodstuffs such as dried fish, fish eggs, dried berry cakes, fresh crabapples in water, rhizomes, nuts and dried seaweeds, as well as the oil of seal, whale or eulachon. A plain bentwood box with a handle across the top became

a bucket to carry and store water in the house. Plain boxes were also used to store general items such as the tools, implements and supplies of craftspeople. Often, however, a creative carver added a design to his own work box. A shaman housed the mystical paraphernalia of his profession in a small box that he took to a ritual curing or other ceremony. The fisherman or sea mammal hunter took his gear along in a small box shaped to fit neatly into the narrow bow of his canoe. The weaver used urine as a mordant in dyeing wool; thus, a urinal box was both a household convenience and collector of urine (which had several uses). Because ghosts and malicious spirits had a revulsion for this bodily waste, the placement of the box by the door served another useful purpose by protecting the inhabitants. A small box stood at the left side of a woman while she spun twine from nettle fibre or cedar bark. The prepared strands, or roving, lay coiled in the box and were covered with sand to prevent them from tangling. As the spinner needed more fibre, she simply pulled it from the box. A basket weaver kept a small box of water at hand to keep the basketry material damp and flexible while working.

When a family made a long journey, perhaps to the fish camp or summer village, they loaded their canoe with boxes full of possessions, as well as empty ones in which to bring back winter food supplies; people used these boxes as seats while travelling. Those who went on trading journeys carried their trade goods in boxes and chests. All canoe travellers took along a food box and a water box. The latter had a tightly fitting lid with two holes in it, each stoppered with a wooden plug. The box was filled through the larger hole; a person who wanted a drink unplugged the smaller hole, inserted a hollow tube of wood and used it like a drinking straw. This prevented any spillage of the precious water, especially during a rough passage.

Bentwood boxes were another valuable trade item, and often the ones made for trade had elaborate and complex designs, either painted or carved, sometimes both, on all four sides; red and black were the most commonly used colours. Similar designs also embellished the large and handsome chests, sometimes made of yellow cedar; these often incorporated a third colour, blue-green, in the background areas. Some designs had inlays of sea otter teeth, opercula or occasionally pieces of abalone shell; the front

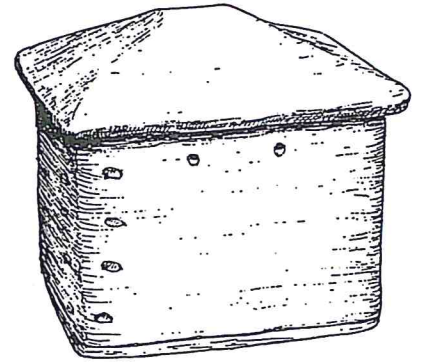
often depicted the head and trunk of a creature, while the back represented its hindquarters. Generally these designs were stylized almost to the point of abstraction, with body parts minimized or rearranged, but a few of the more elaborate ones had a face or head carved in three dimensions.

The spirit of the crest figure that embellished a box or chest dwelt within and guarded the contents for the owner. These masterpieces of the woodcarver's art became highly prized family heirlooms and were passed down from generation to generation. Many of the chest designs are among the most remarkable of any on the Northwest Coast; their elegant, balanced and complex compositions represented a high point of the creativity of the northern peoples.

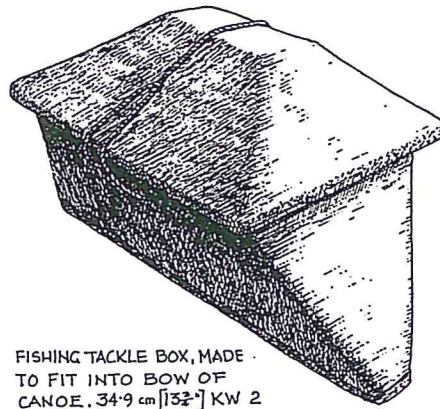
The value of a chest was high, and a wealthy chief might trade for one, or commission an artist-carver to make one. In it he stored his valuable ceremonial possessions, and on important occasions he seated himself on it. A high-ranking family might own several chests, some filled with their dance robes and blankets, furs, masks, rattles, head and neck rings, talking sticks, coppers and other paraphernalia used for ceremonial and state occasions. Other chests and boxes held the finely carved dishes, bowls, ladles and horn spoons used for special feasts. At a potlatch and on certain occasions, the magnificent chests and their contents were set out in a display of opulence to validate the wealth and status of the household. During the singing and dancing of feasts and celebrations, people drummed on the various boxes about the house.

A particularly interesting style of chest had an extending or telescoping lid, built either for strength or to increase the capacity. David Samwell, a surgeon on Vancouver's expedition, recorded: "They appear so much like our chests at first view that we took them for the work of Europeans, being made with lids, one half of the Box is made to enclose the other."

