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Chopstick Heart Revisited

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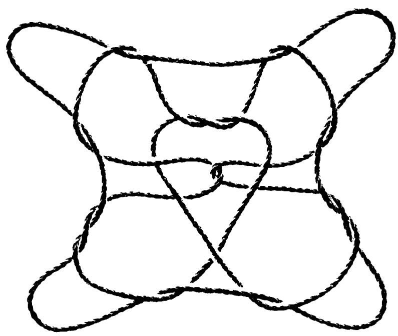

Murphy's 'Chopstick Heart'

ABSTRACT

'Chopstick Heart' is the name of an invented string figure presented in my previously published article on Opening Theory (Murphy 2001). Since then i have continued to explore an aspect of string figure instability referred to as "intensionality" and in the process have created several dozen new variations. Some of these feature a "heart within a heart", while others, which begin with so-called "slant openings" feature a square knot in the center. i end this article with instructions for making an amusing design that resembles the face of a famous cartoon mouse.

In this article i have continued my investigation of heart figures based on the original chopstick heart figure i made years ago when i lived in Whitestone, Queens, in New York City (Murphy 2001).

First i will revisit the methods for making the four simple three loop looms (Murphy 2001:212-214).

THREE-LOOP LOOMS

opening A (*op A*)

The formation of opening A has been amply described throughout the string figure literature. My procedural analysis would be as follows:

- Place both thumbs into the loop of string from below.
- Introduce the little fingers into the loop from below (this results in the formation of a palmar string). In the literature this stage in the formation of opening A is called *Position 1*.
- The right hand reaches to the left palm and the right index picks up the left palmar string and returns to position.
- The left hand then reaches to the right palm, passes through the right index loop from above, picks up the right palmar string, and returns. The result is opening A (fig. 1). Note that both strings running from your right index are above the strings running from your left index as shown below.

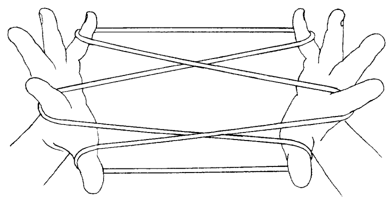

Fig. 1 - *opening A (op A)*

opening B (*op B*)

Opening B is formed in the same way except the left hand acts first, followed by the right hand. The result is shown in fig 2. Note that the strings running from your left index are above the strings running from your right index.

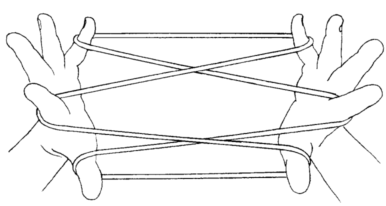

Fig. 2 - *opening B (op B)*

left DNA opening (*ldna*)

The only difference between opening A and a 3-loop DNA loom is the parity of one or more string crossings. Also different is the way the loom is built: rather than starting with Position 1, a DNA loom starts with a single loop on each little finger. i call it a DNA loom because of the way the strings form a spiral or double helix as loops are added to the hands. A left DNA loom is formed by adding loops with the *left* thumb:

- Begin by placing the loop on each little finger so that the near and far strings are parallel and do not cross.
- Create a second loop as follows: Insert the left thumb, *from above*, into the little finger loop and return with the near little finger string (rotate the left

thumb toward you and up); insert the right thumb, from below, into the left thumb loop and extend.

- On each hand transfer the thumb loop to the index finger.
- Now create a third loop: Insert the left thumb, *from above*, into the index loop and return with the near index string (rotate the left thumb toward you and up); insert the right thumb, from below, into the left thumb loop and extend. This is the left DNA opening (fig. 3). To confirm that the loom is correctly formed, rotate your left hand 90° so that the fingers of your left hand point away from you. If none of the strings touch the loom was formed correctly.

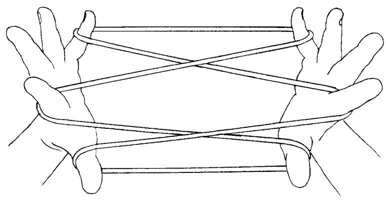

Fig. 3 - *left DNA opening (ldna)*

right DNA opening (*rdna*)
A right DNA opening is formed in the same way, except the *right* thumb is used to create the second and third loops. The result is shown in fig. 4. To confirm that the loom is correctly formed, rotate your right hand 90° so that the fingers of your right hand point away from you. If none of the strings touch the loom was formed correctly.

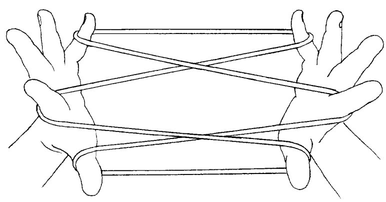

Fig. 4 - *right DNA opening (rdna)*

Another way to confirm that the dna looms are correctly formed is to drop the index loops. Openings A and B will dissolve, but the two dna openings will produce a wrap (a pair of interlocking strings) near the center of the figure.

Next, i revisit loop rotations (Murphy 2001:216). In my notational system, +1/2 indicates a half-turn rotation away from you whereas -1/2 indicates a half-turn rotation towards you. Likewise, +2/2 indicates a full rotation away from you whereas -2/2 indicates a full rotation towards you. 0 is used to indicate no rotations at all. Full-turn rotations are easily accomplished by tracing out a circle with the tip of your finger, avoiding adjacent loops. Half-turn rotations are best accomplished using two transfers (a method I call “rolling”). For example, to accomplish a +1/2 rotation of the index loop, first transfer the index loop to the thumb, inserting the thumb *from below*, then retransfer this loop to the index, inserting the index *from above*. To accomplish a -1/2 rotation do the same, but reverse *from above* and *from below*.

The following is a description of how to form a chopstick heart figure. i call this figure chopstick heart because when i first formed it, i was surprised and wasn't paying strict attention as my hands played with the string. i stuck a chopstick through the figure and hung it from the light fixture above my kitchen table (fig. 5) so i could see it while i tried to form it again with another string. It took a year or so when finally (with the crucial help of Mark Sherman) i was able to form the figure again.

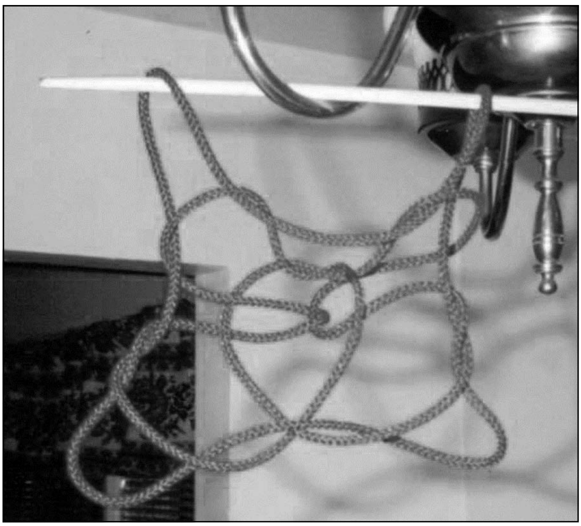

Fig. 5 - *What i looked at longingly for over a year*

FORMING THE CHOPSTICK HEART

Forming the Loom

- opening B.

Rotating the Index Loops

- Rotate both index loops -1/2. (In variations described later on, the index loops may or may not be rotated in either direction singly or as a pair).

CHOPSTICK HEART MOVES

The following series of complex maneuvers will be abbreviated as 'ch right'. If instructed to perform 'ch left' simply swap the terms right and left in the maneuver called *Exchanging the Index Loops*.

