

There are many ways to approach string figures. In the literature which developed after anthropologists began recording various figures from around the world, emphasis was placed on particular methods of formation of different figures in a search for evidence concerning pre-historic contact patterns of pre-literate peoples. And until the appearance of the International String Figure Association, this tended to be the primary emphasis when becoming serious about string figures.

Under the aegis of isfa other approaches have been developed and more systematic investigations have begun. This paper is a small consideration of the consequences of the beginning of any three loop figure.

My analysis will be limited to the following:

- a) placing the strings on the hand
 - 1) opening A
 - 2) opening B
 - 3) left dna
 - 4) right dna
- b) forming a canonical figure in order to observe consequential difference
 - 1) with each of the openings above
 - 2) after spinning the index loops in various patterns
 - 3) a discussion of how the canonical figure was chosen and appropriate modifications of its manufacture in order to elucidate some tentative conclusions about the figures formed in this study

placing the strings on the hand

- 1) the opening A procedure has been described amply throughout string figure literature. My procedural analysis would be as follows:
 - a) place both thumbs into the loop of string from below
 - b) introduce the little fingers into the loop from below (this results in the formation of a palmar string)
 - c) the right hand reaches to the left palm and the right index picks up the left palmar string and returns to position
 - d) the left hand then reaches to the right palm and picks up from below the right palmar string from the center of the right index loop
- 2) the opening B procedure is exactly the same except the left hand picks up first, followed by the right hand
- 3) the right dna procedure would be as follows:
 - a) place both little fingers into the loop of string from below.
 - b) the right thumb is then introduced into the loop from above (near the left little finger) and the thumb is pulled toward oneself as the thumb is made to rotate until it is pointing upward with the string "captured" between the right thumb and the entire right hand
 - c) before pulling the hand apart the left thumb is introduced from below into the loop around the right thumb forming a transversal string on the thumbs
 - d) the hands are then pulled apart
 - e) thumb loops are transferred to the index loops maintaining relative positions (index fingers are introduced into the loops from below)
 - f) b, c, and d are performed again
- 4) the left dna procedure would be done in an analogous fashion with the left thumb leading the formation of the position with the right thumb following

a good way to check to see if you have formed the four basic starting positions correctly is to twist your hand while maintaining pressure to keep the strings taut. The palms should be maintained in a flat position vis a vis each other with the fingers stiff and straight while the left thumb goes away from you and the right thumb toward you. The following should result:

- 1) opening A should have the far index strings touching and no others
- 2) opening B should have the near index string touching and no others
- 3) right dna should have both near and far index strings touching
- 4) left dna should have no index strings touching

the canonical figure

- 1) the middle and ring fingers should be introduced into the little finger loops from above
- 2) the little fingers should be removed from these loops now held by the middle and ring fingers and then reintroduced into the same loops from above. The three fingers should now have a firm grip on the loops
- 3) the middle fingers should then become independent operators while the two lesser fingers maintain their hold.
- 4) the middle fingers should then be introduced into the thumb loops from above, hooking the far thumb strings and returning to position
- 5) the two lesser strings should drop out of the loops and then be reintroduced into them from above so all three fingers hold down the loops as before
- 6) the middle fingers should again become independent operators and pull down and away on the transverse string running under the palmar strings
- 7) the two lesser strings should drop out of the loops and then be reintroduced into them from above so all three fingers hold down the loops as before

the seven moves above results in “fixing the bottom” of the figure to be formed.

Now a katilluik maneuver will be performed as follows: (katilluik is defined by Jenness as an inuit word meaning to bring together.)

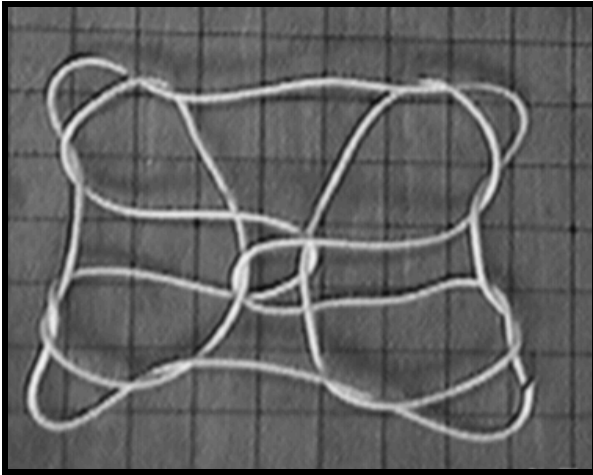
- 1) the thumbs press on the near index strings until the thumb and index control these strings and can maneuver them while holding the strings.
- 2) The near index string held in the right hand is passed behind the left near index string while the hands pass the strings to each other. (the right index loop is passed through the left loop)
- 3) The middle fingers should now become independent again until they join with the index fingers and are both able to reach back through the resulting loops to pinch the near thumb string between them
- 4) the index fingers should then curl away and point up (losing the middle finger en route) and fixing the top of the figure.