Bentwood boxes served the peoples of the Northwest Coast in death as well as in daily life; when a person died, the body (in a flexed position) was placed in a bentwood box, with the head at the corner where the steam-bent plank was joined, to allow the soul to escape through the crack. This burial box was often placed in some type of gravehouse, on top of a platform of planks



SMALL BOX, WITH PERFORATIONS FOR THONG TIES. 14.6cm [5 $\frac{7}{8}$ "] NWC 4

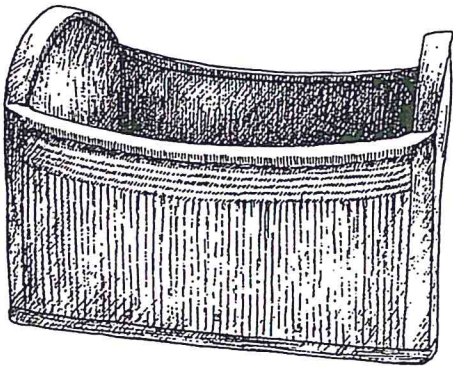


FISHING TACKLE BOX, MADE TO FIT INTO BOW OF CANOE. 34.9 cm [13 $\frac{3}{4}$ "] KW 2

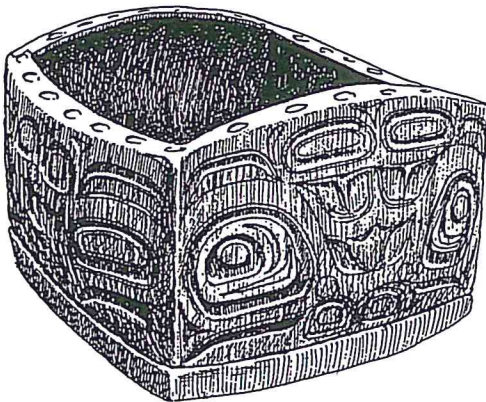
or in the top of a mortuary pole, but not all peoples did so. The southern Kwakiutl took the burial box some distance from the village and placed it in a tall tree, tying it to the branches with cedar bark rope. They preferred a tree that leaned over the water of a chasm and removed the lower branches to render the burial box inaccessible. High-ranking families of the Westcoast people placed the burial box in a cave (above high tide) owned by the bereaved family; many boxes accumulated in these caves over the years.

Bentwood Bowls No feast of a high-ranking northerner was complete without the use of exquisitely shaped and carved bentwood bowls, made from a single plank of yellow cedar (or other wood).

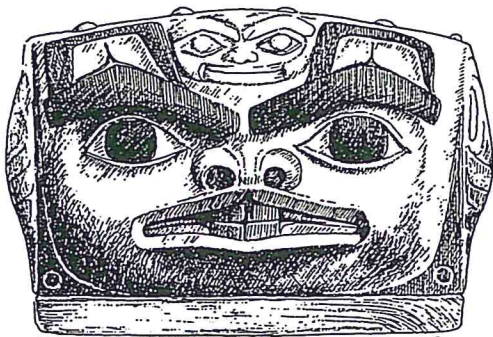
The woodworker carved the four sides of the bowl to give them bulging contours and cut the undulating rim to



BENTWOOD BOWL WITH FLUTED SIDES
33.6 cm [13 $\frac{1}{2}$ "] KW 2



CARVED BENTWOOD BOWL, WITH OPERCULA
INLAID AROUND RIM — BASE OF CEDAR
WOOD. 25.4 cm [10"] HA 3



BOWL FOR OIL, CARVED AND PAINTED TO
REPRESENT A BEAVER, RIM INLAID WITH
OPERCULA — BASE OF CEDAR WOOD.
25.3 cm [10"] WIDE. TL 27

shape — all before steaming and bending the plank. Like the bentwood box, he joined the corner by pegging or sewing, and pegged on the base. The bowl did not have a lid, but occasionally had a woven cedar bark covering shaped to fit over the top and sides. The wide rim of the bowl carried a decoration, often of opercula, sometimes of sea otter teeth. The elegant grace of the bowl's contoured sides and the undulating rim gave the container a fluid form. Often a sculptured animal head emerged from the low relief carving at the ends, imparting a vitality that reflected the richness and strength of the culture.

Large bentwood bowls held quantities of food or oil at a feast; smaller ones were used for lesser amounts of food or for individual use. As with other valuable items, a noteworthy bowl had a name, which the person carrying in the filled bowl announced to the assembled guests.

Box Drums The deep, resonant drumming that rolled through the dance house during a Kwakiutl ceremony came from the box drum, a large instrument made in much the same way as a bentwood box, but painted differently. Slender in width and open at one end, the drum was sometimes suspended by ropes from a house beam, and the drummer, his fists wrapped in shredded cedar bark, pounded out the beat for the dancers. In another method, he knelt on the floor, leaned the drum against his left thigh and beat time with his fists. The awesome sound of the box drum added much to the excitement of the dramatic enactments of the Winter Ceremonials.