Shifting the Loops

- Introduce the middle and ring fingers into the little finger loop from above and close them to the palm to secure the near little finger string.

- Withdraw the little finger from its loop and reintroduce it from the opposite side, closing it to the palm. The three lesser fingers now clutch the former little finger loop.

Fixing the Bottom

- Without withdrawing the middle finger from the lesser fingers loop, pass each middle finger toward you under the index loop and insert it, from above, into thumb loop; curl the middle finger around the far thumb string and draw it away from you through the lesser fingers loop; withdraw the ring-little fingers and close the middle finger to the palm; reinsert the ring-little fingers into the middle finger loop, closing the far middle finger string to the palm.
- Near each middle finger a loop surrounds the palmar string of each hand; the loop has an upper and a lower string (the latter being a transverse string); pass each middle finger toward you through this loop, then curl the middle finger around the lower string, drawing it away from you through the ring-little finger loop; drop the ring-little finger loop and reinsert these two fingers into the middle finger loop, closing the far middle finger string to the palm.

Exchanging the Index Loops

- Transfer the right index loop to the top of the left index, inserting the left index from above; insert the right index from the far side and from below into the upper left index loop; pick up the left upper far index string but do not return; pass the right index tip toward you over the left upper near index string, then insert the right index, from above and from the near side, into the left lower index loop. With the right index tip lift the left lower index loop over the left upper index loop and off the left index; Navajo the right index loops (lift the lower loop over the upper loop and release it). Extend and arrange. The near index strings should interlock. The far index strings coil around each other before entering the center of the design (these strings will form the top of the heart).

Cleaning the Top

- Withdraw the middle finger from the lesser fingers loop and insert it, from below, into the index loop; pinch the near thumb string between the tips of the index and middle fingers, and draw this string through the index-middle finger loop by rotating the index-middle finger pair away from you and up, thus placing the retrieved string on the back of each index (the index-middle finger loop slips off as you return).
- Drop the thumb loop and extend to complete the figure.
- Arrange the center to reveal a ‘Heart’ (fig. 6).

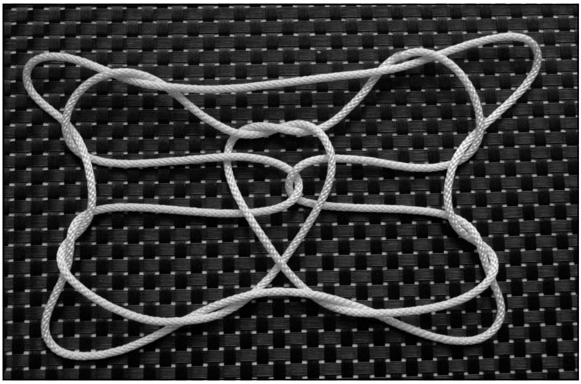

Fig. 6 - *The original opening B chopstick heart (op B, both index -1/2, ch right).*

One of the most important aspects of a detailed analysis of these figures is to determine which ones maintain their integrity of form when the figure is stretched taut on the hands. Joe Ornstein coined the term “intensionality” to describe when a string figure changes its internal form when put under high tension on the hands (Ornstein 1992). As mentioned in the Appendix section of my previous article (Murphy 2001:234), if you were to make the chopstick heart figure above from an ldna opening, rotate both index loops -1/2, then end with chopstick heart right (fig. 7), the figure would flex into a shape which has no hearts (!!) when stretched taut (fig. 8). When i first formed the figure this unstable version is what i chanced upon since i habitually started my figures at the time with the ldna opening. Finding a stable form of the figure (fig. 6) led me to experiment and find the figures in the balance of this paper.

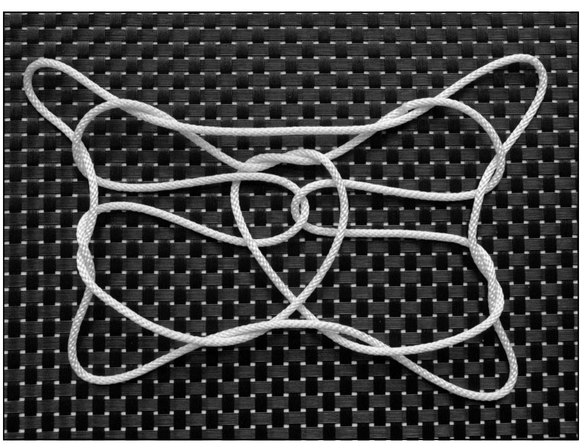

Fig. 7 - *The original ldna chopstick heart arranged (ldna, both index -1/2, ch right)*

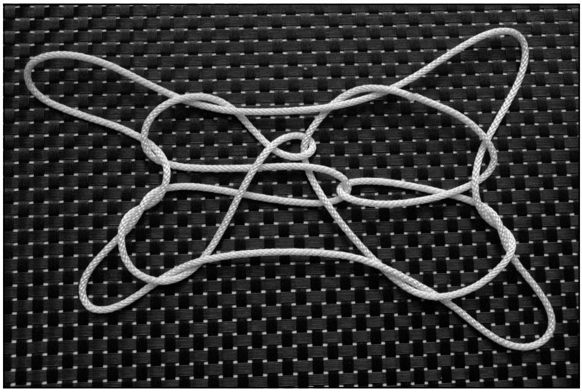

Fig. 8 - *The original ldna chopstick heart with intensionality*

Fig. 9 is the original chopstick heart formed from the opening A loom with both index loops rotated -1/2, and with the index loop exchange instigated by the left hand. This figure does not deform under intensionality.

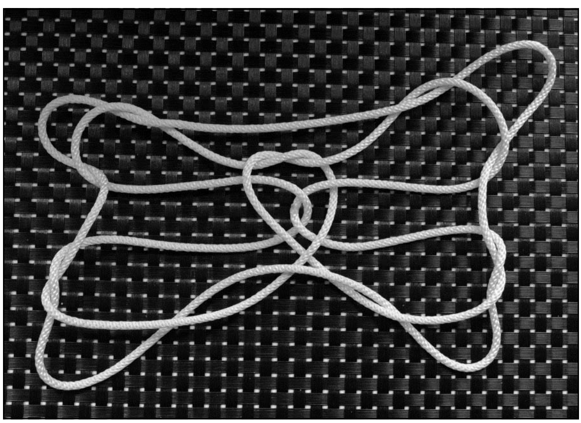

Fig. 9 - *op A, both index -1/2, ch left*

Again note that only one side of the heart figure is "captured".

For the record this is the other stable form of the original chopstick heart. Its unstable version can also be formed: (rdna, both index -1/2, ch left).

Throughout this paper i have not introduced figures which fail to form into interesting final forms from my perspective. For example the rdna figure -1/2 chopstick heart right is to me a degenerate figure, as are a majority of figures formed when experimenting to find new interesting results from fresh concatenations of operations.

While we were emailing each other Joe D'Antoni came up with a simple heart that had its sides held by internal strings (D'Antoni 2002:292, fig. 9). My method of forming his "held heart" figures was twofold (fig. 10, fig. 11).

