Mathematics in Kosraean Weaving: Identification and Possible Integration in Culturally Responsive Mathematics Curriculum

Latika Raisinghani
Mathematics in Kosraean Weaving: Identification and Possible Integration in Culturally Responsive Mathematics Curriculum

Latika Raisinghani
Assistant Professor
Education and Science Department
College of Micronesia-FSM
Kosrae FM 96944 Micronesia
E-mail: latikarai@hotmail.com
Mathematics in Kosraean Weaving

Introduction

This paper focuses on identification and description of mathematical ideas, patterns and thinking involved in the making of specific artifacts of weaving (otwot) in Kosrae, using coconut leaves and fibers (sroacnu), pandanus leaves (lol) and hibiscus bast (ne), and their possible integration in a culturally responsive Mathematics curriculum. Kosrae (pronounced as Ko-shry), also called the “Island of the Sleeping Lady”, is the only island state within the Federated States of Micronesia (FSM) that does not have any outer islands. It is of volcanic origin and is believed to have been formed by the shifting of the great Pacific Tectonic Plate, which was later called the Caroline Plate, approximately 3,000,000 years ago. Kosrae had many other names as well: Kusaie, Katau, Kato, Kosiu, Kusae, Carao Tevya, Strong’s Island, Hope Island; however, the people who found it used none of these. They called it Kosrae (Segal, 1995). Dr. Ernst Sarfert described Kosrae as “the most beautiful island of the great ocean, as honoring its name ‘Gem of the Pacific’ indicates, which it received at the time of its highest popularity with the white people” (Sarfert, 1919). Kosrae covers an area of 42.31 square miles and is roughly triangular in shape. It is most easterly state in the FSM, located at approximately 5° North Latitude and 163° East Longitude (Department of Commerce and Industry, 1999).

Figure 1: Location of the State of Kosrae
I searched the Kosrae State Library, State Museum and Historical Preservation Office, Women’s Center, Kosrae State Visitor’s Bureau and found out that not many attempts have been made to document the culture and traditions of Kosrae. There was no written language until the missionaries came (Segal, 1995); therefore, most of the traditional skills were passed on through word of mouth. There are only a few books touching on the cultural practices of Kosrae. Of those, the volume written by Sarfert in 1919 entitled “Kusae” and its English translation by Carmen C.H. Petrosian-Husa in 2008 is definitely a great resource that contains detailed description of traditional Kosraean cultural practices and skills.

To give an overview of the traditional weaving practices of Kosrae, I am including the descriptions and illustrations of selected weaving artifacts. The condensed information provided in the table 1 is taken from “Kusae” by Sarfert (1919).

Table 1: Names, Illustrations and Descriptions of Selected Weaving Artifacts

<table>
<thead>
<tr>
<th>Name and Illustration</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eä</strong></td>
<td>This was the typical and characteristic neck decoration of females and because even small girls would wear it together with their apron, it was regarded as a part of clothing. It consisted of individual strings, which were twisted from a pair of white (undyed) and black-dyed hibiscus bast string. The strings were knotted in bundles on the neck so that the knot was hanging down like a plait. They were worn in such an amount that they covered the neck like a bandage or cuff. Men also wore eä decoration but they were content with just one string, usually decorated with knots in irregular intervals (eä foko or knotted string).</td>
</tr>
<tr>
<td><strong>Imoal</strong></td>
<td>These were the thin necklaces made up of human hair, woven in strands like braids and also decorated with knots. The necessary hair to make an imoal was provided by the lover of the wearer as a pledge.</td>
</tr>
</tbody>
</table>
This was a very much cherished neck decoration for both genders that was made of red *Spondylus* shell discs. The string was made from one white and two black pandanus leaf strings (*ip en lol*). The shell beads had a hole drilled in the middle and were each attached to the string using strong alko-bast (*Pipturus*).

It was a black string made of hibiscus bast (*ne*) woven in a special way. Women wore it in thin bundles on the ankle. Usually only one *luok* was worn on each foot.

For both sexes, traditional clothes consisted of the well-known, often magnificently ornamented *tol*, made of banana fiber. These *tol* were very short and narrow and ended in fringes, just like the loom-woven cloths of the Central Caroline Islands.

It was a small rectangular, flat basket made of pandanus strips with low vertical sidewalls. When making it, people started with the bottom. Strips of the rib of a coconut frond enforced the edges. This basket was used by women for keeping utensils.
**Kopes Aftof**

A similar basket like *kopes* with an attached lid. Women used it for keeping utensils.

**Foto Kuumpäl**

This basket was made up of two pieces of coconut fronds, which were halved. The halves were interwoven in such a way that the sides of the basket consisted of the two halves, \(a_1\) and \(b_1\), and \(a_2\) and \(b_2\); and \(a_1\ a_2\) and \(b_1\ b_2\) were opposite of each other. The ribs formed the edge of the basket and the ends of the leaves were braided into 2 braids at the bottom and elongated with hibiscus bast to form a handle. The basket was used for cooking fish.

**Foto in Kaki or Foto Kotkot**

This basket was made up of one piece of coconut frond with the rib forming the bottom. The leaves on one side of the frond were interwoven with each other, and the ends were in two braids on one side. By knotting it with the braids of the other side, 2 handles were created, which crossed each other. The rib of the frond was snapped twice so that it had the form of a keel. The basket was used to carry all kinds of coconuts. Usually, two baskets were hung on a carrying stick, one in the front and one in the back.

**Foto Fon**

The *foto fon* was made from a single coconut frond. The leaflets were woven to form a closed cylindrical shape. The rib of the frond was halved when the weaving was finished. It served men to transport the different foods and women to collect crabs. For the latter, the rib of the frond was not halved and the crabs were pushed through spaces in between the leaves into the basket. Men carried it on a
Mathematics in Kosraean Weaving

carrying pole.

**Foto Rotoma**

This basket was made from a single piece of half a coconut frond. The rib was rounded and formed the edge of the basket. The ends of the leaves were formed into a braid at the bottom. The basket was used to transport fruit and meals.

**Foto in Kälat**

This basket was a smaller and deeper basket to collect kälat shells. The kälat were eaten and the shell served as a knife for the female weavers. It was made in a manner quite similar to the foto rotoma. However, the end part of the coconut frond was used for it.

**Foto Läle**

This basket was made from the end pieces of 4 coconut fronds that were not halved. They were woven with the broken off end of the rib on top, the ends of the leaves formed a braid at the bottom. It was used to transport fish, crabs and also fruit. The four ends of the ribs were connected with hibiscus bast and hung on a carrying stick.

**Foto in Pätar**

This basket was women’s basket for fishing. It was made from one piece of coconut frond, which was not halved. The ends of the leaves were partly ripped off so that the leaves all had the same length. The basket was started on the edge, by turning the leaves of one side of the frond to the other and actually all into the same direction. The rib of the frond was rounded to form the edge, usually the braid was missing.
This basket was made of pandanus leaves; the strips had their natural width. A string made of hibiscus bast formed the edge around which the leaves were folded. The elongation of the edge-string also served at the same time as a handle. This form has now become very rare; in the time when there were not many coconut palms it was the most common form.

Sarfert (1919) also identified kinds of weaving found in Kosrae and according to the descriptions, the natives distinguished only two types of weaving:

1. **Uotuot fasa** - a simple cross-weave. The name came from the fact that in the old days, usually the leaves of the nipa palm (*fasa*) were used for weaving. This leaf, because of its width, cannot easily be woven in any other fashion. This also is the reason that Kosraean weaving is nearly always done as a simple cross-weave. It is present in the mats and most of the baskets, although the nipa palm no longer has any significance in weaving. Thus, it seems that over time in Kosrae, the preferred choice of weaving materials changed twice. People changed from using the leaf of the nipa palm to using pandanus leaves, and in modern times to using coconut fronds.

2. **Päfuäs** - a kind of weaving, where the strips are always woven over and under two other ones. It was seldom used; however, the *fusanie* basket of the men always had *päfuäs* only. The fishing basket of the women combined both kinds. There was no name for this combined weaving and the natives also could not give any reason for it. The women, who were asked, thought that, in this way, the basket would be more durable. In modern times it is used for weaving wall hangings and hats.

These descriptions prove that there is lot of mathematics involved in weaving, and affirm the fact that Kosraean weaving had been (and still is) an integral part of living in Kosrae. It is true that many of the artifacts described by Sarfert are no longer made but still we have so many weaving practices that have survived in spite of the rapid changes in the life-style caused by modernization. Therefore, this paper focuses on the description of the weaving of certain artifacts that are still being used, and an effort has been made to identify the mathematical concepts, ideas and patterns involved in their weaving.
Methodology

The research for this paper was conducted mainly by onsite visits and personal informal interviews and hands-on weaving experiences with local weavers. Personal visits were made to search relevant materials and interview people of various departments that include the Kosrae State Library, State’s Museum and Historical Preservation Office, Kosrae Women’s Center, Kosrae State Visitor’s Bureau, and Kosrae State Department of Education, especially the Curriculum Division. I have been fortunate to personally interact with many local experts and educators and spend time with local handicraft weavers, three of whom are active members of the Kosrae Women’s Center and they weave handicrafts as their main profession. One of them is a renowned handicraft weaver and local medicine expert (my main resource person). I observed them weaving, tried weaving with them, and learned about different aspects of weaving, i.e., selection and preparation of weaving materials and weaving of specific objects.

All the descriptions of weaving of different artifacts in the discussion is based on these weaving experiences and all the colored pictures included in this paper are taken by me. All of the experts and educators interviewed were enthusiastic and willing to share their knowledge and skills when I told them that we would try to relate these weaving practices with teaching mathematics to our elementary school kids. Through this research I have not only made new contacts but have reaffirmed many old ones. One of my former student who also happened to be the daughter of my main resource person, happily volunteered her time and helped me in contacting and communicating with elder weavers, another recognized me when I was visiting the Kosrae Women’s Center and helped in taking photographs of objects displayed, another one recognized my voice when I called the Kosrae Conservation and Safety Organization (KCSO) to inquire about a plant used in weaving and to my surprise came to see me in the college within an hour with complete information and photographs of that plant, another one was so enthusiastic when I explained the purpose of the project that he taught me how to weave a ball for the local soccer game.