Making a Bentwood Box The skill of the Northwest Coast woodworker revealed itself in the best of the bentwood boxes and chests. Meticulous measuring ensured that the wooden container would have even sides, vertical corners, a flat base and a lid that fit with exactness. Without ruler, set square or compass, the boxmaker used his own system of geometry for measuring and calculating. By studying the many boxes and chests in museums and other collections, it is clear that artisans devised a variety of ways for joining a box corner. So, too, they undoubtedly followed various procedures for boxmaking; the following gives a general outline of box construction by a Kwakiutl.

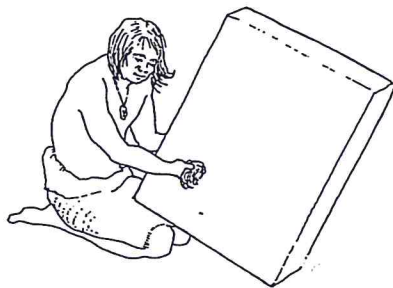
After splitting a plank from a felled red cedar tree, the boxmaker painstakingly prepared it for everness of



BOX DRUM - MYTHICAL SEA-BEAR DESIGN.
97.5 cm [38 1/2"] TL 15



BOX DRUM - BEAR DESIGN .
91.2 cm. [36"] TL 16



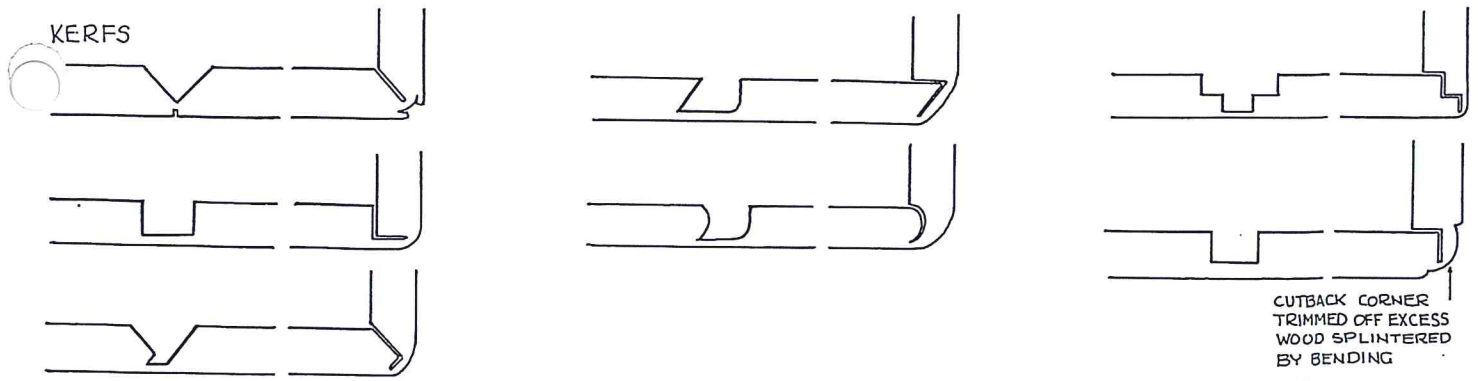
BOX DRUM RESTED AGAINST DRUMMER'S
THIGH—OR SUSPENDED FROM ROOF BEAM—
BEATEN WITH FISTS WRAPPED IN CEDAR
BARK. KW 75/2

length, width and thickness, using measuring sticks that each represented a given measurement of the box. He made sure that all corners and edges of the plank were perfectly true, and that the plank had a smooth, finished surface. Using measuring sticks and a straight-edge, he calculated where the corners of the box should be and scored vertical lines on the wood. Half a finger-width to the right of each line, he scored another line; between each pair of lines, he cut a kerf. The kerfs had to be precise and without slivers. In addition, he sometimes grooved the wood on the reverse side of the kerf to facilitate bending.

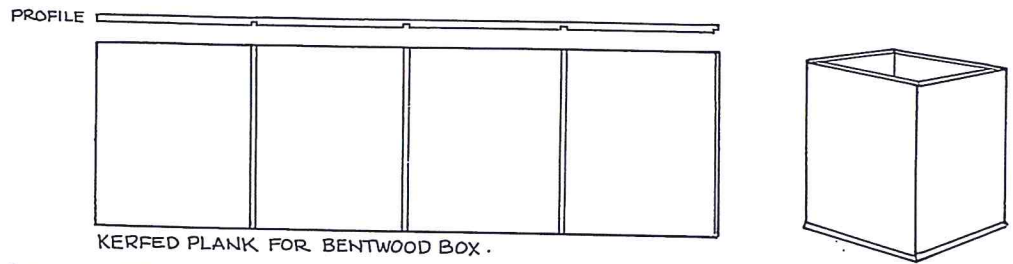
The next step was to steam the plank. In the earthen floor of his house, close to the fire, the woodworker dug three narrow pits to correspond in length and spacing to the kerfs on the board. With wooden tongs, he lifted out small, heated stones from the fire and placed them in the pits. He covered the stones with dulse and dead eelgrass, filling the pits to overflowing, then poured water into each pit. As clouds of steam rose, he placed the board down, ensuring that each kerf was over a pit. Over each groove on the reverse side of the kerfs, he placed seaweed, a row of hot stones and more seaweed, before adding water. As the steam permeated the wood, the thinned areas of the board eventually softened.