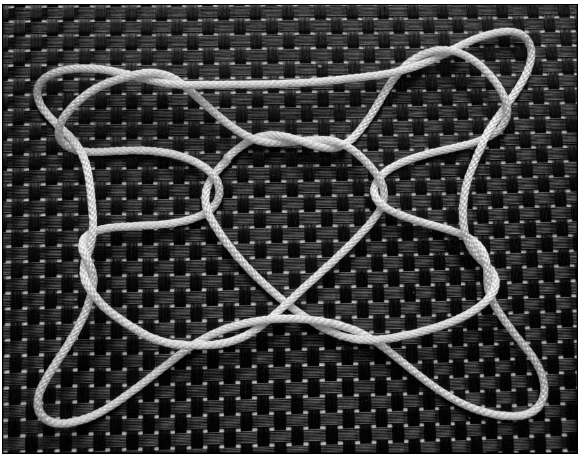

Fig. 10 - *ldna, right index loop up through right little finger loop, both index -1/2, ch right*

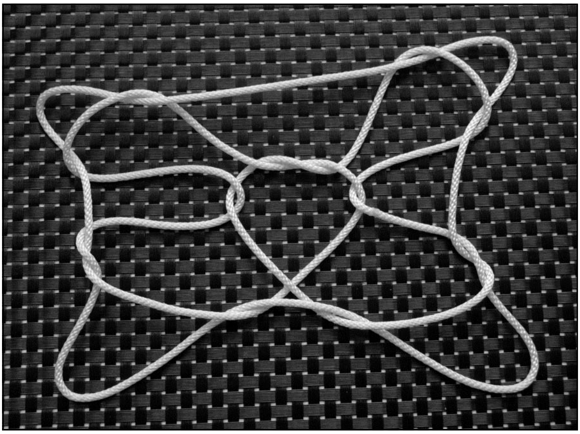

Fig. 11 - *op B, right index loop up through right little finger loop, both index -1/2, ch right*

The phrase *right index loop up through right little finger loop* is my shorthand for "With the left hand, lift the right index loop off the right finger and without inverting it, pass it up through the right little finger loop, then reset the loop on the right index, releasing the grip of the left hand." This is a "loop passage" or "braiding" maneuver (Murphy 2000:235-239).

Note that the string crossings at the bottom of each heart in fig. 10 and fig. 11 are different, and both figures are identical to D'Antoni's figures.

But now compare the following figure (fig. 12) which is seemingly identical at first glance to the ldna version shown above (fig. 10), but the over-under patterns of the strings in the upper half of the heart are opposite in nature.

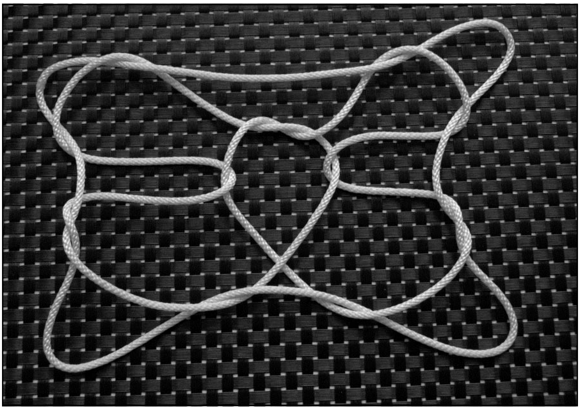

Fig. 12 - *op B, right index loop up through right thumb loop, both index -1/2, ch left*

One of the first figures i discovered as i investigated these procedures was a heart with an upside down heart within it (fig. 13).

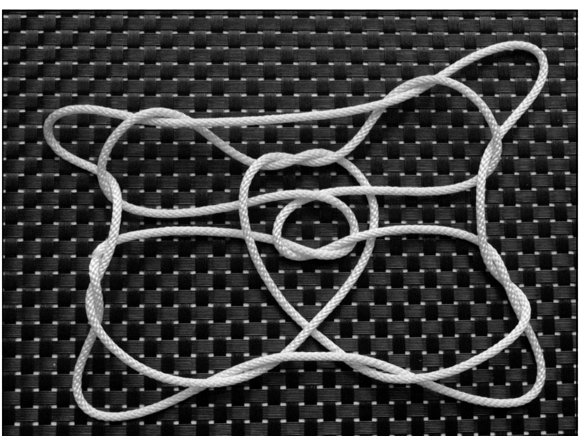

Fig. 13 - *op A, right index loop up through right little finger loop, both index -1/2, ch left*

Note that the upside down heart is not held by the larger heart and can slide to either side by arranging the figure. This figure does not show intensionality.

But note the figure below (fig. 14) which is identically formed except with the chopstick heart right maneuver. It suffers intensionality and the inner heart (when arranged) is held by the larger outer heart.

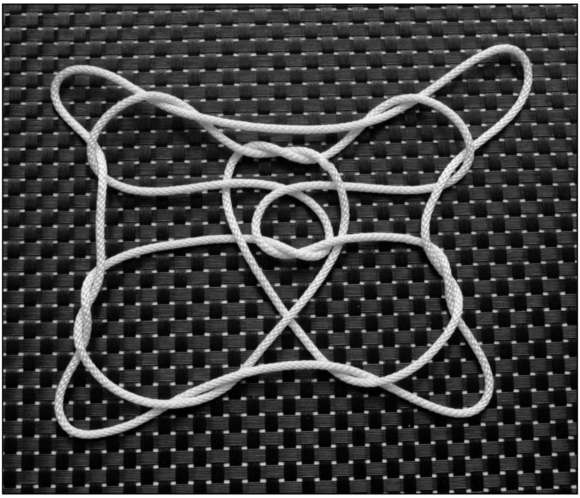

Fig. 14 - *op A, right index loop up through right little finger loop, both index -1/2, ch right*

A remarkably similar figure is formed with the rdna loom and the same weavings (fig. 15). The only difference is in the crossing of the strings at the bottom of the large heart. In the figure below the left crossing string is above the right. And again the inner heart suffers distortion with intensionality.

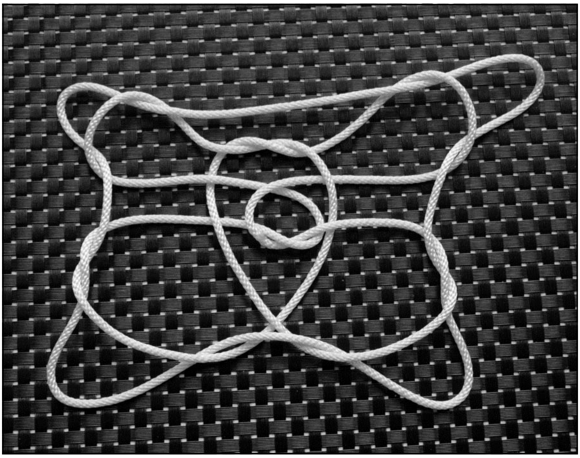

Fig. 15 - *rdna, right index loop up through right little finger loop, both index -1/2, ch right*

It was surprising to me to form the figure from the rdna loom as above (fig. 15) but with a chopstick heart left ending (fig. 16). The inner heart was not held and the larger heart suffered distortion from intensionality but the inner heart does not because the right crossing string now goes over the left.