When the figure is formed from an opening A position there should be two wraps formed in the center of the figure, top and bottom. These are a consequence of the katilluik maneuver. Another way of seeing this consequence is to test the four opening procedures by dropping the index loops. The two dna openings should result in a wrap and the openings A and B should not.

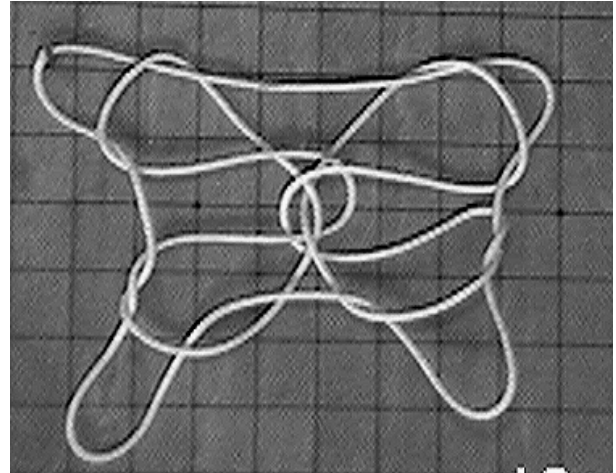
The investigation per se should proceed according to the matrix below:

| opening | index spin | index spin | index spin | index spin | index spin |
|-----------|------------|------------|------------|------------|------------|
| A | 0 | -1/2 | +1/2 | -2/2 | +2/2 |
| B | 0 | -1/2 | +1/2 | -2/2 | +2/2 |
| left dna | 0 | -1/2 | +1/2 | -2/2 | +2/2 |
| right dna | 0 | -1/2 | +1/2 | -2/2 | +2/2 |

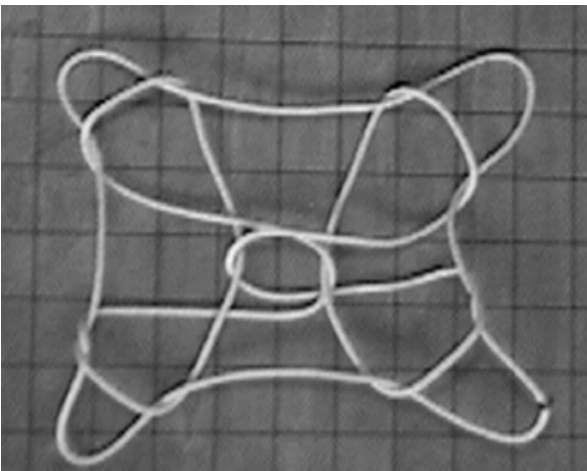
The following figures should result:



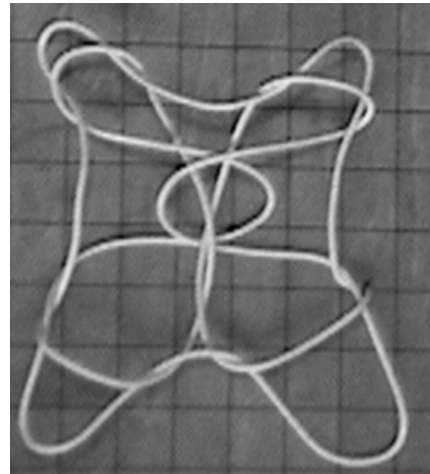
opening A plus $\frac{1}{2}$



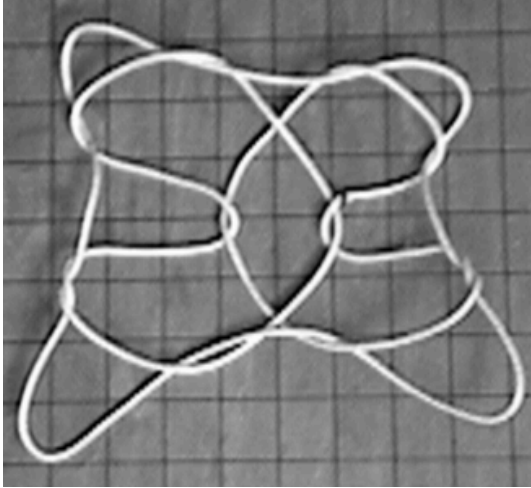
opening B plus $\frac{1}{2}$



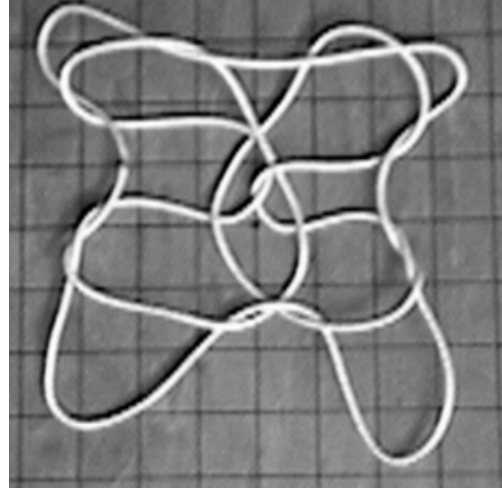
left dna plus $\frac{1}{2}$



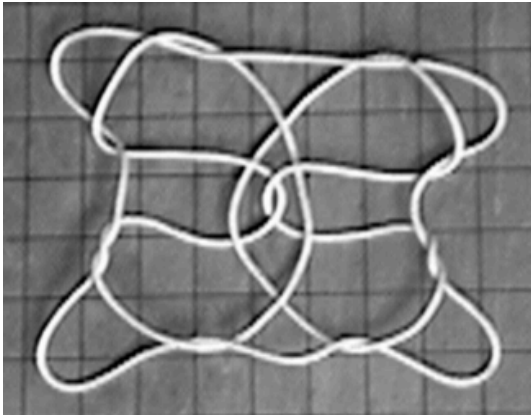
right dna plus $\frac{1}{2}$



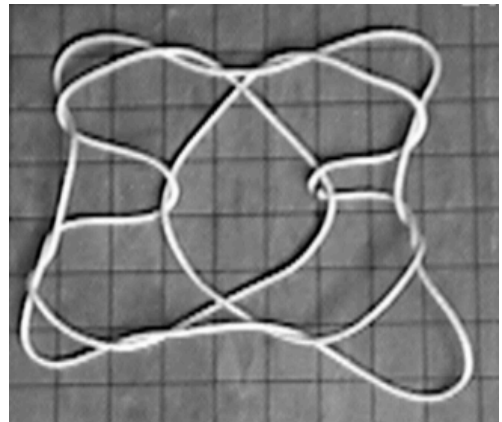
opening A -1/2



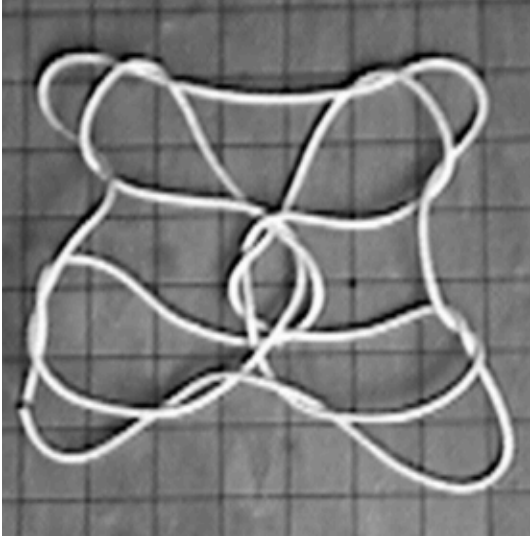
opening B -1/2



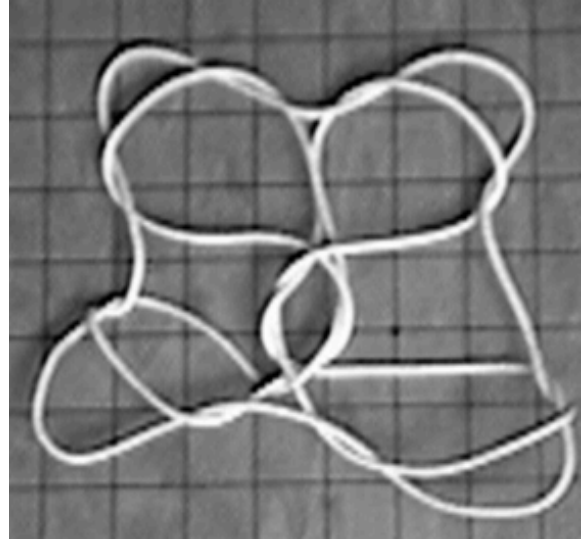
left dna -1/2