Therefore, I am overwhelmed with the courtesy displayed by the people of Kosrae and want to thank them for their wonderful contributions and I am glad to share my hands-on weaving experiences in the following pages.
Description

Weaving (otwot) of specific items that I observed and learned through personal meetings, informal interviews and hands-on experiences are as follows:

1. Weaving of Traditional Food Plate (K uom)

The traditional food plate (k uom) is usually 2.5-3.0 feet long with symmetry along the braided midline. A k uom is made from a single coconut frond (s'roacnu). The word “s'roacnu” is used to indicate coconut leaves regardless of whether it is a complete frond, a part or a half frond split across the great midrib, a single leaflet, or the coconut fiber.

It is advisable to cut a frond and leave it in the sun for at least 2-3 hours prior to weaving, because the leaflets of a freshly-picked frond will tend to snap while weaving and will shrink while drying and this shrinkage leaves holes in a previously tightly-woven article made from a fresh frond. Brief drying in the sun makes for a superior product (Arbeit, 1985).

To make a k uom, the number of leaflets on each side of the frond should be equal and the total number of leaflets is always even. The leaflets on each side are counted by 2’s and the counting system is based on base 10. Usually the elders use sra (1), lo (2), tol (3) … which is one counting system out of the three found in Kosrae (Please see Appendix A for more details about Kosraean Counting Systems). So counting goes, lo (2), ahng (4), on (6), oal (8), singucul (10) and then again, lo (2), ahng (4), on (6), oal (8), singucul (10). The person who demonstrated the weaving of the k uom used 20 leaflets on each side so the total number of leaflets used was 40.

To weave the k uom, people first weave the leaflets and then skewer the great midrib of the frond. To start weaving, the frond is held in an inclined position at an angle (approximately 120°-130°) to ensure that the leaflets are opened fully, and the weaving is accomplished with ease. The leaflets on the right side are woven first by placing the 3rd leaflet over the 2nd leaflet and under the 1st, then the 5th leaflet over the 4th and under the 3rd and then we pick up the 1st leaflet in the right hand and place the 7th leaflet over the 6th and under the 4th leaflet and pick up the 2nd leaflet along with the 1st one in the right hand, then place the 9th leaflet over the 8th and under the 6th and pick the 3rd leaflet in the right hand… and continue weaving in this way until all leaflets on the right side are woven. The leaflets that were picked with the right hand during weaving are tied temporarily. The left-side leaflets of the frond are also woven in a similar way and once both sides are woven, we braid the loose leaflet ends present on the inner side and then we turn the frond on another side and open and braid the leaflets that were carried in the right hand and tied temporarily. The remaining small ends of all the braided leaflets are tied again temporarily.

The woven frond now looks like a narrow woven cylinder. Now starting from the narrower side, the great midrib of this cylinder is split in two, by using a knife. Once the great midrib is split, the shape of the k uom is evident, showing two vertical grooves or
wedges present on each side of the braided midline. To give the finishing touch, the remaining small ends of the braided leaflets that were tied temporarily are opened and crossed under and over the first woven leaflets on both ends and tied with hibiscus bark (ne) for strength and firmness.

An additional interesting fact is that while serving, food is always placed on only one side of the kuom (left or right, it doesn’t matter) and the other side is left empty. I asked many people the reason behind this, and whether one side is left empty to hold the food scraps, but all of them said that it’s just a part of their tradition. The use of kuom as a food plate is declining and a very few people nowadays know how to weave kuom. In the past it was woven only by men, however, both men and women weave it nowadays.

The word “kuom” carries two specific meanings: in addition to designating the traditional food plate on which the food is carried and distributed, it usually indicates a specific quantity of a particular food to be contributed by a particular family during feasts and funerals. The total amount of food contributed by a family is counted as an um (which also refers to the traditional earth oven and for the food cooked in it), and one um comprises a specific number of kuom of pig, breadfruit (mos), taro (pahsruhk), sugarcane (tuh), fahfah (a kind of poi), and coconut (nu). The number of each item in one kuom is also fixed depending upon the type of food, as follows:

One kuom of breadfruit = 4 breadfruit portions in one kuom (the portions can be whole breadfruit, or breadfruit cut into halves or even fourths depending on the size of the breadfruit, but there should be always 4 breadfruit portions placed in one kuom).

One kuom of pig = 1 pig roasted in an um. (Chicken or fish are never given as meat in kuom. Contribution should consist of meat from 4-legged animals, to represent the “Um of Man”).

One kuom of taro = 4 nuk in one kuom (4 packets of grated and roasted taro, wrapped in banana leaves).

One kuom of fahfah = 4 fusanie of fahfah placed in one kuom. (Fusanie is traditional fahfah bowl, usually 8 inches in length, which is made from 16 individual reeds or wild sugarcane leaves, arranged in the form of a four-rayed star. Putting through the opposite rays closes the fusanie.)

One kuom of coconut (nu) = 5 coconuts (nu)

One kuom of sugarcane (tuh) = 1 kahp of sugarcane (for white sugarcane, 1 kahp = 5 tuh; for black sugarcane, 1 kahp = 7 tuh)

*Math involved:* Weaving of kuom involves specific weaving techniques that very few people know nowadays. To begin weaving, the frond is held at a specific angle in an inclined position and then leaflets are woven following a specific pattern: odd-numbered leaflets are woven over and under the preceding two even-numbered leaflets. The weaving patterns
involve arrangement in parallel and perpendicular lines, intersections, ratio, proportions, and counting while interweaving the leaves, and finally parallel splitting of the coconut frond along the great midrib that results in placing the woven split parts at a particular angle. The complete kuom shows symmetry along the middle line. The total number of leaflets used to weave a kuom is always an even number, and there are an equal number of leaflets along both sides of great midrib. The designated number of each food item contributed as a kuom involves counting, and the food is always served only on one side of the kuom.

Figure 2a: Weaving of Kuom
2. Weaving of Ball for Kosraean Soccer (*Epo*)

The word “*epo*” is used to indicate both the Kosraean soccer game and also the ball used to play it. The ball for *epo* is woven with three pandanus leaves (*lol*) and brown banana leaves (*sra in usr mahi*) are used as filling. Freshly picked pandanus leaves can be used for weaving *epo* but weaving is accomplished more easily if leaves are prepared at least 2-3 days in advance and then used for weaving (please see Appendix B for details about preparation method). To weave *epo*, the ends of two pandanus leaves are placed in a cross-wise manner, one vertical and another horizontal, and brown banana leaves, (the older leaves that have wilted and are falling from the tree, and have been smoothened and compressed into a ball shape) are placed on top of the crossed pandanus leaves. The amount of banana leaves used depends on the desired size of the ball; however, usually one fistful of banana leaves is used as filling. Now the pandanus leaves are wrapped over the banana leaves by weaving one leaf up and another over the first one in a crosswise manner. The third pandanus leaf is added to enclose the banana leaves completely inside the pandanus leaves. The weaving is continued in an alternate over-and-under manner until most lengths of pandanus leaves (usually 3-4 layers of weaving cycles) are used up and the ball has attained desired firmness and size. Finally, the tips are interlocked by weaving them in an in-and-out manner into already-woven leaves. The remaining tips are cut and white coconut fibers are used to tie across the square-shaped completed *epo* to prevent unfolding of the *lol* and to give it more firmness (nowadays people have started using cellophane tape to maintain the firmness and prevent the leaves from unfolding).
*Epo* is a local game, also called “circular soccer” and is played only by boys and men. To play *epo*, the players stand in a circle with one to three players standing in the center of the circle usually making a small triangle. So it’s a small triangle or a single point at the center of a big circle. One player kicks the *epo* (the ball) in the air and starts the game (it doesn’t matter who and from which particular position). The players in the center of the circle help in kicking the *epo* across if it is kicked only halfway through the circle. The objective of the game is to keep the *epo* in the air by repeated kicking by all the players. The players usually jump up to kick the ball but no running is involved and the players maintain their specific positions in the circle. People play it just for fun as one team and there is no restriction regarding how many people can be in outer circle. They play it until they tire of the game. If somebody is not able to kick back the ball on time and up to needed distance, and it touches the ground, he is scolded by the other players but not excluded from the game. And the game is started again. No counting of points is involved.

**Math involved:** Weaving of *epo* involves specific preparation of pandanus leaves and their arrangement in horizontal and vertical, perpendicular lines, critical thinking, spatial orientation, congruent shapes and counting while interweaving the leaves in cross-wise manner. The time and technique for softening the leaves is also specific. The amount of banana leaves used as filling determines the size of the ball and thus requires estimation skills and understanding about ratio, proportion and related size. The finished *epo* is square in shape and shows a repeated cross-wise weaving pattern. The game *epo* is always played in a circle and therefore could be used to teach all concepts related to circle such as circumference, radius, diameter, central angles and so on. It also encourages social skills as it ensures equal participation and boosts motivation by allowing everyone to stay in the game in spite of the mistakes made and inspires them to more effort, therefore, it could be used effectively in making mathematics an interesting adventure for all kids regardless of their abilities.

![Figure 3a: Weaving of Epo](image-url)
3. **Weaving of Spinning Windmill (Lauringring)**

A single, green coconut leaflet (sroacnu) is stripped from its midrib (noak) and the leaf strips are used to make the wheel of a spinning windmill (lauringring). To make the wheel, the middle parts of the leaf-strips are placed in a cross-wise manner, one leaflet strip is placed in a vertical position and the other is placed on it in a horizontal manner, making a plus (+) sign. Then the open sides of the leaflet strips are folded to make double-folded loops and these tips of the loops are interlocked and pulled outwards resulting in a 4-squared interlocked center with four linked, outward-directed leaflet strips making the wheel. The tips of the leaflet strips are trimmed with a V-shape cut. The center of the wheel is pierced and the midrib of the leaflet is inserted through it, and a knot is made to hold the wheel, around which it spins when placed in the air. The children play lauringring by running and holding it up in the air so that it can spin freely.