When the boxmaker thought the board was ready, he removed all the seaweed and rocks. Working quickly, he moved the board to a flat area of the floor and slipped the "board protector" over one end of the plank. Near the edge of the first kerf he placed a length of cedar wood across the plank's width, so that part of it extended over each side. Standing over the board, with one foot on each end of the crosspiece, he then took the ends of the board protector in his hands and carefully drew it upwards, bending the plank at the kerf. This was the crucial part: the wood could crack, break or not bend sufficiently if the kerfing and steaming had not been properly done. He attended to trouble spots in the kerfs with a sharp knife, making sure the grooves were cleanly cut to allow perfect bending.

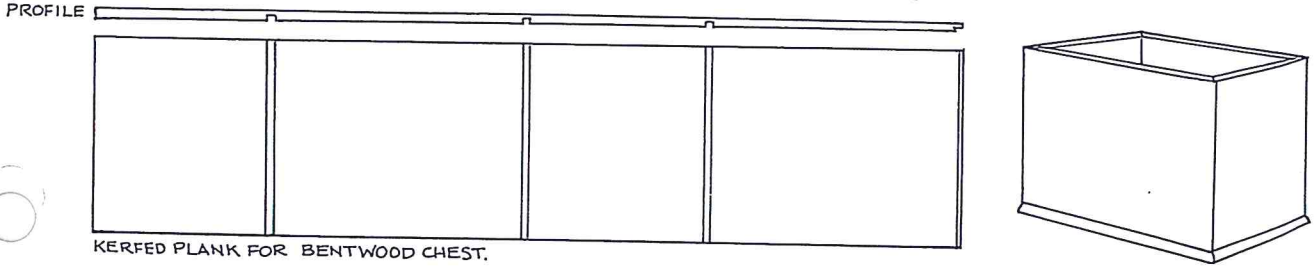
After he had bent the wood to a ninety-degree angle, and the kerf folded over onto itself (or closed up, depending on the type of kerf), the boxmaker removed the board protector and slid it over the other end of the plank. He bent the middle kerf and then the third kerf in



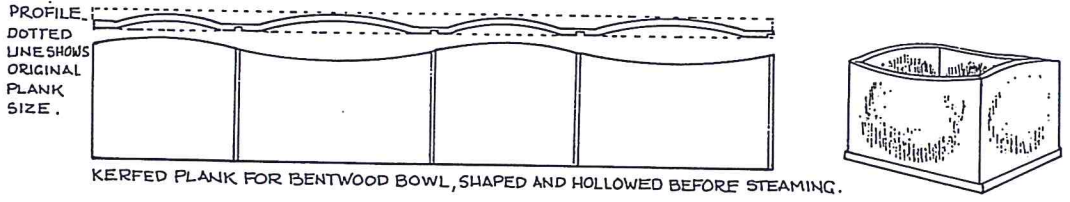
SEVEN TYPES OF KERFING USED FOR BENT BOXES AND/OR BOWLS, SHOWING SHAPE OF CUT AND FINAL BENT CORNER. [IN REALITY, WELL CUT KERF WOULD LEAVE NO GAP WHEN BENT] MOST CORNERS WERE SMOOTHED TO REMOVE ANY WOOD SPLINTERED THROUGH BENDING.



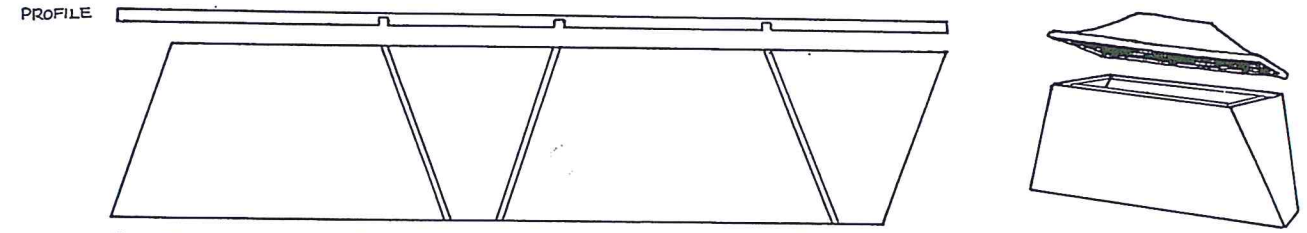
KERFED PLANK FOR BENTWOOD BOX.



KERFED PLANK FOR BENTWOOD CHEST.