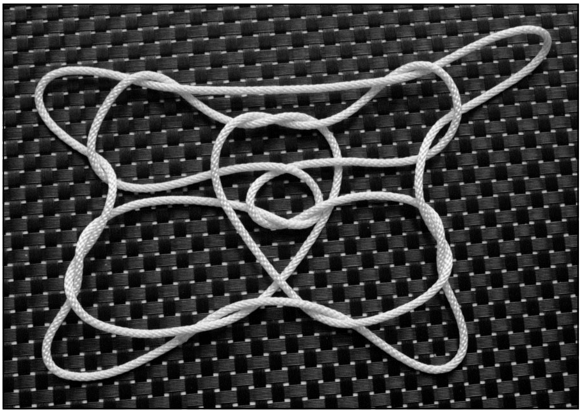

Fig. 16 - *rdna, right index loop up through right little finger loop, both index -1/2, ch left*

All of the heart within a heart figures above get confused in the mind unless a summary comparison is made. In the following table the four figures beginning with opening A or rdna have the right index loop passed up through the right little finger loop. All the opening B or ldna figures have the left index loop passed up through the left little finger loop. All eight figures have both index loops rotated -1/2. The crossing strings referred to in the table are the strings that form the pointed end of the heart in the design.

opening	heart ending	inner heart	intensionality	large heart crossing string on top	small heart crossing string on top
A	left	sliding	stable	right	right
A	right	both caught	inner distorts	right	left
rdna	left	sliding	large distorts	left	right
rdna	right	both caught	inner distorts	left	left
B	left	both caught	inner distorts	left	right
B	right	sliding	stable	left	right
ldna	left	both caught	inner distorts	right	right
ldna	right	sliding	large distorts	left	right

Another interesting variation of the movements within this series of figures makes what i call a quasi-heart (fig. 17).

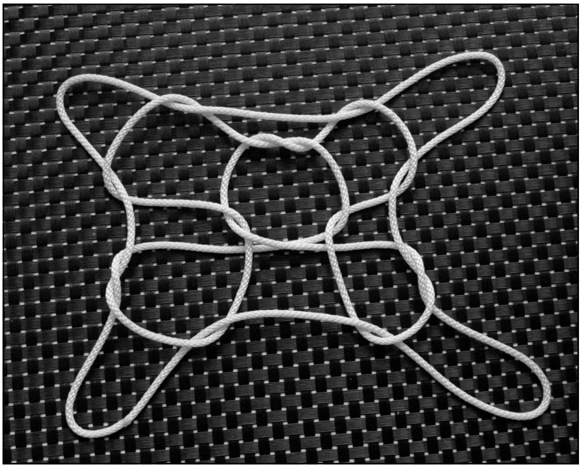

Fig. 17 - *opening A, left index loop up through left thumb loop, both index no rotation, ch right*

There are other variations, but this suffices to show what is possible with small differences.

Now we return to figures with one large heart and horizontal strings which form a single wrap in the center of the figure, as in the original chopstick heart. In the variations described below, you should note at the outset that the difference in their manufacture consists mainly of putting the opposite hand index loop up through the corresponding little finger loop. So with an ldna opening you would put the right index loop up through the right little finger loop.

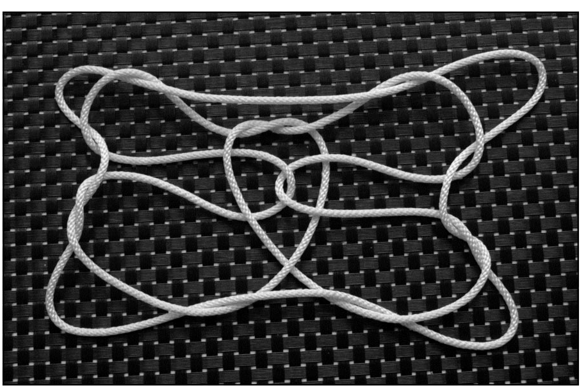

Fig. 18 - *ldna, right index loop up through right little finger loop, both index -1/2, ch left*

The loops in the center of this figure (fig. 18) merely hold themselves in a center wrap, and this wrap is free to slide through the heart in either direction.

For identification of differences in this and the following figures, the salient features are the top left string running to the wrap in the center and the crossing strings at the bottom of the heart. In this figure the top left string goes over the right string and the right string goes over the left at the bottom of the heart. This is a stable figure.

As you might remember, terminating the above figure with a right chopstick heart move makes a heart with the sides held and no wrap in the center (fig. 10). This should mean that using the same hand to initiate the opening and the index loop exchange in the chopstick heart moves will form a figure similar to the above, whereas using opposite hands to initiate these moves will not.

To check this conjecture out i made the following:

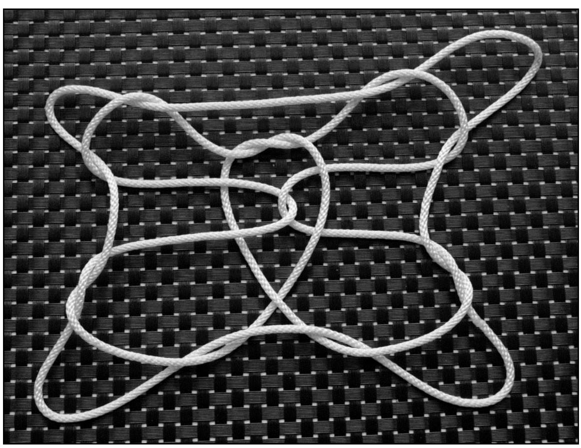

Fig. 19 - *rdna, left index loop up through left little finger loop, both index -1/2, ch right*

Fig. 19 is the chiral (mirror-image) figure of the one just above (fig. 18). The wrap is free to move to either side and the figure is stable.

Fig. 20 differs from the one above (fig. 19) by the crossing strings at the bottom of the heart, and this figure is unstable.

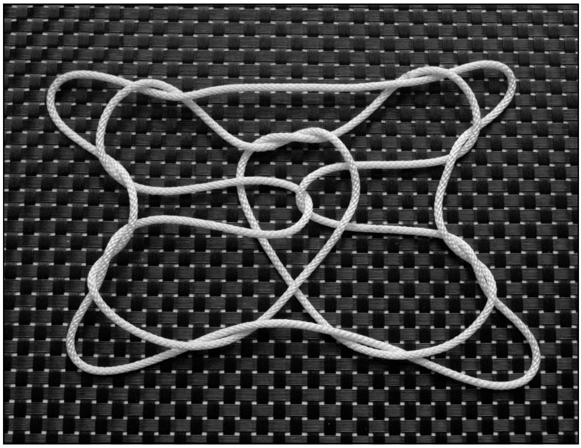

Fig. 20 - *op A, left index loop up through left little finger loop, both index -1/2, ch right*

And you should anticipate the results of the last figure of this small series:

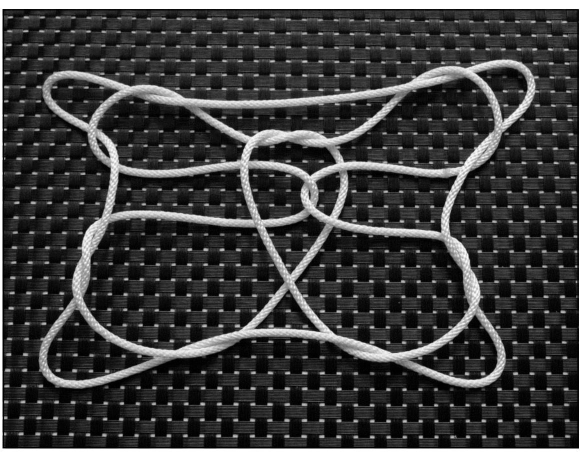

Fig. 21 - *opening B, right index loop up through right little finger loop, both index -1/2, ch left*

In Fig. 21, the wrapped strings are under the heart on the left and over the heart on the right (opposite to the opening A figure) and the crossing strings at the bottom of the heart are opposite. This is also an unstable figure.

To summarize:

The rdna and opening A figures differ only in the crossing strings at the bottom of the heart and the opening A figure is unstable.
The ldna and opening B figures differ only in the crossing strings at the bottom of the heart and the opening B figure is unstable.

The ldna and rdna figures differ in the sliding wrap strings which are opposite and the strings at the bottom of the heart are opposite. Both figures are stable.