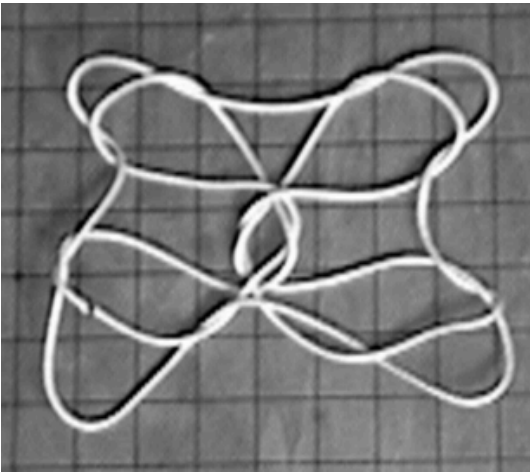
right dna -1/2



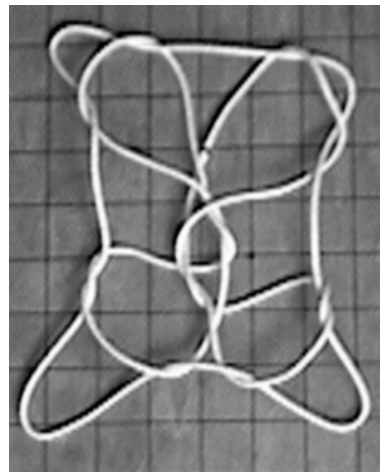
opening A $+2/2$



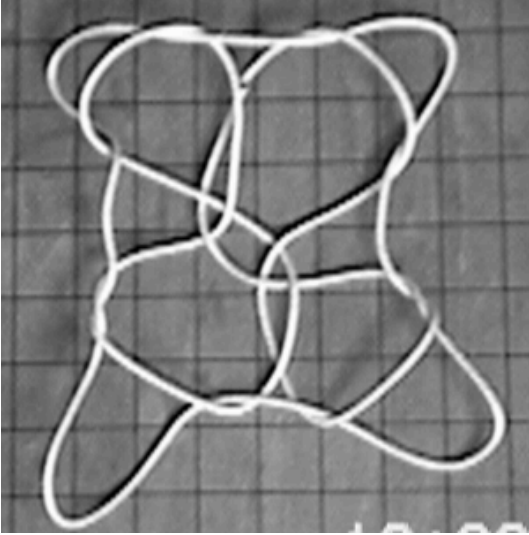
opening B $+2/2$



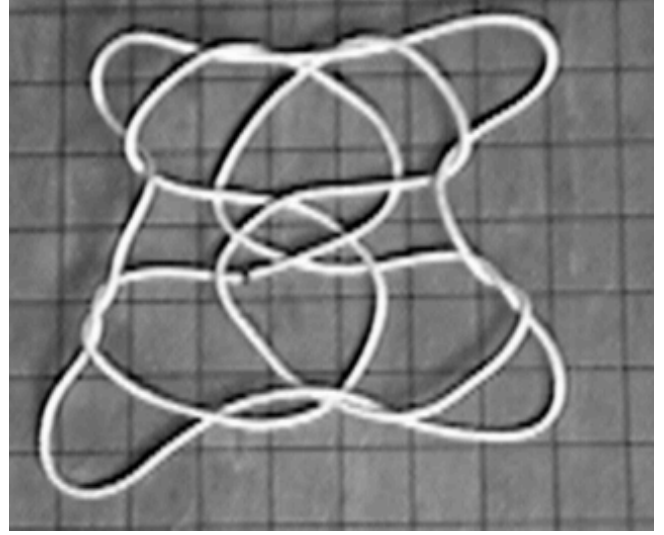
left dna $+2/2$



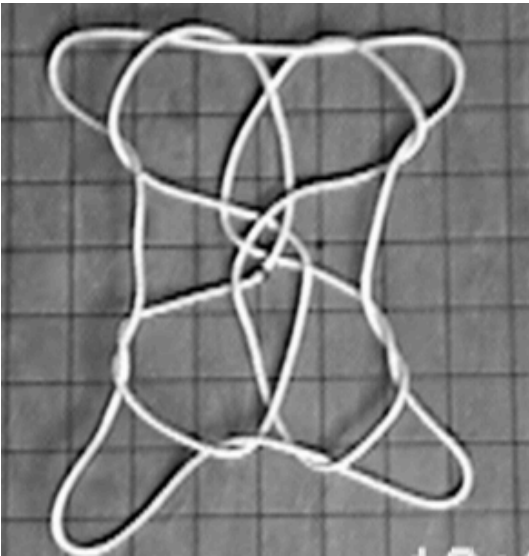
right dna $+2/2$



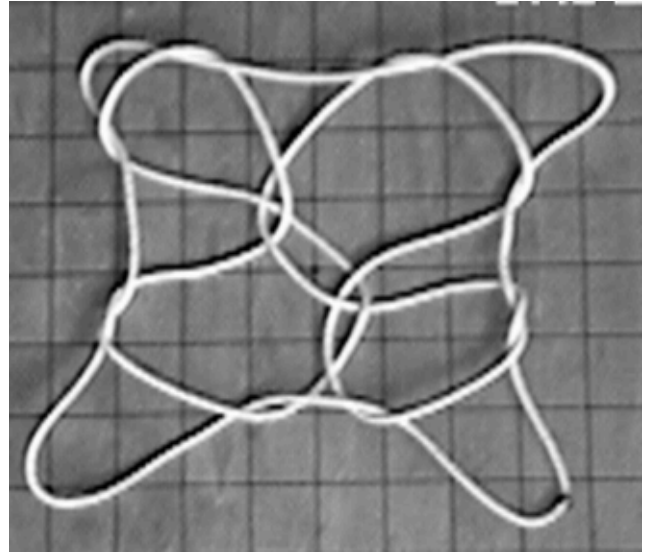
opening A $-2/2$



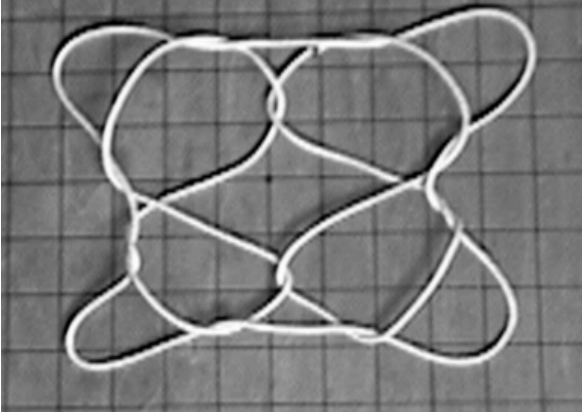
opening B $-2/2$



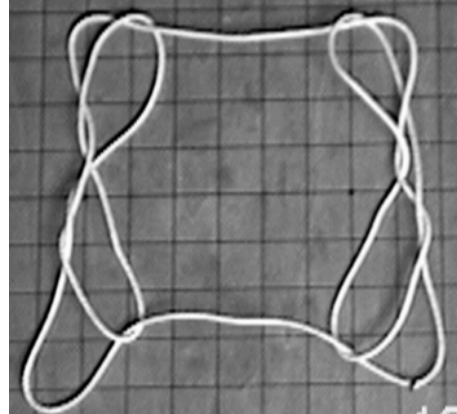
left dna $-2/2$



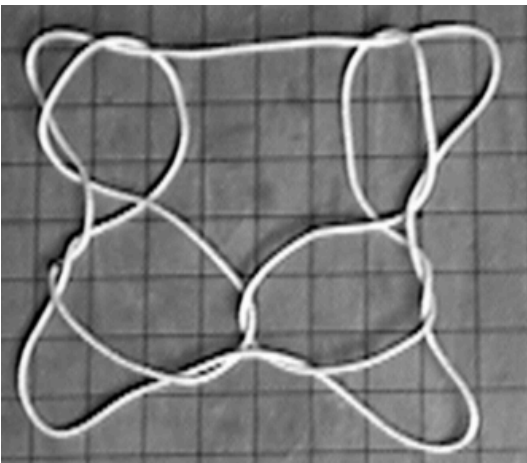