*Math involved:* Weaving of lauringring is very simple and quick and it can be made easily with a single coconut leaflet. The making of lauringring involves parallel splitting of leaflet strips along the midrib and their specific arrangement in horizontal and vertical perpendicular lines. Interlocking the leaflet loops requires critical thinking, spatial orientation, and problem solving skills and results in 4 congruent square shapes making the center of the wheel. Lauringring could be used to teach various mathematical concepts including geometrical orientations, dimensions, directions and also speed, and could be used effectively in making the learning of mathematics an interesting experience for kids.
4. **Weaving of Dried Flower Wreath (Ros ne Marmar)**

Weaving of a dried flower wreath (ros ne marmar) involves preparation of specific decorative items such as flowers and balls that are woven along with the base while making the marmar. The materials used involve mature pandanus leaves (lol), hibiscus bast (ne) and coconut fibers (sroacnu) (please see Appendix B for details about preparation method). The pandanus leaves are stripped to required widths and these leaf strips (ip en lol) are used for weaving the flowers (ros) and the square-shaped balls (boc), and for wrapping the circular base of the marmar.

4.1. **Weaving of Rose Flower (Ros)**

A 1.5-foot-long and 0.75-inch-wide strip of pandanus leaf (ip en lol) is used. The length is measured by placing two hands placed together with palms facing down and thumbs touching each other (equal to one foot) and one more hand, palm facing down with stretched thumb (equal to 0.5 foot). The width is measured by 3/4 of the index finger’s first joint. To weave the rose flower, the strip is folded double along the vertical midline (the smooth upper side of the strip is kept outside while the rough lower side is folded inside). The double-folded strip is then held in the left hand and a fold is made, leaving the desired length of the stalk. This is the base, and twisting the strip around this base with the right hand makes the petals of the flower. At each twist, the strip is turned in such a way that the top edge turns away from the weaver and down. While twisting, the base is turned to roll the flower around the stalk. The flower petals stay at the same level for beginning turns and then they begin to
drop back. It is important to keep the strip folds tightly and twisted around the stalk while turning and twisting, and turning continues until only about 4 cm of leaf strip is left. Finally, the left-over strip is wrapped around the stalk twice and the end is slipped inside upwards and under the last loop to lock and is pulled tight. The remaining tip is cut. One side of the double-folded stalk is also cut and the remaining fold of stalk is used to attach the flower in the marmar.

Figure 5: Weaving of Ros (Black and white illustrations are from Arbeit, 1985)

4.2. Weaving of Square Ball (Boc)

Three 1.5-foot-long and 0.5-inch-wide strips of pandanus leaf (ip en lol) are used to make a square ball (boc). The length is measured by placing two hands placed together with palms facing down and thumbs touching each other (equal to one foot) and one more hand, palm facing down with stretched thumb (equal to 0.5 foot). The width is measured by 1/2 of the
index finger’s first joint. The strips are folded along the horizontal midline and two of them are placed vertically next to each other, thus making 4 vertical strips (I’ll refer to them as “1, 2, 3 and 4”). The third folded strip is used horizontally, thus making two horizontal strips (“5 and 6”). To begin weaving, the two horizontal strips (5 and 6) are cross-woven with the four vertical strips (1, 2, 3 and 4) following an alternate under-and-over weaving pattern. Then the upward-extended ends of the four vertical strips are grasped in both hands, two in the left (1 and 2) and two in the right (3 and 4) and the weaving is bent slightly in the middle of four parallel vertical strips in such a way that they cross each other at right angles and at this point the two vertical strips to the right (3 and 4) are interwoven with the vertical strips to the left (1 and 2) and the ends are pulled to tighten the weaving pattern. By doing so, one corner of the boc is made and a new group of four strips on the right side is made (1, 2 and 5, 6). Again the bending and interweaving process is repeated by bending the 4 parallel strips and the two strips to the right (5 and 6) are interwoven with the vertical strips to the left (1 and 2) making another corner and a new group of four parallel strips (3, 4 and 5, 6) to the left. This similar process of bending and interweaving is repeated to close the boc and the beginning middle-fold corners are folded inside while adding additional layers. Usually three layers are added on top of the inner layer to make the boc firm and of the desired size. Finally to close, the end tips are placed under and over the already-woven strips at least twice to interlock. The five remaining tips are cut neatly leaving one, which is used to attach the boc to the marmar.

Figure 6a: Weaving of Boc (Black and white illustrations are from Arbeit, 1985)
4.3. Weaving of Wreath (Marmar)

To make the base central ring of a marmar, a stripped and flexible midrib, made by removing the leaflets and splitting and scraping the great midrib from the top part of the coconut frond, was used in the past. Nowadays people use the plastic strapping from cases of frozen chicken because they are more flexible, durable and easily available. The main decoration around the marmar is done by placing uncolored or colored loops of hibiscus bast fiber (ne) (please see Appendix B for details about preparation method). The loops made from dried and natural color hibiscus bast (ne) or dyed hibiscus bast (ngos ne) are woven by placing the open ends of the loops in between the 0.5 cm-wide pandanus leaf strips (ip en lol), which are used to wrap around the central ring and also to hold the hibiscus loops. (Some people have started using imported colored ribbons in place of pandanus leaf strips, because the imported material is easier to work with and more durable). In between these hibiscus loops, the ros
and boc are added, following the design and spatial orientation preferred by the weaver. The decorations are made all around the ring and finally the pandanus strip is interlocked by placing the end tip underneath the already-wrapped strip and the remaining tip is cut. In addition to ros and boc, sometimes flowers made from taro stalk fibers (pwepasruk) and coconut fibers (sroacnu) are also added while decorating marmar.

**Math involved:** Weaving of a dried flower wreath (ros ne marmar) involves specific preparation of materials. There are specific techniques to prepare each type of material, and the coloring and weaving techniques for specific decorations all have unique systematic step-wise procedures. The weaving of ros involves measurements and critical thinking to fold, twist and turn pandanus leaf strips in a particular direction and manner. The weaving of boc requires specific measurements and spatial orientation at right angles of parallel vertical and horizontal strips while weaving. The arrangement of decorations along the central ring requires critical thinking, measurements and creativity involving spatial arrangements to create symmetry or translations across the whole marmar.

Figure 7: Weaving of Marmar

### 5. Weaving of Local Mats (Kiaka)

Weaving of mats is an integral part of Kosraean material culture, as evident from early descriptions by Europeans (Buck, 2005; Segal, 1995; Lewis, 1967; and Sarfert, 1919). Mats are woven only by women. There are specific terms in the Kosraean language to indicate stages in weaving a mat. The beginning stage is called “srihmet” i.e., having just started weaving the mat; the middle stage is “nwacna” meaning “getting to the middle part”; “sikhiht” denotes that the weaver has almost finished weaving the mat; and “irak” means that the weaver has to only braid the margins or is braiding them at that moment. “Kiaka sisik” refers to a smaller mat while “kiaka luhlahp” indicates a big mat.

Based on the type of materials used and the weaving patterns, three types of mats are woven nowadays in Kosrae, which are as follows:

#### 5.1. Weaving of Kiaka Tuhlah

These mats are prepared by sewing whole pandanus leaves (lol) with hibiscus bast (ne). These are considered to be the most ancient mat types, as also evident from the description of
‘Kosraean Sitting Mats’ given by Dr. Elisabeth Kramer-Bannow (Sarfert, 1919). However, nowadays people mostly use them during the funerals, as these were the mats that were used to wrap the body in past burial practices. During funeral services, Kosraeans usually place the dead body on *kiaka tuhlah* (some families use *kiaka otwot*) and the mat is placed inside the coffin as the base mat under the body, and is buried with it.

To prepare the mat, whole pandanus leaves (*lol*) are sewn using hibiscus bast (*ne*) (please see Appendix B for details about preparation method). To weave the *kiaka tuhlah*, the hibiscus string is tied to one big toe and then around the waist and back to the same big toe (as displayed by Mrs. Kenye Lipan Kephas) or between two big toes (as illustrated and described by Prof. Elisabeth Kramer-Bannow) (Sarfert, 1919). Then the whole pandanus leaves are folded along the middle horizontal line and these double-folded pandanus leaves are placed adjacent to each other with one side up and another down the hibiscus fiber. The edges of two pandanus leaves are overlapped and a needle is used to sew them together (the needle traditionally was made from fish bone but nowadays a long metal needle is used). Additional pandanus leaves are added until the desired length is achieved (which is measured by placing two pandanus leaves lengthwise one after another). Inside these double-folded pandanus leaves, another set of pandanus leaves is placed in a perpendicular (vertical) manner and sewn confined within the outer horizontal pandanus leaves to give the desired firmness and strength to the mat. Usually five pandanus leaves are sewn underneath on one side, with the stitches made marking their boundaries to hold them in place. The ends are folded and decorative patterns are made along this side of the mat with colored hibiscus bast (*ngos ne*). This makes one half of the *kiaka tuhlah*. The other half is prepared in exactly same manner and finally both halves are sewn together, each having five pandanus leaves sewn underneath, for a total width of ten. The complete *kiaka tuhlah* shows symmetry along the midline. The normal size of *kiaka tuhlah* is 6 feet x 4 feet (L x W); however, *kiaka tuhlah* made for funerals are 6 feet x 3 feet (L x W) and specific decorations are made on it with colored hibiscus bast (or nowadays with threads or yarn) on the borders along the length. Weaving of a *kiaka tuhlah* requires patience and time, taking up to 2 weeks for a skilled weaver to complete.