The opening A and opening B figures differ in the sliding wrap strings which are opposite and the strings at the bottom of the heart are opposite. Both figures are unstable.

To round out my heart figures made from the normal four openings (A, B, ldna and rdna) i add a few variants from the many to be made through further investigations.

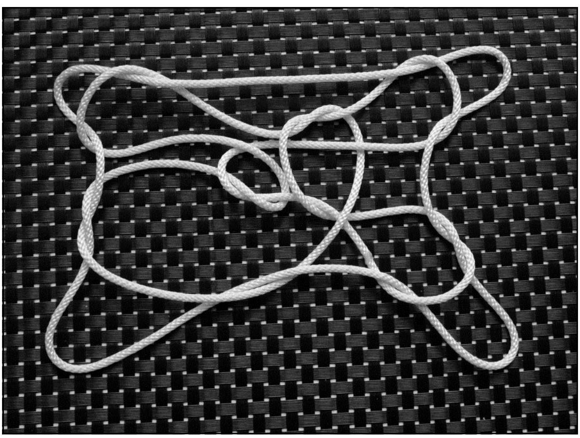

Fig. 22 - *ldna, left index loop up through left thumb loop, roll the figure, right index only -1/2, ch left*

In fig. 22 the inner heart is held on the right and moves freely on the left.

The “roll the figure” move is as follows:

Rolling is a technique for “turning over” a loom or a partially completed figure so that the underside can be manipulated. A crude way to “turn over” opening A would be to lay the figure on your lap, fingers pointing down, release all loops, then reinsert the fingers from below (i.e., insert the thumb into the former little finger loop, the index into the former index loop — but from the opposite side — and the little finger into the former thumb loop). This achieves a +1/2 rotation of the entire figure (assuming that the axis of rotation is a line connecting the knuckle of each index finger). A much more elegant way of doing this is as follows:

- Transfer the thumb loop to the middle finger, inserting the middle finger from above (this introduces a +1/2 spin).
- Pass each thumb away from you under all the strings, pick up the far little finger string and return with it, then drop the little finger loop (this is merely a way of transferring the little finger loop to the thumb while simultaneously introducing a +1/2 spin).
- Transfer the middle finger loop to the little finger, inserting the little finger from below.
- Transfer the index loop to the thumb, inserting the thumb from below, then retransfer this loop to the index, inserting the index from above (this introduces a +1/2 spin). The entire figure has now been rotated a half turn away from you.

A similar figure formed from the opening B position is below (fig. 23):

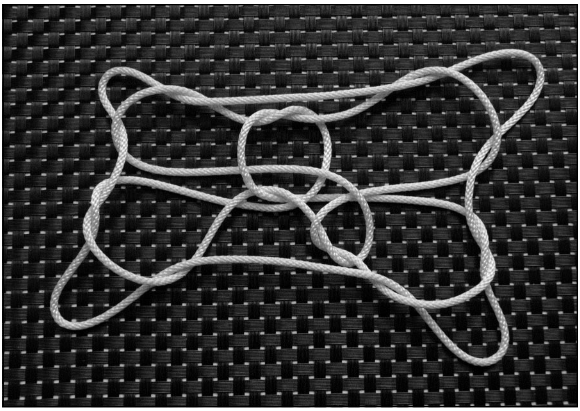

Fig. 23 - *opening B, left index loop up through left thumb loop, no index loop rotation, ch left*

This time (fig. 23) the upside down heart can slide to the right and or the left, but since the left side of this heart is formed from a string from the bottom of the figure it always slides to the right. This figure is stable under minor tension.

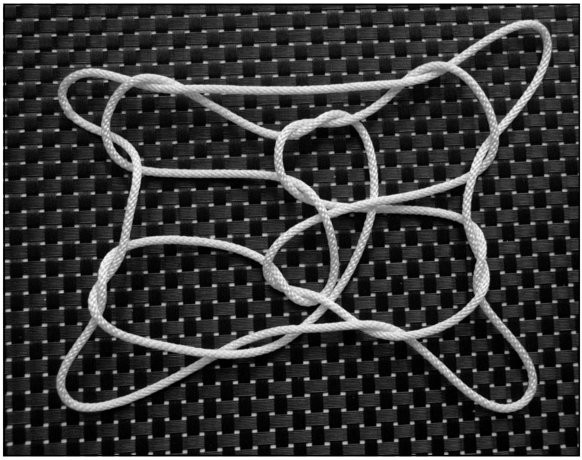

Fig. 24 - *ldna, right index loop down through right thumb loop, right index only -1/2, ch left*

This time (fig. 24) the upside down heart is free to move to the right.

And this concludes the heart figures (formed with the original four openings) which i am adding to this paper.

SLANT OPENINGS

When i began imagining how to form three loop openings other than the opening A, opening B, left dna and right dna quartet, i made 16 other geometries with one of the near little finger strings making a diagonal to the far side of the opposite thumb. This diagonal string passed over or under three crossing strings. The following illustrations (fig. 25, fig. 26) show the result of my efforts when displayed with fingers pointing away from the body. The thumbs go down through the top triangle, the index down through the smaller inner triangles, and the little finger goes down through the bottom triangle.

i was continuing my investigation into the figures formed with my chopstick heart maneuvers. But i found no easy method of forming these sixteen openings (fig. 25, fig. 26) and resorted to a different easily formed set of openings which i called my slant openings (not shown). They were formed as follows:

i started with either an ldna two loop beginning or an rdna two loop beginning. If one places the loop of string on the little fingers and then using either the left or the right thumb to go down into the loop to scoop the near transverse string up toward you, inserting the other thumb under and into the resulting loop, you can form the ldna or rdna two loop beginning. The only difference between the

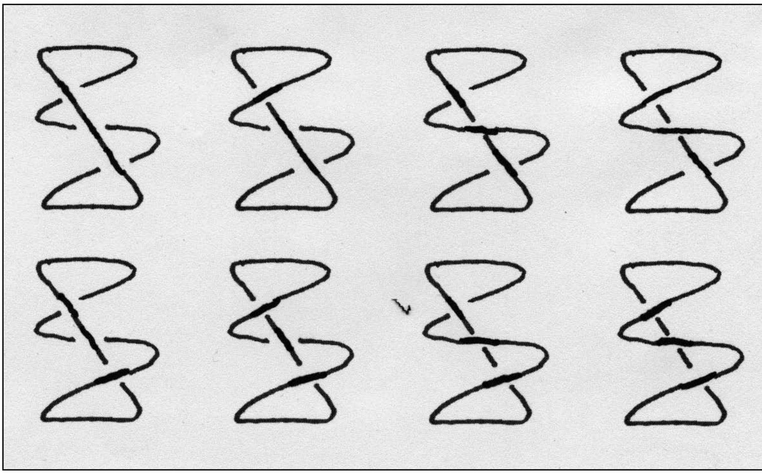

Fig. 25 - *first set of hypothetical three loop openings*

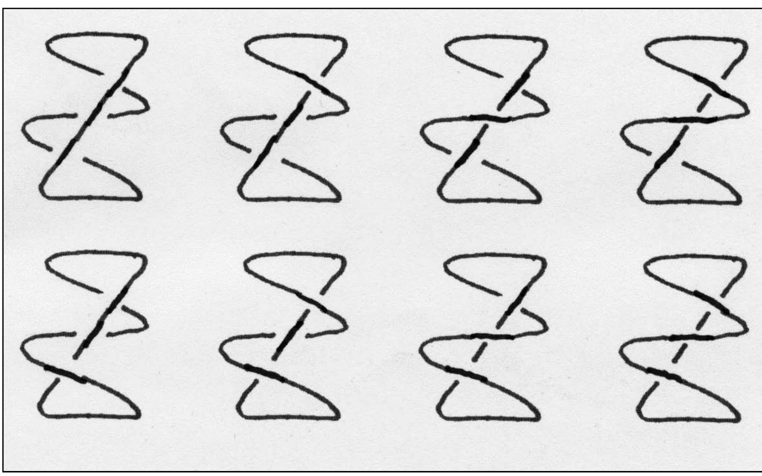

Fig. 26 - *second set of hypothetical three loop openings*

beginnings can be seen by looking out through the two loops with the hands extended away from of you. The ldna beginning has the left near little finger string pass in front of the right near finger string where they cross in the middle of the figure. The rdna two loop beginning has the opposite.