right dna $-2/2$



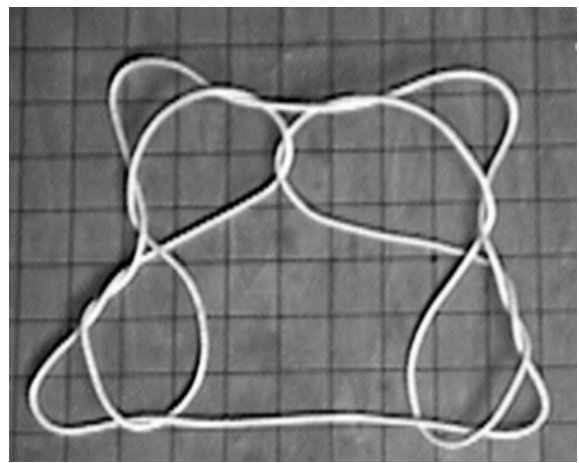
opening A no spin



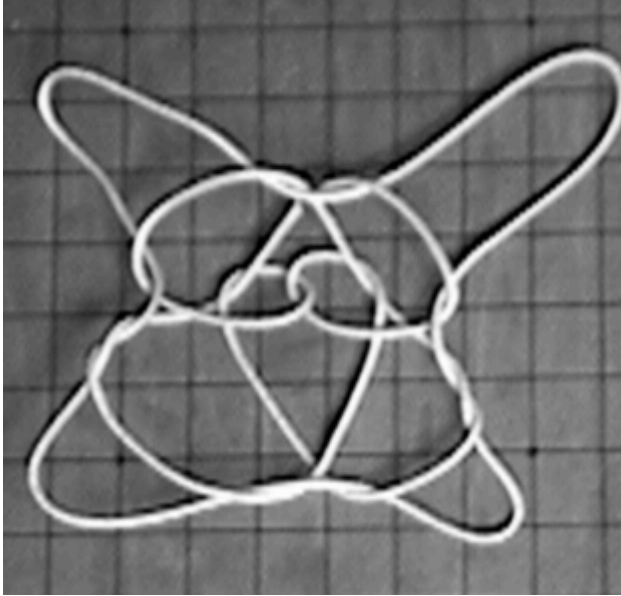
opening B no spin



left dna no spin

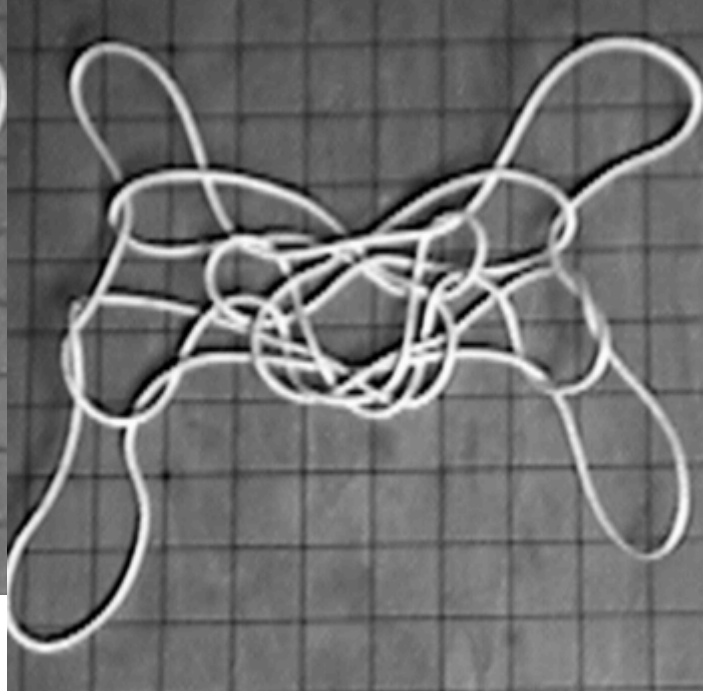


right dna no spin



left dna heart

The figure above is formed exactly as the left dna $-1/2$ figure except the index fingers pick up the far index strings where they cross in the center before the loops are katilluiked.



left dna mickey

the figure above is formed from the left dna $-1/2$ beginning. Then the first inuit net move is made followed by a modified second inuit net move. This is accomplished by reaching under both index loops and pulling the far loop under the near loop until the thumbs can go back over the near index string to pick up the far little finger string to return to position. drop little finger loops, and rotate middle finger loops $+1/2$ onto little fingers. Then proceed as all above figures (except for heart).