“*Sapko*” is one kind of *kiaka tuhlah*, according to Sarfert (1919), “This is the woven mat with the width of the strip of the natural leaf. It is less carefully done than the so-called sewn mats. Withered leaves are used. However, they are not initially beaten, but the teeth and the mid rib are removed. They are smoothened (*kerära*) with a panak-shell and the tip and the foot of the leave are cut off. All that remains of the last one are only 2 tails at the edge, the natural folded edges of the withered leaves. These tails are plaited into a braid at the bottom side of the mats, where they are actually started, to weave and finish them to both sides. This kind is easy to make and can also be made quickly. It serves as a pad for sitting and as blanket”.
Figure 8: Hibiscus Fiber and Pandanus Leaves and Weaving of *Kiaka Tuhlak* (Black and white illustrations are from Safret, 1919)
5.2. Weaving of Kiaka Otwot

These mats are comparatively modern as compared to *kiaka tuhlah* and they were used as gifts and presentations to the king (*tohkohrsrah*) in the past. Commoners were not supposed to use these mats (Sarfert, 1919). However, today these mats are more commonly available and used than the *kiaka tuhlah*. To prepare *kiaka otwot* the pandanus leaves (*lol*) are prepared in the same way as mentioned for *kiaka tuhlah* but instead of using whole leaves they are stripped into approximately 1 cm-wide strips by using a specific tool called “*mwesruh sra lol*”, which has nails embedded at equal distances in piece of wood. To start weaving *kiaka otwot*, two pandanus leaf strips (*ip en lol*) are taken and placed one upon another and considered as one. Thus this doubled single strip is then folded half in the middle, making two connected vertical strips (double folded). Then a second pandanus leaf strip (actually two strips, placed one upon another) is taken, which is also folded in half in the middle, and woven horizontally across the first two strips following a one-over-and-one-under pattern. After weaving, both ends of the second leaf strip are folded upwards resulting in four vertical strips. Then the third pandanus leaf strip (again two strips placed together) is taken (also folded in half in the middle), and woven horizontally across the four vertical strips in a similar one-over-and-one-under pattern. The same weaving pattern is repeated and new leaf strips are added until the desired size of mat is achieved. The double strips are used to ensure the desired strength and thickness of the mat. Finally, the open ends are braided to mark the edges. Sarfert (1919) described *kiaka otwot* as “*Saki mat*” and noted the margins of these mats were decorated with specific patterns, but nowadays these mats are mostly made plain without any decorative patterns. Sarfert (1919) also noted that sometimes people used pandanus leaves that were artificially dried over a fire or in the sun (*saläl* = to dry artificially; *oajok* = to dry under the sun) to get the lighter brown shades, but these mats had comparatively less strength and durability than the mats woven with naturally dried, dark tan leaves. Weaving of *kiaka otwot* is tedious and time consuming and could take 2 weeks to complete by a skilled weaver.
This could be considered the most recent mat because it is made from the green coconut leaves (*sroacnu*) and is used often in cooking houses as sitting mats. To make *kiaka tinae* two coconut fronds of a length appropriate for the required size of the mat, are split parallel across the great midrib of the frond. The number of leaflets are counted by 2’s (as described in the weaving of *kuom*) using the traditional Kosraean counting system (Please see Appendix A for more details about Kosraean Counting Systems) and the total number of leaflets is always even with equal number of leaflets on both sides of the great midrib of both fronds. To begin, out of the total of four split frond parts, the two are placed close to each other and their leaflets are interwoven by braiding the leaflets in an alternate over-and-under pattern. While braiding, the leaflets are folded double showing their midrib on the upper side.
Now the 3rd half-frond is woven on one side by placing its first leaflet over the first leaflet of braided leaflets, then the second leaflet of the newly-added frond is placed under the first leaflet of braided leaflets and over the second leaflet of the braided leaflets and this weaving pattern of alternate over-and-under is continued until all the leaflets of the half-fronds of one side are interwoven together. To close the mat border, the last woven leaflet is placed under the preceding woven leaflet, followed by the second last and so on until all upright leaflets are finished and then the tips of these upright woven leaflets are braided downwards to make the outside border/edge (if needed, the beginning leaflets are interwoven before braiding to get the equal width across the entire length) and the remaining tips are interlocked at the end. The 4th half-frond is woven on another side in a similar manner. A skilled weaver can weave a full-length (made from more than 3/4 length of coconut frond) kiaka tinae within an hour.

Figure 10: Weaving of Kiaka Tinae

Math involved: Weaving of all mats involves specific methods for selection and preparation of materials and requires specific weaving techniques, patterns and time duration needed to complete, according to the specific sizes. Weaving patterns involve arrangement in parallel and perpendicular lines, intersections, critical thinking, spatial orientation and counting while interweaving. Weaving of kiaka tuhlah involves geometric decorations that involve congruent shapes and translations along the length and complete kiaka tuhlah shows symmetry along the midline. The weaving of kiaka otwor has a unique manner of counting two leaf-strips as one and the weaving pattern shows translation of congruent patterns, which could be also be seen as mirror images. Weaving of kiaka tinae involves parallel splitting of coconut fronds and specific and even numbers of leaflets to be used. The complete kiaka tinae also shows symmetry along the midline.
6. Weaving of Hats (Suhrrafraf/Susu)

Weaving of hats (suhrrafraf/susu) is not considered an indigenous weaving skill and might have been introduced by the Marshallese (Sarfert, 1919). However, weaving hats has now become a traditional skill in Kosrae and only skilled women weavers know how to weave hats. In the past hats were made from pandanus leaf strips (ip en lol) but nowadays they are also made with coconut fibers (sroacnu). However, an individual hat is always made with a single material, either coconut or pandanus, but never with both combined. However, the fibers could be differently colored. To make a hat with colored pandanus leaves, the naturally aged leaves, which are dark tan in color, are used along with the artificially dried leaves (green leaves are cut and dried over a fire or in the sun), which are lighter in color. Using a modern steel needle, the leaves are split into very thin strips, which are placed over-night into a pot of fresh water, weighted down by a stone. The next day the strips are washed in salt water and hung for 1-2 days in a row on a string to dry and bleach in the open air (under the sun). The weaving of a hat is started in the center of the head section. Weaving always starts with counting strips/fibers as multiples of 4 and therefore mostly 4 x 4 = 16 strips/fibers are used. Additional fibers are added while the weaving continues in a circular manner. The stitches are made using päfuäs (a kind of weaving, where the strips are always woven over and under two other ones), which is sometimes combined with uotuot fasa (a simple cross-weave involving alternate over-and-under weaving), and specific patterns and designs are made while weaving. Once the top circular shape (srihmet) is woven, the hat is tied onto a wooden mold/frame called “suckan suhrrafraf” and then weaving is continued downwards until the desired length of the middle part (tuhpah) is achieved, which is usually measured by placing the thumb on the top of the suckan suhrrafraf and stretching the hand downwards and measuring up to the tip of the middle finger. After reaching the desired downward length, the weaver resumes weaving in a horizontal manner to make the brim (paho) of the hat. The hats have the form of stiff straw hats, however the brim is very wide. They are extremely finely woven and therefore very soft. In this respect, and in the width of the strips they are similar to Panama hats (Sarfert, 1919). Nowadays people have started weaving hats with coconut leaflets also which are usually woven with 8 (4 x 2 = 8) leaflets and are worn mostly while fishing.

Math involved: Weaving a hat is a highly technical skill that requires specific weaving skills involving counting and multiplication, arrangement in parallel and perpendicular lines, intersections, critical thinking, spatial orientation, shapes, ratio and proportion and specific measurements. Patterns made during weaving show congruent figures, translations and symmetry. A finished hat shows both point and/or line symmetry.
Figure 11a: Mold for Weaving of *Suhrafa*, Measurement Method and Weaving of *Suhrafa*
7. **Weaving of Kosraean Fans (Pahl)**

There are three types of Kosraean fans, which are woven only by women. The description is as follows:

7.1. **Weaving of Pahl Tok**

This is the traditional fan made up of white coconut fibers (*sroacnu*), turtle shell (*tuhp in ngoe*) (removed by boiling the turtle in the water), dyed feathers of rooster (the process of dyeing is called “*ngos*” and “*ngos lec*” means already dyed) and bamboo (*pahmpu*). The handle of the fan is made from bamboo, split into two halves that are then trimmed at the ends to make a flatter or smaller central hole, and are then dried. These dried bamboo halves are placed together, the rounded ends on the outer side making a convex shape. The center of the fan is made up of turtle shell - cleaned, dried, polished and cut into the desired shape, which is inserted at one side in between bamboo halves that are then tied temporarily. Pandanus leaf strips are woven around the convex-shaped bamboo, first as strips and then in a crosswise manner to cover the handle by making specific designs. The central turtle shell is surrounded by the weaving patterns made by white coconuts fibers, and finally the dyed feathers of rooster are used to make the outer fringes of the fan. *Pahl tok* was used as gifts and mostly used by the king and higher chiefs as a hand fan. Unfortunately, this fan has now become extinct and I couldn’t even find a picture of it.

7.2. **Weaving of Pahl Malem**

This fan is the commonly used hand fan nowadays and is given as gifts also. It is made up of coconut fibers (*sroacnu*), pandanus leaf strips (*ip en lol*), taro stalk fibers (*pwepasruk*) and bamboo (*pahmpu*). The handle of the fan is made from bamboo, split into two halves that are then trimmed at the ends to make a flatter or smaller central hole, and are then dried. These dried bamboo halves are placed together, the rounded ends on the outer side making a convex shape and tied temporarily. Weaving is started using pandanus leaf strips that are woven around the handle (*fung in pahl*) first as strips and then in a crosswise manner. The main body of the fan (*inka in pahl*) is woven with coconut fibers, either white or colored, and pandanus leaf strips or with only coconut fibers. Various patterns are created while weaving and they resemble the patterns found in old *tol* belts and exhibit specific geometric figures,
orientations and transformations. The main weaving pattern is usually *uotuot fasa* (a simple cross-weave with alternate over-and-under weaving which creates crosswise stitches). The process of weaving designs and decorations is called “*tihl*”. To measure the dimensions of the main body of the fan (*inka in pahl*), as two equal halves of a circular shape, a pattern of cardboard cut in a “D” shape (similar to a protractor) is used. The border of the fan is made up of two separate layers: the inner thinner border is called “*tata*” while the outer thicker border is called “*siske*”. To make *tata* and *siske*, both dyed (*ngos*) and natural colored taro stalk fiber (*pwepasruk*), is used, (please see Appendix B for details about preparation method). Both *tata* and *siske* are made separately and usually involve elaborate geometric figures and translations of congruent figures that involve visualization of specific shapes and counting and spatial orientation of horizontal and vertical bands to create particular shapes. These are attached to the main body of the fan with coconut fiber using a needle. Complete *pahl malem* exhibits symmetry along the midline. Weaving of *pahl malem* is time consuming and could take 2 weeks to complete by a skilled weaver.