Then in order to form a three loop slant opening either the left or the right index finger presses its palmar surface, from behind, against one of the four interior crossing strings, twists clockwise or counterclockwise to capture (scoop up) the string, then the other index is inserted from below to form the third loop.

For example if after the 2 loop ldna beginning is formed the right index finger is passed from above behind the left near little finger string near the left hand and is scooped back to catch this string, by twisting the index finger toward the left and up and inserting the left index from below into the forming loop imparts a clockwise twist. This should result in the right near little finger string passing over and touching the right far thumb string and no other touching of strings. My shorthand for forming this three loop slant opening is: 2 ldna, slant op (right index, left near little finger string cw).

And if the right index finger is passed from above behind the left near little finger string near the left hand and is scooped back to catch this string, by twisting the index finger toward the right and up and inserting the left index from below into the forming loop imparts a counterclockwise twist and results in both the right near little finger string and the right far index string passing over and touching the right far thumb string as it goes to the far side of the left index finger. My shorthand for forming this three loop slant opening is: 2 ldna, slant op (right index, left near little finger string ccw).

By practicing both clockwise (cw) and counterclockwise (ccw) scooping moves one can quickly become adept at accomplishing them.

The 3 loop slant opening has two to the fourth power or 16 different configurations when made from the 2 ldna beginning and the same number when made from the 2 rdna opening. Of course you can also pass the index finger down through a loop before scooping up a string belonging to a different loop. For example you can reach down into the little finger loop and back up through the triangle formed by the interior strings near either hand and push down on the far thumb string to scoop it up either clockwise or counterclockwise back under the near little finger string and insert the other index from below to form the third loop (another 32 variants). This system of openings is easy to accomplish with practice and affords a goodly number (64) of different positions to form new figures with.

And i am sure that intrepid investigators can imagine other different methods of forming the third loop from the two loop dna beginnings. i had fun doing so.

The following is a report of some of the figures i found using the chopstick heart ending with these openings. i call them my heart series of figures although not all of them produced hearts.

In comparing fig. 27 and fig. 28, note the difference in the over-under patterns on the strings running through the heart and the opposite twist of the strings of the circle to the left of the heart.

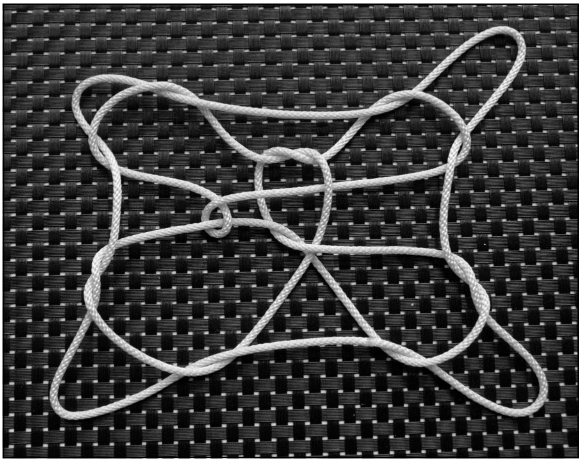

Fig. 27 - *2 ldna, slant op (right index, right near little finger string cw), left index loop up through left little finger loop, both index no rotation, ch right*

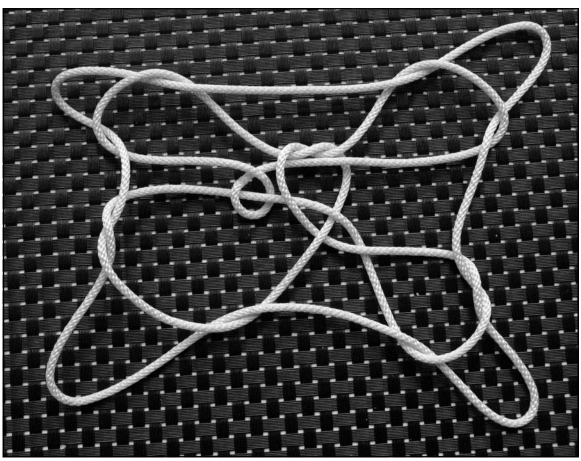

Fig. 28 - *2 ldna, slant op (right index, left near little finger string ccw), roll figure, right index loop up through right little finger, both index -1/2, ch left*

Now comes a figure which completely surprised me. Instead of a heart in the center of the figure there is a square knot (fig. 29). It is to be distinguished from a granny knot because the strings running from the right side of the knot both come up from below, and conversely the strings running out of the left side of the knot both dive below. Sailors were trained to tie this knot rather than a granny (where the side strings running out from the knot varied, one coming up from below and one diving down). i struggled for a long time trying to form a granny knot in a string figure before a mathematics professor Philip Ording showed me a proof that a granny knot cannot be formed from a closed circle of string.

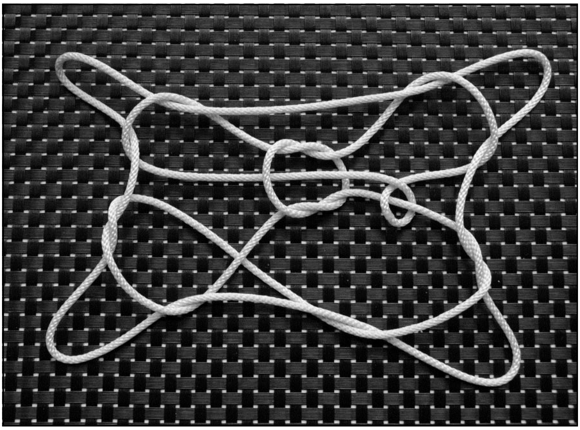

Fig. 29 - *2 ldna, slant op (left index, right near little finger string cw), right index loop up through right little finger loop, both index no rotation, ch left*

Then i was able to change the orientation of the square knot and the orientation of the loop to the right as shown in the figure below (fig. 30).

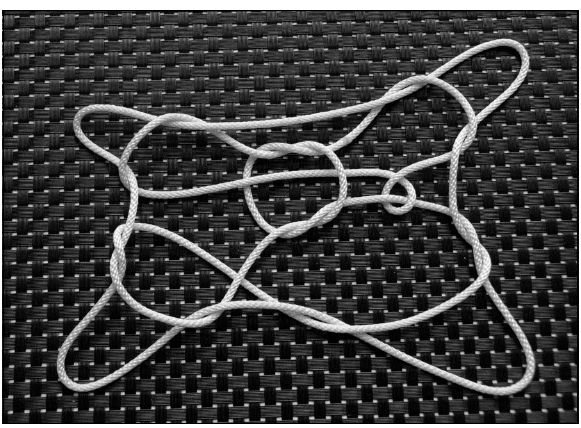

Fig. 30 - *2 ldna, slant op (right index, left near little finger string ccw), roll figure, right index loop up through right thumb loop, both index -1/2, ch right*

Then i made a figure chiral to the first square knot shown above by performing all of the maneuvers chirally (fig. 31).