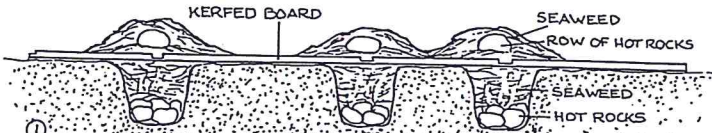


KERFED PLANK FOR BENTWOOD BOWL, SHAPED AND HOLLOWED BEFORE STEAMING.

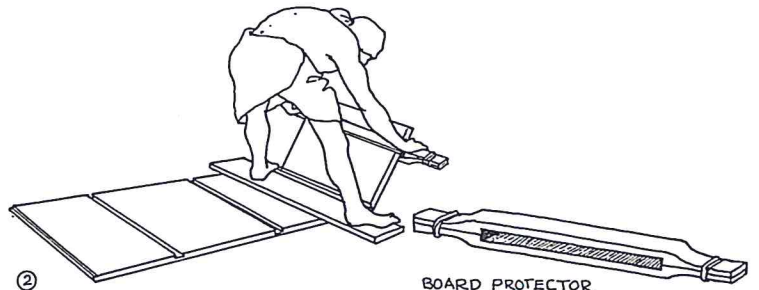


KERFED PLANK FOR BENTWOOD FISHING TACKLE BOX, SHAPED TO FIT INTO BOW OF CANOE.

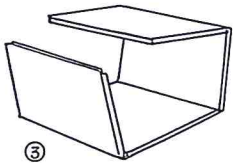
STEPS IN FORMING A BENTWOOD BOX. KW #34



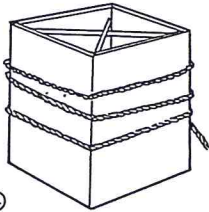
① STEAM PITS FOR SOFTENING KERFS CUT INTO BOARD. WATER WAS POURED ONTO ROCKS IN PITS AND ABOVE KERFS.



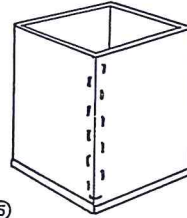
② BENDING BOARD AT FIRST KERF, USING BOARD PROTECTOR. PRESSURE OF MAN'S WEIGHT ON CROSSPIECE ALONG EDGE OF KERF PREVENTED IT FROM BREAKING.



③ STEAMBENDING NEARLY COMPLETED.



④ TWO STICKS ACROSS CORNERS ENSURED BOX HAD 90° ANGLES. ROPE HELD SIDES IN POSITION UNTIL WOOD COOLED.



⑤ CORNER DRILLED AND SEWN WITH CEDAR WITHE OR PEGGED.
⑥ BASE FITTED AND SECURED BY DIAGONAL PEGGING.

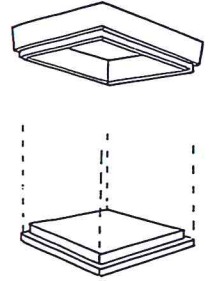
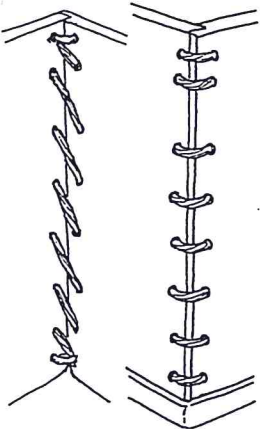
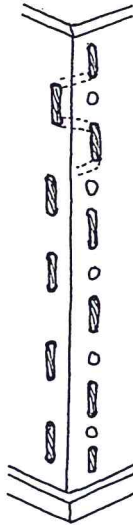


DIAGRAM SHOWING FORM OF BASE AND LID.

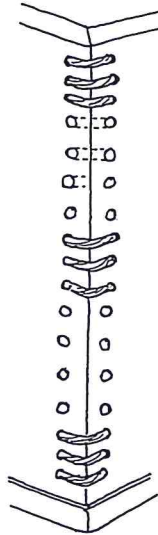
METHODS OF JOINING BENTBOX CORNERS



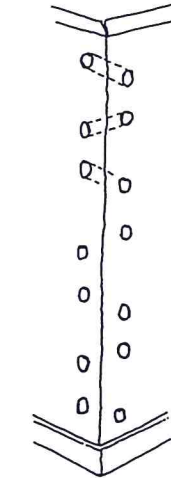
HORIZONTAL SEWING
LEFT: INSIDE OF BOX
RIGHT: OUTSIDE OF BOX.



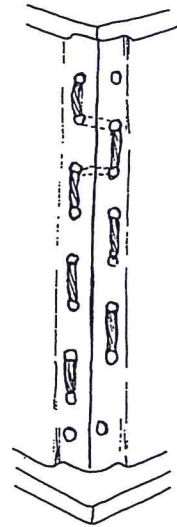
VERTICAL SEWING AND PEGGING COMBINED.