Figure 12a: Taro Stalk Fiber, and Coconut Fiber, Bamboo Plant, and Cardboard Pattern (D) used for Weaving of *Pahl Malem*
7.3. Weaving of Pahl Sroacnu

This diamond-shape fan is the commonly used hand fan in Kosraean kitchens to fan the fire and also at the same time to fan the cook. It is made up of approximately 8-to-9-inch-long leaflets from two green coconut fronds (sroacnu). The number of leaflets in each frond and also the number of leaflets on each side of a frond should be same and it is usually an even number. The person demonstrating the weaving of pahl sroacnu used 6 leaflets on each side of the frond so total $6 \times 4 = 24$ leaflets were used. To begin, the leaflets of each frond are braided along the great midrib with an alternate over-and-under method, keeping the leaflets in a face-down position. The top two leaflets are tied temporarily. Then both fronds with leaflets braided along the great midrib are placed together with the braided side up. Then the leaflets of both fronds are interwoven following the uotuot fasa (a simple cross-weave with alternate over-and-under method), first on one side and then on another side and the top two
temporarily tied leaflets are opened while weaving. When all the 6 leaflets of each side of both fronds (12 on each side - 6 of each frond) are interwoven, all the leaflets (total of 24) are interwoven together to make the top half of the fan. Finally, the tips of woven leaflets are folded and interlocked in the already-woven fan by placing alternate leaf tips on one side of the fan and the remaining half tips on another side of the fan. The finished pahl sroacnu exhibits symmetry along the midline. A skilled weaver could make a pahl sroacnu (normal size with total 24 leaflets) within 45 minutes.

Math involved: Weaving of fans requires specific materials and specific methods for preparation of materials and involves specific weaving techniques, patterns and time duration needed to complete according to the specific size and design patterns. Weaving patterns involve arrangement in parallel and perpendicular lines, intersections, critical thinking, spatial orientation, measurements, ratio, proportion, counting and multiplication. Weaving of
pahl malem involves specific geometric figures, orientations and transformations of congruent figures and or patterns. Complete pahl malem and pahl sroacnu exhibit symmetry along the midline.

8. Weaving of Bracelet (Lohlpo)

Bracelets (lohlpo) are made by weaving pandanus leaf strips (ip en lol) and coconut fibers (sroacnu) around plastic strapping from cases of frozen chickens. The plastic strapping is cut in to desired widths and lengths according to the weaver’s choice and the size of the wrist. The pandanus leaf strip of the same width and length is then stripped into seven strips of equal thinness, which are kept attached on one side for at least 1 cm length. Then this stripped pandanus strip is placed on the circularly folded plastic ribbon and the strips are used as horizontal bands. The coconut fibers are then inter woven with horizontal pandanus leaf strips as vertical bands and specific geometric shapes are made, which include diamonds, squares, hearts, and the letters of the alphabets by using a crosswise alternate over-and-under weaving technique that requires critical thinking, visualization of specific shape and counting and spatial orientation of horizontal and vertical bands to create particular shapes. I feel that these lohlpo are modernized transformations of ancient tol belts because they exhibit basic units of geometric patterns evident in tol belts.

Figure 14: Weaving of Lohlpo

Math Involved: The creation of bracelets lohlpo involves measurements for the desired size and a specific weaving technique that involves arrangement in parallel and perpendicular lines, intersections, spatial orientation and counting, multiplication and more specifically
critical thinking and understanding of geometric shapes, congruent figures and translations. Visualization of specific shape and counting and spatial orientation of horizontal and vertical bands are required to create particular shapes. The finished lohlopo is circular in shape and thus can be used to teach concepts related to circle, such as circumference, radius, diameter etc.

9. Weaving of Round Basket (Fohtoh Round)

The round basket (fohtoh round) is made with a green coconut frond split along the great midrib. The size of the basket determines how many leaflets attached with the midrib are needed but the total number of leaflets required to make a round basket is always even. The person demonstrating the fohtoh round used 12 leaflets attached to the split great midrib. To begin weaving, the great midrib is bent into a circular shape and then all the leaflets are held in one hand, leaving a single leaflet (which is counted as the 1\textsuperscript{st} leaflet). To begin weaving, this 1\textsuperscript{st} leaflet is placed under the 6\textsuperscript{th} leaflet (5\textsuperscript{th} leaflet coming after it), placed over the 7\textsuperscript{th} and under the 8\textsuperscript{th} and so on. Then the leaflet preceding the 1\textsuperscript{st} leaflet (the 12\textsuperscript{th}) is placed under the 5\textsuperscript{th}, over the 6\textsuperscript{th}, under the 7\textsuperscript{th} and so on. Then the leaflet preceding it (the 11\textsuperscript{th}) is placed under the 4\textsuperscript{th}, over the 5\textsuperscript{th}, under the 6\textsuperscript{th} leaflet and so on. This alternate over-and-under weaving is continued until all the leaflets are woven. Then the tips of all the woven leaflets are pulled to make the weaving tighter and to make the circle perfect. Then tips of opposite 3-3 leaflets (total 6) are braided and the braids are tied in the middle to make the handle. Tips of remaining 6 leaflets are cut neatly.

\textit{Math involved}: Weaving of fohtoh round involves parallel splitting of the coconut frond along the great midrib, and arrangement in a circular shape, counting while interweaving the leaves, intersections, and critical thinking. The complete fohtoh round shows symmetry along middle braided handle and could be used effectively to teach the concepts related to circle, such as circumference, radius, diameter etc.

![Figure 15a: Weaving of Fohtoh Round](image)
Figure 15b: Weaving of Fohtoh Round
10. Weaving of Basket (*Fohtoh*)

*Fohtoh* or baskets for carrying food are woven in particular sizes, which depends on the number of leaves after which the weaving would be turned (*kotkot*). A *fohtoh* of 5 *kotkot* is comparatively shallow and is used for carrying lighter stuff such as breadfruit and fish while a *fohtoh* of 7 *kotkot* is much deeper and is used for carrying heavier stuff such as coconuts, gravel or stones. Two *fohtoh* can be made from one coconut frond. To weave a *fohtoh*, a green coconut frond is split parallel along its great midrib and one half of this frond is used to make a *fohtoh*. The weaving pattern is *uoautuot fasa* (a simple cross weave where leaflets are woven in an alternate over-and-under manner). These contemporary *fohtoh* look similar to the traditional *foto rotoma* described by Sarfert, 1919, however, the complete name of the basket seem to be lost.

To weave a *fohtoh* the weaving is started from the wider side of great midrib, keeping the midrib of the leaflets on the upper side. To begin, the 3rd leaflet is woven over the 2nd and under the 1st leaflet. Then the 5th leaflet is woven over the 4th, under the 3rd and over the 1st leaflet. Then the 7th leaflet is woven over the 6th leaflet, under the 4th, over the 2nd and under the 1st leaflet. Then the 9th leaflet is woven over the 8th, under the 6th, over 4th, under 2nd and over 1st leaflet. Then the 11th leaflet is placed over the 10th, under the 8th, over the 6th, under the 4th, over 2nd and under 1st leaflet. At that point we have 2 groups of woven leaflets – one on the left hand side with 6 leaflets and the other on the right hand side with five leaflets. To make a *fohtoh* of 5 *kotkot* the first leaflet (which is lowest or the furthest on the right in the left hand group) is now folded back and placed under the 4th leaflet to temporarily lock it.

Continuing, we use only the left-hand group of leaflets to weave further. The 13th leaflet is woven over the 12th, under 10th, over 8th, under 6th, over 4th and under 2nd. And then the 2nd leaflet is folded back and placed under the 6th leaflet temporarily to lock it. Then the 15th leaflet is woven over the 14th, under 12th, over 10th, under 8th, over 6th, under 4th and then the 4th leaflet is folded back and placed under the 8th leaflet to temporarily lock it. The weaving and the folding back and temporary locking of the last-woven leaflet in each step continues in the similar manner until all the leaflets are woven. It is important to note that total number of leaflets used to weave a *fohtoh* is always even (we used total of 26 leaflets). In the end again we have 6 leaflets on the left-hand side and out of these we fold back the first one (the lowest or furthest to the right) and interlock it to hold the woven leaves from unfolding. Then the entire length of the basket is woven with 5 open leaflets on both sides and 8 folded backwards in the middle (the number of folded leaflets would increase with the size of the basket).

The basket is then turned back showing its split midrib on the upper side and it is bent to make a circular shape so both ends can be connected. To begin, the last leaflet (the 26th in our basket) is placed inside the gap between the 1st and 2nd leaflet and looped around the great midrib and folded back and woven backwards, i.e., under the 24th, over the 22nd, under the 20th, over the 18th and the interlocked leaflet (the lowest or the leaflet furthest to the right of the left-hand group) is opened and woven with it and then it is folded backwards and placed under the 20th leaflet to temporarily lock it. Now the 3rd leaflet is woven over the 24th, under the 22nd, over the 20th, under the 18th, and the 18th leaflet is folded backwards and
placed under the 22\textsuperscript{nd} leaflet to temporarily lock it. Then the 5\textsuperscript{th} and 7\textsuperscript{th} leaflets are also woven in the similar manner and the 20\textsuperscript{th} and 22\textsuperscript{nd} leaflets are folded backwards and locked respectively at each step. Finally the 24\textsuperscript{th} leaflet is also folded backwards and interlocked temporarily. At this point the basket looks circular with alternate open and folded interlocked leaflets. Finally to close the basket, the leaflets are braided together. To begin braiding, any one of the folded leaflet is unfolded and woven over the first open leaflet on its right side (the open leaflets of the right side are not braided now, they would be braided while returning) and is braided with the first open leaflet on its left side, the 2\textsuperscript{nd} folded leaflet of the right side is now opened and braided to make the third strand of the braid. While braiding, open leaflets of the left side are braided along with the unfolded leaflets of the right side and after all these leaflets are woven the braiding is turned and then the open leaflets of the right side (which at this point becomes the left) are braided with the unfolded leaflets of the left side (at this point, the right side). The braiding continues until all the leaflets are braided and finally the remaining tips are tied to complete the basket.