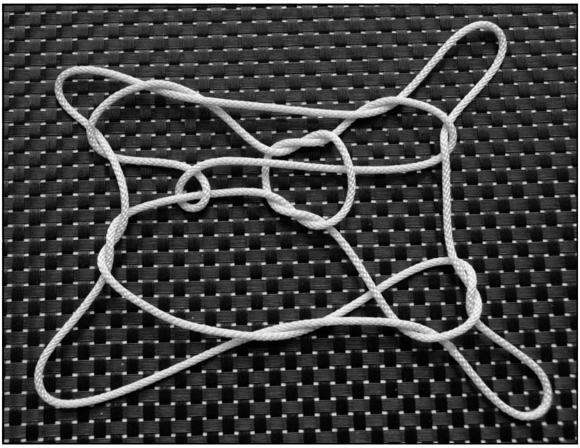

Fig. 31 - *2 rdna, slant op (right index, left near little finger string ccw), left index loop up through left little finger loop, both index no rotation, ch right*

Then i made the following figure (fig. 32) which differs from the first knot figure above (fig. 29) only in the crossing strings at the bottom left side of the figure. The string running down from the bottom left of the knot goes under the string running from the left side of the figure.

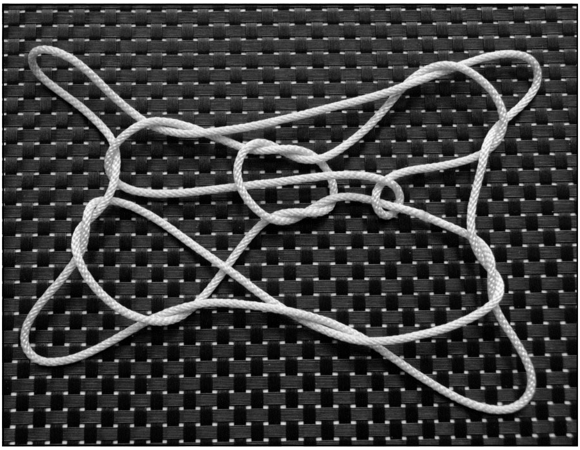

Fig. 32 - *2 rdna, slant op (left index, right near little finger string cw), right index loop up through right little finger loop, both index no rotation, ch left*

The following knot figure (fig. 33) is the first i found when investigating these figures, but i then was unable to make it again, and for quite some time was frustrated looking at the photograph i had made of it. Then i was fooling around with my original notation and found that i had to rearrange the figure after forming it. The wrap formed in the center of the figure must be pulled to the right in order for the knot to form. i should learn to trust my notation system more (and probably to add special instructions when needed).

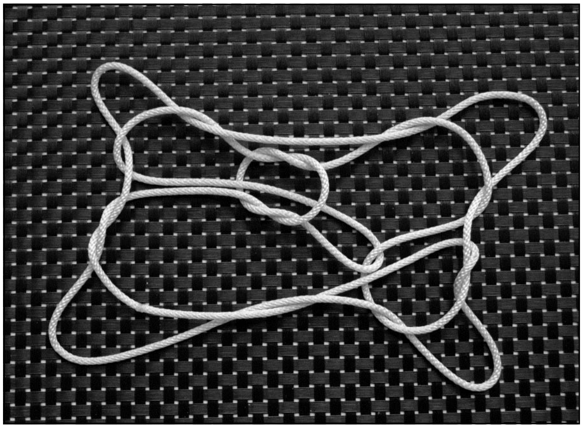

Fig. 33 - *2 ldna, slant op (right index, left near little finger string ccw), left index -1/2, right index +2/2, ch right*

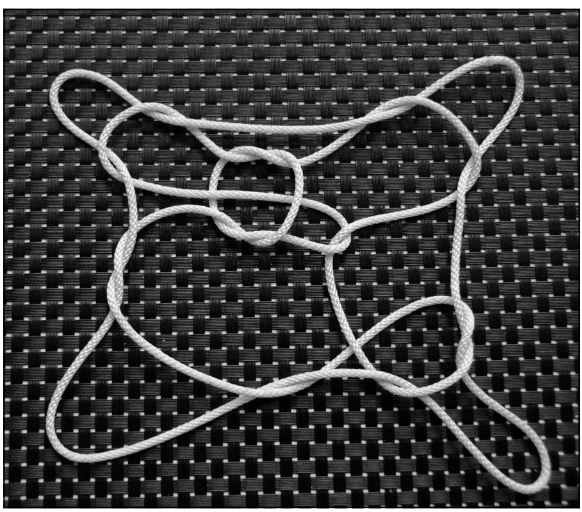

Fig. 34 - *2 rdna, slant op, (right index, left near little finger string ccw), left index -1/2, right index +2/2, ch right*

The above two figures (fig. 33, fig. 34) are exactly the same except for the crossing strings which originate from the two lower frame line wraps and pass into the interior of the figure. In the rdna figure the string coming from the left passes under the string from the right and the ldna figure is the opposite. Note that some figures look different depending on how they are "arranged".

Then i conjectured that the peculiar rotating of the index fingers should lead to more figures and made the following series:

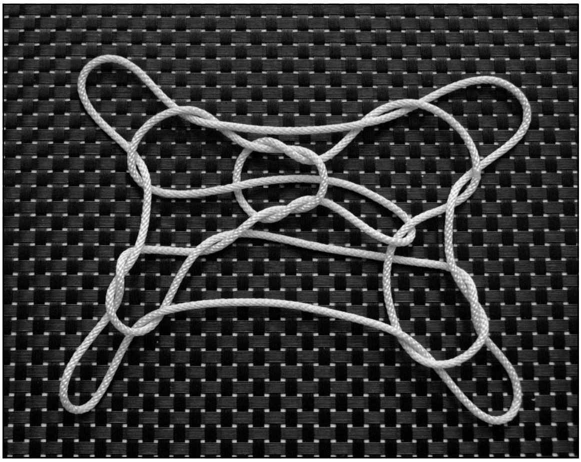

Fig. 35 - *2 ldna, slant op, (left index, right far thumb string ccw), left index -1/2, right index +2/2, ch right*

And then i found the following (fig. 36):

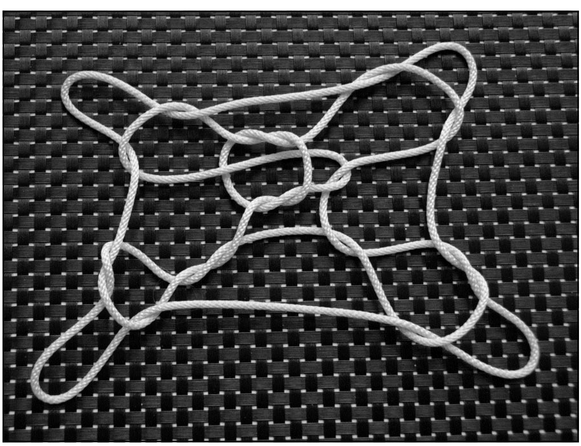

Fig. 36 - *2 ldna, slant op (left index, right near little finger string pulled under right far thumb string, then ccw), left index -1/2, right index +2/2, ch right*

During the formation of fig. 37 and fig. 38 a far thumb string is scooped up. Be aware that the index passes behind (to the far side of) this string before scooping it up. During the formation of fig. 39 the left near little finger string is passed down through the left thumb loop before being scooped up by the right index.