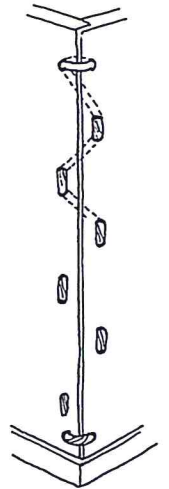
HORIZONTAL SEWING AND PEGGING ALTERNATED.



DIAGONAL PEGGING



VERTICAL SEWING, WITH PEGS DRIVEN IN TO TIGHTEN STITCHES.



VERTICAL SEWING WITH SMALL STITCHES

the same way, leaving only a single fitted corner to be joined. Taking a length of cedar bark rope previously soaked in water, he wrapped it several times around the bent plank to prevent it from springing open or warping. With the rope in place, he drilled a hole diagonally through the open corner. Taking a slender, pointed peg of yellow cedar (or some other wood harder than the red cedar of the box), he moistened it with saliva and drove it into the drillhole. At intervals of three finger-widths, he drilled other holes, alternating diagonal directions, and drove in pegs. As an alternative to pegging, the box-maker could use cedar withes to sew the corner together, drilling holes two finger-widths apart.

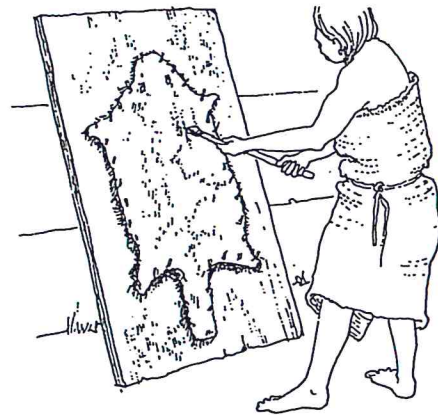
After careful measuring, he fitted a bottom to the box, pegging it on with diagonally drilled holes. Finally, he fitted and shaped the lid so that its inside lip sat comfortably within the box rim. If he was also a good artist, he painted a design on the four sides using, as a rule, red and black paints. To add to the value of the box, he might carve the design in low relief, setting off the painted areas to advantage, as well as decorate the outer rim of the lid with inlaid opercula or sea otter teeth.

Contemporary native artists have revived the skills of making bentwood boxes and these are, as previously, valuable and highly prized by their owners.

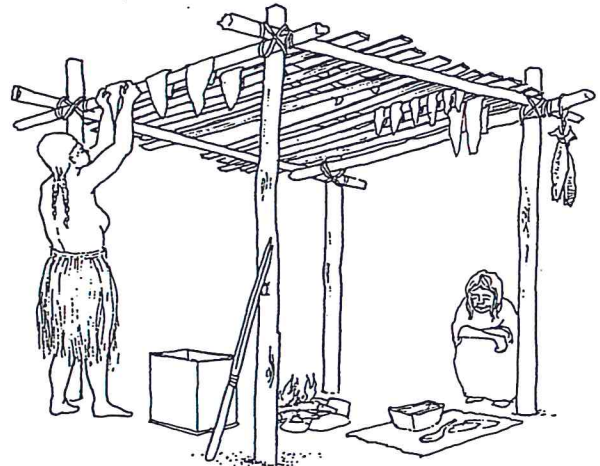
PLANKS AND BOARDS Cedar planks — straight, broad and lightweight — provided Northwest Coast inhabitants with a near-perfect building material for their housing needs. They also used planks and boards in a number of other ways. For dance performances, initiation ceremonies, a girl's puberty ceremony and other special occasions, large boards were joined together to form a huge screen, which had an elaborate family crest painted on it. This screen formed a backdrop to the event and also gave the dancers a place to change masks and costumes out of the audience's sight. The dance house had a separate room at the rear for this, constructed of planks, which was strictly out of bounds for the uninitiated.

On certain ceremonial occasions, a northern chief sat with grandeur in an extravagantly carved and/or painted seat. Constructed from wide boards, this legless seat, sometimes called a settee, was placed on the platform at the rear of the house — the most honoured place.