Figure 16a: Weaving of Fohtoh
Math involved: Weaving of fohtoh involves parallel splitting of the coconut frond along the great midrib, and arrangement in parallel and perpendicular lines, intersections, critical thinking, spatial orientation and counting while interweaving the leaves. The finished fohtoh shows symmetry along middle braided closing line.

11. Weaving of Local Food Plate (Puhlwet Sroacnu)

The puhlwet sroacnu (food plate) for serving food is woven in particular sizes, which depends on the number of leaves woven and it varies from 4 to 7 leaves. One coconut frond could be used to make 5 puhlwet sroacnu. To make a 16-inch-long puhlwet sroacnu, the frond is cut into pieces, each about the length of an outstretched hand (approximately 8 inches). One puhlwet sroacnu is made from one piece of frond by splitting it across the great midrib. The split parts are then placed in a V-shape making an angle of 160° with each other.
and the leaves are woven in an alternate over-and-under interlocking pattern using *uotuot fasa* (a simple cross weave) and finally tied in knots at the ends.

*Math involved:* Weaving of *puhlwet sroacnu* involves measurement of the required length by using an outstretched hand from thumb tip to the tip of pinky (usually 8 inches long) and number of leaves (4-7) according to the size required, parallel splitting of the coconut frond along the midrib and placing of split parts at a particular angle (usually 160°) making mirror images/reflection. Weaving involves arrangement in parallel and perpendicular lines, intersections, ratio, proportions, and counting while interweaving the leaves. The finished *puhlwet sroacnu* shows symmetry along middle line.

![Image of woven leaves](image_url)

**Figure 17: Weaving of Puhlwe Sroacnu**

**12. Weaving of Wall Hanging/Wall Tray**

Weaving of a wall hanging involves use of coconut midribs; pandanus leaf sheaths (*lol*), coconut fibers (*sroacnu*) and shells (*ful*) (please see Appendix B for details about preparation method). The patterns involve various geometrical shapes. To prepare the concentric rings, the coconut midrib is split and scraped and the desired width of the midrib (usually 0.5 cm) is wrapped around with pandanus leaf sheaths. To get the sheaths, the pandanus leaves are stripped into approximately 1 cm. wide strips by using a specific tool called “*mwesruh sra lol*”, which has nails embedded at equal distances in a piece of wood. The upper sheath (the smooth side) of these strips is then removed and wrapped around the coconut midrib. Then one end of the wrapped coconut midrib is bent into a desired size circle, and the rest of the length of the wrapped midrib is folded around it as concentric rings. While folding, each
concentric ring is attached to the previous inner ring by using coconut fibers (sroacnu). The tying with the coconut fibers is done with the help of a needle and in a manner that each stitch forms a slanted angle (acute angle) and the pattern shows transformation around the concentric circles. These concentric rings are used as a base for most wall hangings. The patterns found in most wall hangings involve making various congruent shapes, usually triangles, within and in-between these concentric rings. To make triangles, the wrapped coconut midribs are used and cut into the desired size of the triangles. The angle of a triangle is measured by measuring the angle made between the stretched-apart index and middle finger. Other triangles are made by using the first one as a template. Inside patterns of these triangles are made with white coconut fibers following the usual cross-stitch weaving uotuot fasa by alternate over-and-under weaving, however, the length of stitches vary depending on the distance between vertical strands. Sometimes påfuäs (a kind of weaving, where the strips are always woven over and under two other ones) is also used, and various designs are made. The outermost boundaries of wall hangings are usually made of shells (ful), tied with the white coconut fibers.

Math involved: The splitting of the coconut frond across the midrib and the splitting of pandanus leaves into 1 cm strips shows parallel lines. Formation of concentric rings involves translations across the ring while tying with coconut fibers. Preparation of white coconut fibers involves treatment with a particular concentration of limejuice for specific amount of time. Formation of congruent shapes involves counting of stitches and measurements at particular angles, critical thinking, and logical and spatial organization. Weaving of inner designs involves arrangement in parallel and perpendicular lines, intersections, ratio, proportions, and counting. The wall hanging could be used to teach various geometrical concepts related to shapes and transformations. The finished pattern shows both point and line symmetry.
Figure 18b: Coconut Fiber and Pandanus Leaves, Peeling of Upper Pandanus Leaf Sheath, Concentric Rings and Details of Wall Hanging
Figure 18c: Details of Wall Hanging
13. **Weaving of Kosraean Tol Belts**

Even though Kosraean tol belts are no longer being made or worn by anybody, and may be considered “extinct”, I want to share some aspects about weaving tol, about which I came to know through personal interviews with Mrs. Kenye Lipan Kephas, who was involved in an effort to revive tol in 2000-2001. Mrs. Kephas and her friend Mrs. Kenye Lampert (now deceased) were asked by the Kosrae Historical Preservation Office to make tol and they were provided with a traditional Kosraean loom. Mrs. Kephas explained to me that she and her friend were able to produce a hand-length sample of tol but they couldn’t complete it because producing only that much took them two months, and the two weavers were not in agreement regarding how to proceed further in order to make patterns. Therefore, they gave the unfinished tol to the Historical Preservation Office to be displayed in the Kosrae State Museum. I tried to find that unfinished sample but the officials have been unable to locate it. The following description of the tol is based on Sarfert (1919).

Decorative tol belts were part of traditional clothing in Kosrae. In earlier times people mainly used tol belts as clothes. For both sexes, clothes consisted of the well-known, often magnificently ornamented tol, made of banana fibers, the most beautiful and finest example of Micronesian weaving. These tol were very short and narrow. They ended in fringes, just like the cloths-mats of the Central Caroline Islands. The expedition crew of the South Seas Expedition 1908-1910 (Sarfert, 1919) was able to obtain all 8 kinds of tol described by the natives. However, even at that time their production was no longer practiced. In the words of Prof. Elisabeth Kramer-Bannow, one member of the crew, “Tol belts of Kusaeans belong to
the most beautiful and in a way most accomplished that can be achieved by handmade loom weaving. Their charm lies in the rich and appealing coloring, shown in the warp, which has been knotted many times and are produced in a half-loom weaving fashion”. Prof. Kramer-Bannow was able to persuade an old Kosraean woman to weave the warp of an old tol in front of her, and she described in great details the Kosraean loom-weaving technique, including a description and illustrations of the loom, preparation of the loom, measuring positions, natural dyes and weaving technique (Sarfert, 1919).

The tol was made from the stem fiber of a specific banana which does not bear edible fruit (usr kusus, according to Mrs. Kenye Lipan Kephas) or perhaps the stem was cut before the fruit appeared, according to Prof. Elisabeth Kramer-Bannow, who noted that the fibers for tol were prepared from two varieties of banana, kurra for coarser fibers and uschuosch or
usr mos for finer fibers, that normally bear fruit, but the stem is cut before the plant bears fruit to get the pseudostem suitable for the production of yarn.

![Figure 20: Banana Used for Making Yarn for Tol](image)

The process of preparing yarn from the banana stem is called *kusus* and it is similar to process of making banana fiber described by Rubinstein and Limol (2007) in “Reviving the Sacred Machi - A Chiefly Weaving from Fais Island, Micronesia”. The exterior layers of the pulpy pseudostem of the banana palm were removed when cutting the pseudostem because they were dirty and couldn’t be used. Then a medium-wide strip about three fingers in width was loosened and ripped off the pseudostem and placed on a round peeled wooden cudgel (*neilo*), which was held in position by placing the knee on it. The right hand held the scraper, a piece of coconut shell (*ipän alla*), which had been sharpened on the edge with the rough shell (*dokschak*, a Venus shell) tightly against the round wood. The left hand held the banana bast and pulled it several times through the scraper and the wooden cudgel so that the pulpy tissue was removed as waste (*bokensiäsä*), leaving the cleaned threads of silky white bast fiber. The process of sharpening is called “*deida*” and process of scraping and making the smooth fibers is called “*siacsac/siäsä*”.

Prof. Elisabeth Kramer-Bannow noted that most of the *tol* she viewed had plain weaving where the weft first covered the evenly numbered threads of the warp, 2, 4, 6, 8 and then the odd-numbered warps 1, 3, 5, 7, 9, etc. She also noted that the design patterns of all the *tol* included old traditional designs, each with a specific name, and she was amazed to see that among all the examples available to her (about 40), no two were identical. All the textiles were ornamented, most had a blank middle part and colorful ends of about 1.5-2 hand spans in length. One of these ends had broken (knotted) designs in an especially rich color change, the other one was simple, unbroken with smooth, alternating warp threads. In others there were individual quadrilaterals of one color in between the colorful small stripes of the design. The main colors that were used to make *tol* were black (*sroalsroal*), made from faded calyx of mangrove; yellow (*rangrang*), made from yellow root corm (*aan*); red (*sruhsrah*), made from roots of *Morinda citrifolia* and ashes of trunk of the *Alsophila* fern tree; and white (*fasr fasr*) uncolored yarn.
Figure 21: Selvedge, *Tol* Belts and Details of *Tol* Belts (Black and white illustration is from Sarfert, 1919)
Prof. Dr. Augustin Krämer, described the order and ornamentation of Kosraean tol and studied their relationship with those from the Ralik-Ratak island of Marshalls. He studied 29 Kosraean tol available to him in great detail and categorized them into 5 types (However, the expedition was able to distinguish all 8 types of tol). According to Dr. Augustin Kramer, all five kinds always consist of 3 parts:

1. The head (*fesoma*), the meaning seems to be (*fen = over, siom = your belly*); design-stripe (*soma*), which means the section of *tol* which used to lie over the thigh.