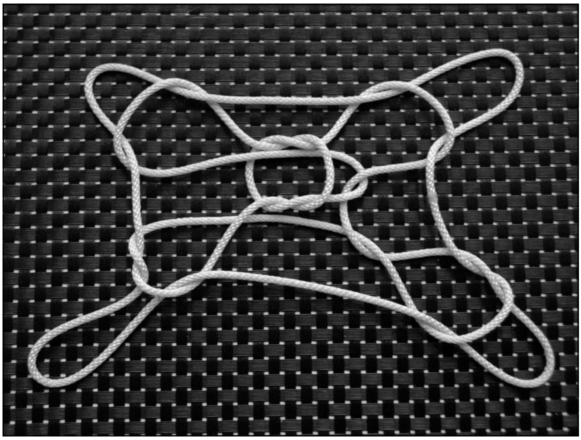

Fig. 37 - *2 rdna, slant op (right index, left far left thumb string ccw), left index -1/2, right index +2/2, ch right*

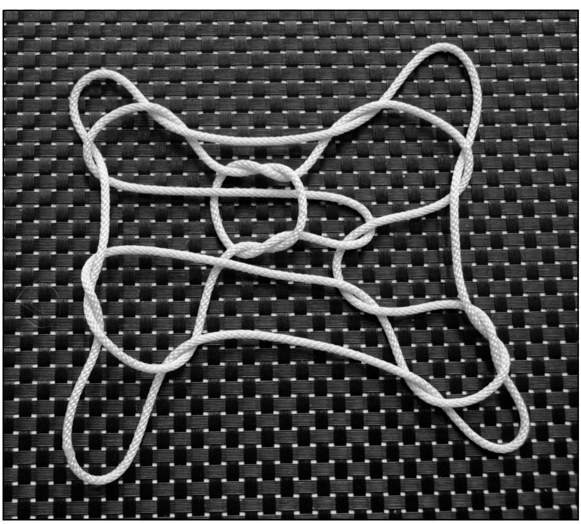

Fig. 38 - *2 ldna, slant op, (right index, left far thumb string pulled under left near little finger string, then ccw), left index -1/2, right index +2/2, ch right*

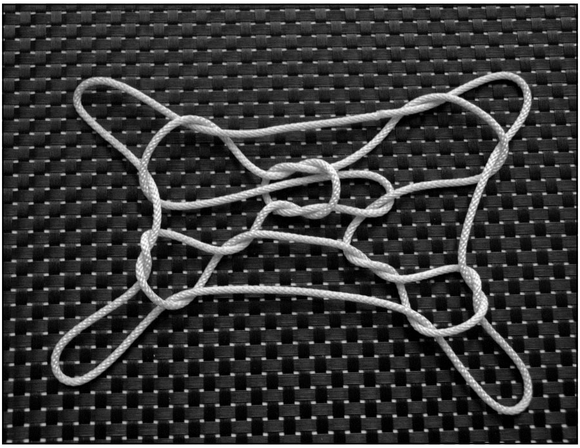

Fig. 39 - *2 ldna, slant op (right index, left near little finger string is pulled over then under left far thumb string, then ccw), left index -1/2, right index +2/2, ch right*

As you can see the basic square knot with a pull through loop held on the right is characteristic of all these latter figures. The differences in the figures are over-under crossing patterns as well as different wraps on either side of the figure.

And in conclusion i will add my favorite heart figure (fig. 40).

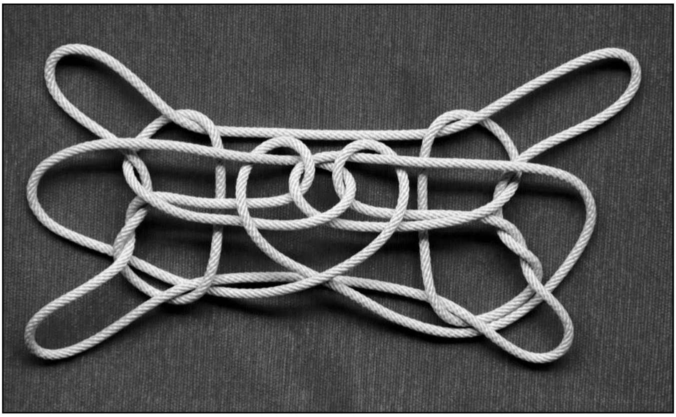

Fig. 40 - *my favorite heart figure*

And as i am a teacher who loves to set hard tasks for my students i will only briefly indicate the complex manufacture of this figure. A somewhat stiff string is required for the curvilinear nature of the figure to blossom and the length of the string which forms the loop is 1¼ of my span.

- 4 ldna (Murphy 2000:219-220).
- Index loops left dominant switch (Murphy 2000:274-275, Without inverting the left index loop transfer it to right index over the right index loop to become a lower loop; then without inverting the former right index loop transfer it to the left index finger).
- Thumbs pick up index loops from below.
- Middle finger loops -1/2 to top of thumbs.
- Little finger loops -1/2 to top of indices.
- Little fingers up through all three thumb loops to hook down near index strings.
- Index and middle finger pinch near lower thumb string through index loops and away while thumbs shed all but (now) two Katilluik strings.
- R Katilluik both pairs of thumb loops, disentangling them one pair at a time, beginning with the thumb loops whose near string is seen to span the index and little finger transversals.
- While completing the Katilluik, make sure all four near thumb strings Navajo over thumbs, and drop index loop. Extend loosely.
- Turn back of hands toward you and look down at the figure. Two pairs of horizontal strings cross at the center of the figure, one pair going left to run under the left little finger loop and one pair going right to run under the right little finger loop. Two of the four horizontal strings cross to form the bottom of the heart seen in fig. 41. Index and middle fingers pass between their respective horizontal strings and catch the ones that cross to form the bottom of the heart, then they pinch and remove the thumb transversal, and return while rotating away and up between the horizontal strings. Thumbs remove index loops from below.
- Turn back of hands toward you and look down at the figure. Four strings go from the little finger transversal to the thumb transversal, two passing under the figure and two passing on the upper side of the figure. Along the little finger transversal arrange the two strings that pass under the figure so they are closest to their respective hand. Index finger picks up the portion of the little finger transversal between the two closest strings hanging from that transversal. Release little finger loops. Arrange (fig. 40).

Another of my favorite figures is Mickey Mouse (fig. 41). It is also a part of my heart series.

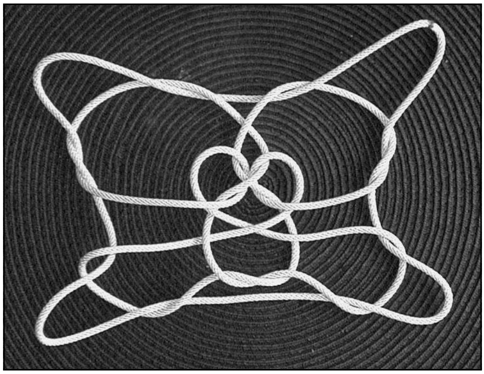

Fig. 41 - *mickey mouse*

- ldna
- index loops left dominant switch
- roll figure
- fix bottom
- both index -2/2
- last part of chopstick heart right (Exchange index loops, Clean the Top)
- roll on hands again
- spread and arrange (fig. 41)

This paper was fun to write, but barely scratches the surface of figures formed using similar methods of manufacture. i am sure i will be back with other figures.

* * *

ACKNOWLEDGMENTS

i want to thank Mark Sherman and Joe D'Antoni for going over my manuscript with a fine tooth comb. i get so wrapped up in playing with my string that i forget to be completely accurate in my notation of how to form each figure.

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