Inside Westcoast houses, partitions made of boards



WOMAN STRETCHED SEA OTTER SKIN OVER CEDAR BOARD, PEGGING OR TYING IT DOWN FOR SCRAPING. WC * 43

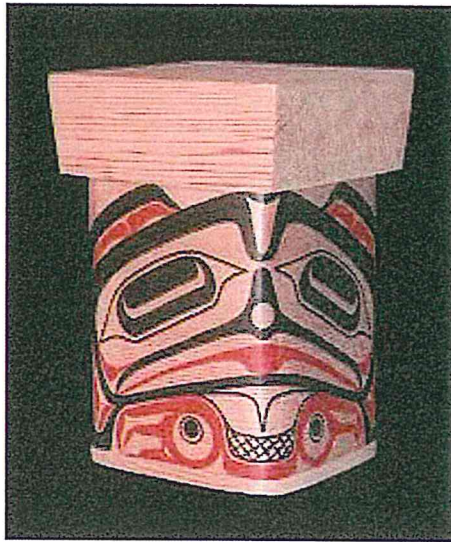


FISH-DRYING RACK OVER FAMILY HEARTH — SPLIT CEDAR PLANKS PLACED OVER FRAMEWORK. WC * 43

often formed sleeping compartments against which people could lean, facing into the house, during the day. Wide boards placed across poles or logs formed beds for those who did not sleep directly on the plank platforms. To store fish and other dried foods, householders suspended boards, above head height, with rope from the beams and rafters. This not only kept provisions safe from dogs and insects but prevented them from becoming mouldy because the rising warmth of the fire kept the food dry.

To help keep the house warm, a wide cedar board was placed over the open doorway. If a weaver lived in the house, she might have a pattern board for a Chilkat

Volume Formulas for the Bentwood Box



❖ Surface Area = Top Area \cdot 2 + Front Area \cdot 2 + Right Side Area \cdot 2

❖ Volume for a cylinder = $\pi r^2 h$

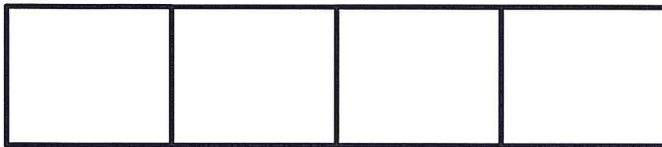
❖ Volume of a prism = Area of base \cdot Height

Name _____

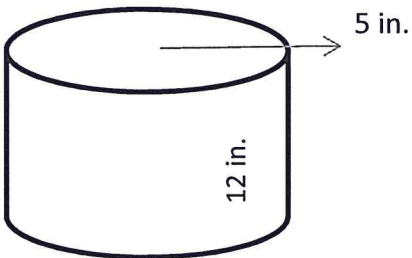
Bentwood Box Gift

Beaver just got done making a special drum. In order to protect the drum, Beaver decides to make a bentwood box out of cedar. Beaver knows that he can steam the cedar in order to bend it into the shape of a box.

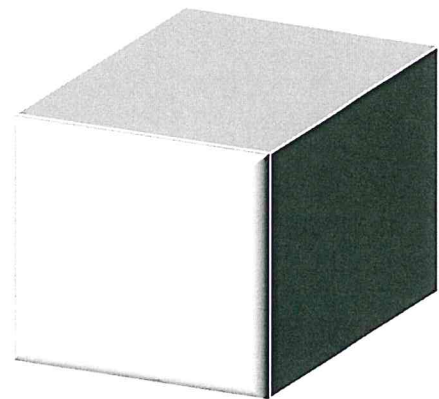
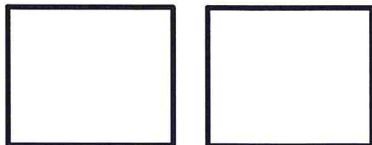
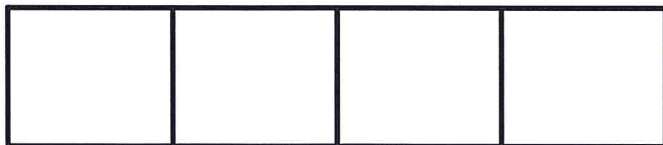
If Beaver steams and bends the cedar as shown below, he can make the box he needs.



Beaver measured the drum and found that it has a height of 6 inches and a radius of 13 inches.



A. What is the volume of the smallest box Beaver could build to hold the drum? Show the steps you used to come to your conclusion. Label each part of the box, such as top/bottom and label each dimension with the unit of measure.



Name _____

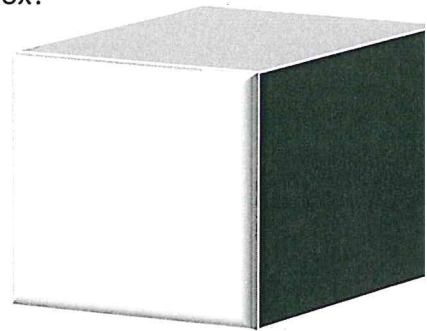
B. What is the surface area for this box? Show your steps.

C. Beaver wants to make sure that the drum doesn't get damaged in any way in the box. Beaver collected moss to fill the empty space of the box to protect the drum. Approximately how much extra space will be in the box that can be filled with moss? Show your steps.

D. If Beaver were to have made a drum with twice the radius and the same height as the original drum, how will the volume of the drum change?

- How will the larger drum affect the surface area of the bentwood box?

- How will the larger drum affect the volume of the bentwood box?