2. The medium section (*inkabo*), (*in = in, kab = buttocks*) as the middle part used to be situated at the crotch.

3. And the tail (*tafotok*) (according to Sarfert, 1919 *tafo = half, tok = back*) because this section used to lie on the back.

Figure 22: Five Types of Tol Belts (Black and white illustration is from Sarfert, 1919)

Within this general design structure, only the ornamentation varied extensively, according to the type of the *tol*. In most cases, the head and the tail were richly decorated, the mid-section not at all. With the exception of the first kind (*menkof*), it was black in all others. The head used to be characterized by cross stripes and the tail by vertical stripes. Furthermore, the knotted broken designs were mostly in the head, although the tails of the *fensem fon tol* were an exception. At the two ends of each tol there were warp fringes.

Dr. Augustin Kramer was able to identify and describe various design patterns found in *tol* and he identified some of them as having been borrowed from the Raliks, for example the four red squares (*muot sruhsrah*) that were also found on the Ralik mats. However, there they were called *dram* (corner) because they were situated in the corners (Sarfert, 1919).
Figure 23: Design Patterns Found in Tol (Black and white illustration is from Sarfert, 1919)

*Math involved:* All aspects of making tol starting from making the yarn, preparation of dyes and coloring the yarn, preparing the loom, determining measuring positions, and finally
weaving tol with specific patterns and designs included mathematical measurements and calculations. Various types of tol exhibited unique geometric patterns that included specific number of horizontal and vertical parallel stripes and design patterns exhibiting transformations.

Even though, it is disappointing that such a unique cultural aspect of “Kosraean Loom Weaving” has been lost within a short period of less than two hundred years, I am delighted to say that traditional design patterns present in tol are still evident in many weaving artifacts such as pahl malem, lohlpø and borders of mats. I am hopeful that maybe someday a skilled weaver would be able to revive these tol based on the description given by Prof. Elisabeth Kramer-Bannow (Sarfert, 1919).
Conclusion

While conducting this research, I got the opportunity to meet and personally interact with various educators, policy makers and local handicraft weavers. And it is wonderful to know that all of them welcomed the efforts to conduct research on traditional Kosraean weaving. In fact the Kosrae State Department of Education has developed a “Cultural Curriculum” and according to Mr. Paul Hadik, the current Director of Education, they already tried implementing the “Cultural Curriculum” last year, partly by inviting the indigenous skilled elders to come to elementary schools (only on Fridays) and teach cultural skills to the students. However, the teachers at these schools expressed concerns about the time lost from the teaching of specific subject areas, especially when they have to prepare students for National Standardized Tests and, therefore, they are unwilling to use the regular class time to accommodate the teaching of the “Cultural Curriculum” within their everyday school schedule.

It is disheartening to know that most of them view education and culture as totally separate or I should say contradictory things. I believe that we must not teach culture separately as a different subject so that it seems to be snatching precious time away from the instruction in key subject areas, as required by the standardized regular curriculum. I feel that we need to make people realize that to ensure successful education we must relate learning to the real life of the learners and this could be done effectively by integrating cultural contexts into the teaching of different subject areas. We must not teach culture separately but we should teach all subjects through culture.

And I am positive that with the efforts such as that of Project “MACIMISE” to integrate traditional cultural practices into mathematics curriculum and teaching, we would serve multifold purposes: by creating cultural contexts we would be able to relate learning to the real life of the learners, and at the same time also help to keep cultural practices and skills alive in the hearts and minds of the younger generation in a meaningful way.
Literature Cited


Persons Interviewed

Mr. Aaron Sigrah, (a respected member in the community and Librarian, Rose Mackwelung Kosrae State Library, Kosrae)

Mr. Alik Phillip (a respected elder in the community, former senator and current Part-time Instructor, COM-FSM, Kosrae)

Mr. Alister Tolenna (a respected member of the local community and Program Coordinator, Department of Education, Kosrae State Government, Kosrae)

Mr. Kalwin Kephas (a respected elder in the community and Campus Director, COM-FSM, Kosrae)

Mr. Nena Mike (a respected educator in the community and Instructional Coordinator, COM-FSM, Kosrae)

Mr. Paliknoa Sigrah (an elder member of the community and a Youth Extension Agent)

Mr. Paul Hadik (a respected educator in the local community and Director of Education, Kosrae State Department of Education, Kosrae)

Mr. Salik Charley (College student)

Mr. Tulen Peter (a respected elder in the community and Math Specialist, Department of Education, Kosrae)

Mrs. Ines Alokoa (a local handicraft weaver and an active member of Kosrae Women’s Center, Kosrae)

Mrs. Kenye Killin (a respected member in the community, local handicraft weaver and Assistant Director, Cooperative Research and Extension, Kosrae)

Mrs. Kenye Lipan Kephas (a respected elder in the community, expert in traditional weaving and local medicines, and an active member of Kosrae Women’s Center, Kosrae)

Mrs. Lalita Charley (a member of the community and local handicraft weaver)

Mrs. Neimon Alokoa (a respected member in the community and Secretary, Design and Engineering, Kosrae State Government, Kosrae)

Mrs. Rose Soriano (a local handicraft weaver and an active member of Kosrae Women’s Center, Kosrae)

Mrs. Shru Leo Stanley (a member of the community and a housewife)

Mrs. Shru Robert (a member of the community, local handicraft weaver and a Custodian)

Mrs. Sorlin Harrison (a member of the community, a student and a housewife)

Ms. Lona Tora H. Alokoa (High school student and local handicraft weaver)

Ms. Shru Stanley (Hotel maid and a local handicraft weaver)

Regent Lyndon Cornelius (a respected elder in the community, current member of the Board of Regents, COM-FSM and Chairman, Advisory Board for Special Education, Department of Education, Kosrae)
Mathematics in Kosraean Weaving

Reverend Hanson Sigrah (a respected elder in the community and Chief of Curriculum, Department of Education, Kosrae)

Reverend Michael William (a respected member in the community and Library Technician, Learning Resource Center, Rose Mackwelung Kosrae State Library)
Appendix A

Kosraean Counting Systems

It is interesting to note that there are three ways, or for ease of understanding I should say Systems of Counting, in the Kosraean language, which are as follows:

Table A: Kosraean Counting Systems

<table>
<thead>
<tr>
<th>English Counting System</th>
<th>Kosraean Counting System 1</th>
<th>Kosraean Counting System 2</th>
<th>Kosraean Counting System 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>Sie</td>
<td>Sra</td>
<td>Soko</td>
</tr>
<tr>
<td>Two</td>
<td>Luo</td>
<td>Lo</td>
<td>Lukuac</td>
</tr>
<tr>
<td>Three</td>
<td>Tolu</td>
<td>Tol</td>
<td>Tolkoe</td>
</tr>
<tr>
<td>Four</td>
<td>Ahkosr</td>
<td>Ahng</td>
<td>Yoko</td>
</tr>
<tr>
<td>Five</td>
<td>Limekosr</td>
<td>Luhm</td>
<td>Luhmko</td>
</tr>
<tr>
<td>Six</td>
<td>Ohnkosr</td>
<td>On</td>
<td>Onko</td>
</tr>
<tr>
<td>Seven</td>
<td>Itkohsr</td>
<td>It</td>
<td>Itko</td>
</tr>
<tr>
<td>Eight</td>
<td>Oalkosr</td>
<td>Oal</td>
<td>Oalko</td>
</tr>
<tr>
<td>Nine</td>
<td>Yuc</td>
<td>Yuc</td>
<td>Yuc</td>
</tr>
<tr>
<td>Ten</td>
<td>Singucul</td>
<td>Singucul</td>
<td>Singucul</td>
</tr>
</tbody>
</table>

Kosraean Counting System 1 is the most common system and is used to teach counting in the schools. This system has some numbers borrowed directly from the English Counting System, for example ‘thousand’ and ‘million’. This counting continues until infinity whereas Counting System 2 and 3 stop at ‘10’ and it is important to note that they are identical to System 1 after number ‘8’.

To indicate rank (1st, 2nd, 3rd, 4th, 5th and so on) and/or ordering in sequence, the prefix “ahk” is added to the numbers in System 1: ahksie (1st), ahkluo (2nd), ahktolu (3rd), ahkahkosr (4th), ahklimekosr (5th) and so on.

Interestingly, the above-mentioned system of counting is not always followed while counting certain objects or taking measurements in day-to-day life activities. Mostly the elders in the community use Kosraean Counting System 2, which is the more traditional way of counting and is often used while taking measurements for building a house and making a canoe or counting breadfruits and coconuts. And to indicate the number of certain objects or things, the third system, Kosraean Counting System 3, is used. For example one spear = sacsoko; one river/a river = infwalcsoko; one plane = oaksoko; one fish = ikosoko; and one unicorn fish = ikwoa soko. However, it is important to note that not all fish are counted by using the third system of counting, for example - one muhlahp fish is counted as muhlahp sie, and also wohn fish is also counted as wohn sie. And surprisingly, the same wohn sie is used to indicate one single wohn fish, and also one group of wohn fish.

Moreover, to distribute fish when there is more than a handful and they can’t be carried in the hands, people usually count by itut, which refers to a certain number of fish.
strung together on a rope made from hibiscus bark or any strong local vine. *Itut* may be further categorized as ‘*itut fototo*’ or shorter *itut*, which is usually a one-foot-long rope with about 3 to 10 fish strung on it, or ‘*itut loeloes*’ or longer *itut* containing more than 10 fish. However, it is important to note that while categorizing *itut* as ‘*itut fototo*’ or ‘*itut loeloes*’, not only the number of fish or length of rope is taken into account, but also the expectations and feelings of the person who is receiving ‘*itut*’. A person who was expecting more could call an ‘*itut*’ as ‘*itut fototo*’, but the same ‘*itut*’ could be called as ‘*itut loeloes*’ by another person who wasn’t expecting it or is more generous in giving thanks.

How do we determine when to use which system of counting? The answer is not very specific but the use of a particular system of counting is more or less related to the shape of the object or thing that is being counted. There may be other factors in choosing which counting system to use for counting a particular object or thing, but to identify them, we need more research. And I have a gut feeling that there must be a standard system of classifying objects based on which different systems of counting have evolved.

Figure A-1: Kosraean Counting Systems (Pictures: Courtesy of Mr. Alister Tolenna, Program Coordinator, Department of Education, Kosrae State Government, Kosrae)
Figure A-2: Kosraean Counting Systems (Pictures: Courtesy of Mr. Alister Tolenna, Program Coordinator, Department of Education, Kosrae State Government, Kosrae)

Information Source:

1. Mr. Kalwin Kephas, a highly respected member of the Kosraean community and the Director of Kosrae Campus, College of Micronesia, Kosrae.

2. Mr. Alister Tolenna, a respected member of the Kosraean community and Program Coordinator, Department of Education, Kosrae State Government, Kosrae.
Appendix B

Preparation of Materials

1. **Coconut Fronds (Sroacnu)**

   It is advisable to cut a frond and leave it in the sun for at least 2-3 hours before weaving it, because leaflets of a freshly picked frond tend to snap while weaving and shrink while drying and this shrinkage leaves holes in a previously tightly woven article made from the fresh frond. Brief drying in the sun makes for a superior product (Arbeit, 1985).

2. **Hibiscus Bast (Ne)**

   To prepare the bast fiber, the hibiscus bark is stripped and tied into strands and then these strands are placed under running river water in an estuarine area for 8-10 days until all the pulp is detached from the bark leaving thin, somewhat transparent and lustrous fiber strips. These fiber strips are then dried in the sun, cut into desired sizes, and dyed if desired (ngos: dyed or the process of dyeing). In the past, natural dyes made from plants were used but nowadays people use food coloring to dye the fibers.

3. **Pandanus Leaves (Lol)**

   The leaves that are aged and have turned brown are picked from the tree. Weaves say that they usually pick the leaves at high tide because the leaves picked during high tide are softer and they continue to mature and are better for weaving. Likewise, weavers prefer rainy days for weaving because on sunny days the leaves get tougher, making it hard to weave. After the leaves are picked, their spines along the edge and mid rib are removed, and the roots and tips are cut-off to ensure equal width across the whole length of the leaf. Then the leaves are softened by rolling and pressing, using a specific tool called “osra in tuk lol”, which is mostly made from wood (some people have made it from copper, such as my main resource person, Mrs. Kenye Lipan Kephas) and folding and smoothing by hand. Freshly-picked leaves are not used for weaving because they do not have the desired smoothness. The naturally-aged leaves are dark tan in color. To achieve a light tan color, the green pandanus leaves are picked from the trees and are dried artificially in the sun or over a fire.

4. **Shells (Ful)**

   The shells of desired type are picked from the beach during low tide and are left under the sun or in the fresh water to kill the organism present inside. Then the shells are cleaned, washed with soap water and/or water and bleach, and are finally pierced with a sharp needle and a hammer to make a hole through which they are tied while weaving.

5. **Taro Fiber (Pwepasruk)**

   To prepare pwpasruk, the stalk of hard taro is cut into approximately 1.5-inch-thick and 36-inch (3 feet) long pieces and the outer green and inner white layers are scrapped off leaving
thin, somewhat transparent and lustrous fiber strips, which are washed with water and/or water and lime juice for additional whiteness. These fiber strips are then dried in the sun and cut into desired sizes and dyed if desired. In the past, natural dyes made from plants were used but nowadays people use food coloring to dye the fibers.

6. **White Coconut Fibers (Sroacnu)**

The topmost light-yellowish leaves of fruit-bearing coconut trees are picked, scraped and then boiled with lime juice until they become white in color and are then dried in the sun for a day.
Appendix C

Glossary

Aan: yellow root corm
Ät: neck decorations made up of *Spondylus* shell discs and pandanus leaf strings
Boc: box, square-shaped ball
Bokensiäsä: moist, pulpy tissue of banana stem that is left over as waste after scraping the fibers
Deida: the process of sharpening
Dokschak: rough shell (a Venus shell)
Eä foko: knotted string
Eä: neck decorations made up of knotted hibiscus bast string
Epo: ball for Kosraean soccer made up of pandanus leaves, also Kosraean soccer game
Fahfah: a kind of poi
Fasa: nipa palm
Fasr fasr: white, referring to undyed natural fibers
Fesoma: head section of tol, which means the section of the cloth which used to lie over the thigh
Fohtoh round: the round basket made up of green coconut leaflets
Fohtoh (also foto): basket
Foto fon: a basket used by men to transport food and by women to collect crabs
Foto in kaki (also Foto kotkot): a basket used to carry all kind of coconuts
Foto in Kälat: a small, deep basket used to collect Kälat shells
Foto in pätar: a women’s basket for fishing,
Foto kuumpäl: a basket used for cooking fish
Foto läle: a basket used to transport fish, crabs, and also fruit
Foto lol: a woven basket made up of whole pandanus leaves
Foto rotoma: a basket used to transport fruit and meals
Ful: shells
Fung in Pahl: handle of the fan
Fusanie (also Fuhsranyac): traditional fahfah bowl
Imoal: thin braided and knotted necklaces made up of human hair
Inka in pahl: the main body of the fan
Inkabo: The medium section of tol, the middle part, which used to be situated at the crotch
Ip en lol: pandanus leaf strips
Ipän alla: the scraper made up of a piece of coconut shell
Irak: braid, the final stage of weaving mats, means that the weaver has to only braid the margins of the mat or is braiding them at that moment
Kahp: bundle
Kerära: the process of smoothing pandanus leaves
Kiaka luhlahp: a big mat
Kiaka otwot: mats prepared by weaving pandanus leaf strips
Kiaka sisik: a small mat
Kiaka tinae: mat made up of woven green coconut fronds
Kiaka tuhlah: mats prepared by sewing whole pandanus leaves with hibiscus bast
Kiaka: Mat
Kotkot (also Kohtkoht): turning of weaving or folding back of leaflets while weaving
Kopes afiof: a similar basket like kopes with lid
Kopes: a flat, rectangular basket used to keep utensils
Kuom: traditional food plate, also the specific quantity of a particular food to be contributed by a particular family during feasts and funerals
Kurra: a variety of banana used to produce yarn for tol (for coarser fibers)
Kusus: the process of preparing yarn from banana stem
Lauringring: spinning windmill
Lohlpo: bracelets made by weaving pandanus leaf strips and coconut fibers on plastic strapping from cases of frozen chickens
Lol (also Lohl): pandanus leaves
Luok: leg decorations made up of woven hibiscus bast
Marmar: wreath
Mos: breadfruit
Muot sruhsrah: red squares
Mwaresruh sra lol: a specific tool, which has nails embedded at equal distances in a piece of wood used to strip pandanus leaves
Ne: hibiscus bast
Neilo: a round peeled wooden cudgel
Ngos ne: dyed hibiscus bast
Ngos: the process of dyeing
\textit{Nngos lec}: already dyed

\textit{Noak}: midrib

\textit{Nu}: coconut

\textit{Nuk}: bundle, pack, packets of grated and roasted taro, wrapped in banana leaves

\textit{Nwacna}: the middle stage of weaving the mat

\textit{Oajok} (also \textit{Oacyac}): to dry under the sun

\textit{Osra in tuk lol}: a tool used to soften the pandanus leaves for weaving

\textit{Otwot} (also \textit{Ututot}): weaving

\textit{Päfuäś}: a kind of weaving, where the strips are always woven over and under two other ones

\textit{Pahl malem}: fan made up of coconut fibers, pandanus leaf strips, taro stalk fibers and bamboo

\textit{Pahl sroacnu}: diamond-shape fan made up of green coconut fronds

\textit{Pahl tok}: traditional fan made up of white coconut fibers, turtle shell, colored feathers of rooster and bamboo

\textit{Pahl}: fan

\textit{Pahmpu}: bamboo

\textit{Paho}: brim of the hat

\textit{Pahsruhk}: taro

\textit{Puhlwet sroacnu}: local food plate made up of green coconut leaflets

\textit{Pwepasruk}: taro stalk fibers

\textit{Rangrang}: yellow

\textit{Ros ne marmar}: dried flower wreath

\textit{Ros}: rose, flowers

\textit{Saki mat}: same as \textit{kiaka otwot}

\textit{Salāl}: to dry artificially

\textit{Sapko}: one kind of \textit{kiaka tuhlah}, made by weaving the whole pandanus leaves

\textit{Siacsac/siäsä}: the process of scraping and making smooth fibers

\textit{Sihkiht}: stage that denotes that the weaver has almost finished weaving the mat

\textit{Siske}: the outer thicker border of the fan

\textit{Sra in usr mahi}: brown banana leaves

\textit{Srihmet}: to begin, start, the beginning stage of weaving the mat, weaving of circular top of the hat

\textit{Sroacnu}: used to indicate coconut leaves regardless of whether it is a complete frond, a part or a half frond split across the great midrib, a single leaflet, or the coconut fiber
Sroalsroal: black
Sruhsrah: red
Suckan suhrafraf: wooden mold/frame used to determine size and shape of the hat while weaving
Suhrafraf/susu: hat
Tafotok: the tail of tol because this section of the cloth used to lie on the back
Tata: the inner thinner border of the fan
Tihl: the process of weaving designs and decorations in fan
Tohkohsrah: king, traditionally the highest-ranking political office in Kosrae
Tol: traditional loom-woven cloth worn as a belt in Kosrae, made of banana fibers
Tuh: sugarcane
Tuhp in ngoe: Turtle shell
Tuhpah: middle part of hat
Um: the traditional earth oven, also the food cooked in it
Uotuot fasa: a simple cross-weave with alternate over-and-under weaving which creates crosswise stitches
Uschuosch (also Usr mos): a variety of banana used to produce yarn for tol (for finer fibers)
Usr kusus: a variety of banana used to produce yarn for tol

The spellings and meanings of above all words are mainly based on information collected through personal interviews with local weavers. Some words and their meanings are taken from “Kusae” (Sarfert, 1919).

In Kosraean language there are many multiple-meaning words. However, in the above glossary only the meanings related with weaving are included.