Name _____

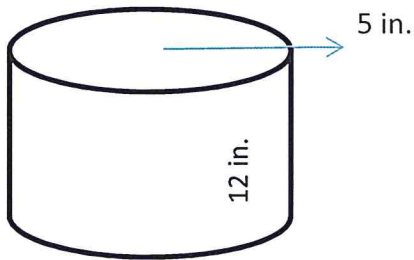
Bentwood Box Gift Answer Key

Beaver just got done making a special drum. In order to protect the drum, Beaver decides to make a bentwood box out of cedar. Beaver knows that he can steam the cedar in order to bend it into the shape of a box.

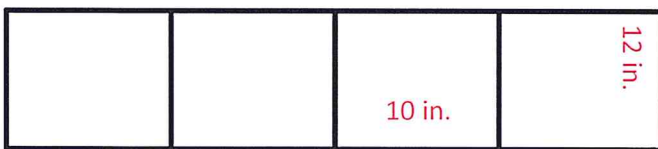
If Beaver steams and bends the cedar as shown below, he can make the box he needs.



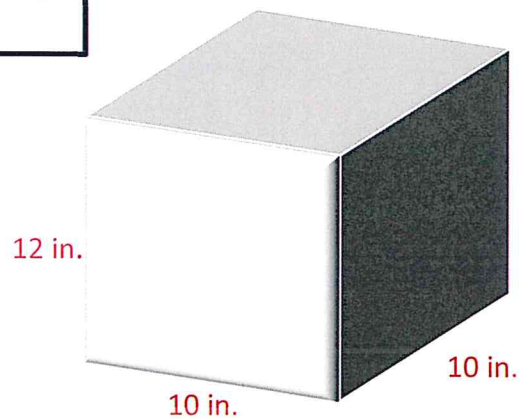
Beaver measured the drum and found that it has a height of 6 inches and a radius of 13 inches.



A. What is the volume of the smallest box Beaver could build to hold the drum? Show the steps you used to come to your conclusion. Label each part of the box, such as top/bottom and label each dimension with the unit of measure.



$$\begin{aligned} V &= Bh \\ V &= (10 \cdot 10)12 \\ V &= 100 \cdot 12 \\ V &= 1200 \text{ in.}^3 \end{aligned}$$



B. What is the surface area for this box? Show your steps.

$$SA = \text{Top Area} \cdot 2 + \text{Front Area} \cdot 2 + \text{Right Side Area} \cdot 2$$

$$SA = (10 \cdot 10) \cdot 2 + (10 \cdot 12) \cdot 2 + (10 \cdot 12) \cdot 2$$

$$SA = 100 \cdot 2 + 120 \cdot 2 + 120 \cdot 2$$

$$SA = 200 + 240 + 240$$

$$SA = 200 + 480$$

$$SA = 680 \text{ in.}^2$$

C. Beaver wants to make sure that the drum doesn't get damaged in any way in the box. Beaver collected more cedar and made it into strands to fill the empty space of the box to protect the drum. Approximately how much extra space will be in the box that can be filled with cedar strands? Show your steps.

$$\text{Volume of the drum} = \pi r^2 h$$

$$V = \pi \cdot 5^2 \cdot 12$$

$$V = 300\pi$$

$$V = 942 \text{ in.}^3$$

$$\text{Volume of box} - \text{Volume of drum} = \text{Volume of extra space}$$

$$1200 \text{ in.}^3 - 942 \text{ in.}^3 = 258 \text{ in.}^3 \text{ extra space}$$

D. If Beaver were to have made a drum with twice the radius and the same height as the original drum, how will the volume of the drum change?

$$V = \pi r^2 h$$

$$V = \pi \cdot 10^2 \cdot 12$$

* The new drum has a volume four times greater than the original drum

$$V = 1200\pi$$

$$V = 3768 \text{ in.}^3$$

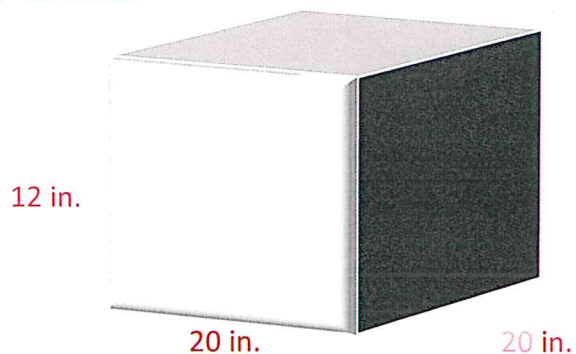
- How will the larger drum affect the surface area of the bentwood box?

$$\text{Surface Area of new bentwood box} = 400 \cdot 2 + 240 \cdot 2 + 240 \cdot 2$$

$$SA = 800 + 480 + 480$$

* The surface area of the new bentwood box increased by 1080 in.²

$$SA = 1760 \text{ in.}^2$$



Name _____

- How will the larger drum affect the volume of the bentwood box?

Volume of new bentwood box = $(20 \cdot 20)12$

$V = 400 \cdot 12$

$V = 4800 \text{ in.}^3$ * The volume of the new bentwood box is four times the volume of the original