After looking over the evidence of the figures above, it should be evident that there is a basic division in the consequences of the openings caused by the choice of leading hand. So opening A and right dna are pairs and opening B and left dna are pairs in their over-all consequences. I feel that the opening A sequence is the most interesting for my purposes of further analysis, since the double wrap center of the non-spin opening A figure gives a semi-symmetrical center.

A word or two should be entered here concerning chirality. We live in a four dimensional universe and thus have handedness, or chirality as a constant companion. Our two hands can be matched as mirror images by placing the palms together, but they exhibit asymmetry when place one on top of the other since the thumbs lie on the opposite sides of the "pancake". Another way of saying the same thing is that the double center wraps can be achieved from the opening B position using the canonical operations listed above with the sole exception of forming the katilluik move by passing the left near index string behind the right near index string (passing the left loop through the right loop and changing no other part of the manufacturing process. A good test of your growing sense of the consequences of chirality is to discern if any difference occurs between the two figures!

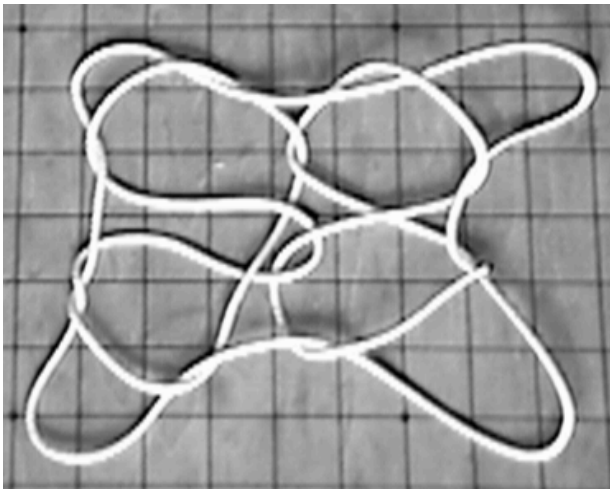
Now I would like to modify my procedures somewhat to include the following options of the openings.

- I. The two dna openings are not modifiable in the way I will suggest.
- II. The other two openings can be modified in a two different consequential procedures
 - a. by twisting the strings as they are picked up by the index fingers
 1. $+1/2$ and $-1/2$ twists are achieved by inserting the index fingers from above and twisting back to the normal attitude of the
 2. index fingers pointing upward
 3. $+2/2$ and $-2/2$ twists are achieved by inserting the index fingers from below and twisting one whole time to get back to the normal attitude of the index fingers pointing upward
 - b. by picking up the second string not in the center of the first index loop but to the thumb (or near side) of the loop or the little finger (or far side) of the loop

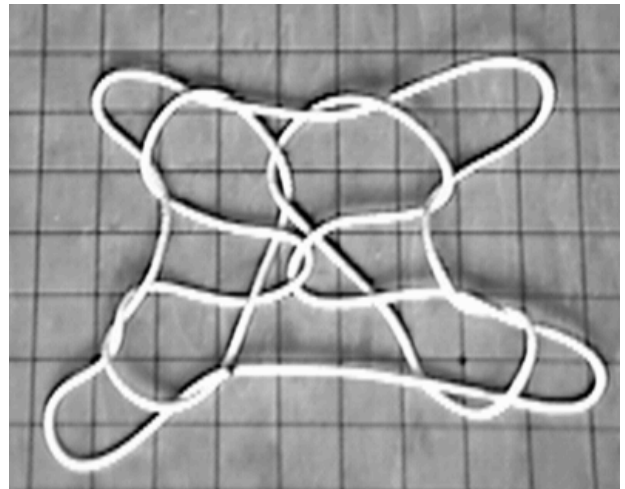
I will limit my inquiry to variations formed with the opening A (or right index picking up first) family of figures thus formed. Consequential differences should be seen when the following are tried:

1. picking up secondly in center
 - a. $+1/2$ spin first (note spinning the second loop without spinning the first does not differ from spinning the second loop after forming the original opening A!)
 1. second pick up $+1/2$ spin
 2. second pick up $-1/2$ spin
 3. $+2/2$
 4. $-2/2$
 - b. $-1/2$ spin first
 - 1 through 4 as above
 - c. $+2/2$ spin first
 - 1 through 4 as above
 - d. $-2/2$ spin first
 - 1 through 4 as above
2. picking up secondly on thumb or near side
 - a through d as above (note that the second pick up can now be done without spin and consequential difference occurs and that a zero spin opening pick up now matters also!)
3. picking up secondly on little finger or far side
 - a through d as before (note that the second pick up can now be done without spin and consequential difference occurs and that a zero spin first pick up now matters also!)

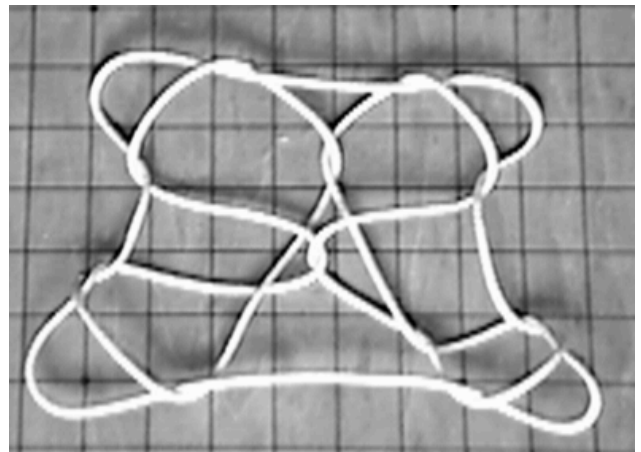
| first pick up | second pick up |
|-----------------|-----------------|
| $+ \frac{1}{2}$ | 0 |
| $+ \frac{1}{2}$ | $+ \frac{1}{2}$ |
| $+ \frac{1}{2}$ | $- \frac{1}{2}$ |
| $+ \frac{1}{2}$ | $+ \frac{2}{2}$ |
| $+ \frac{1}{2}$ | $- \frac{2}{2}$ |



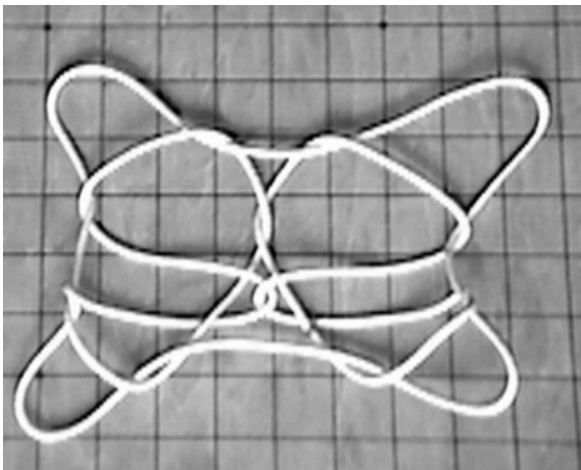
$+ \frac{1}{2} 0$



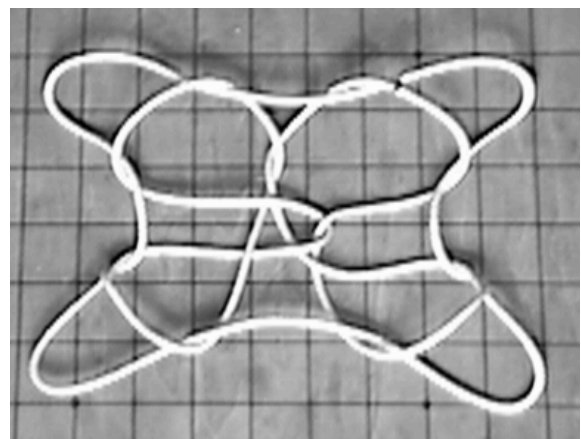
$+ \frac{1}{2} - \frac{1}{2}$



$+ \frac{1}{2} + \frac{2}{2}$

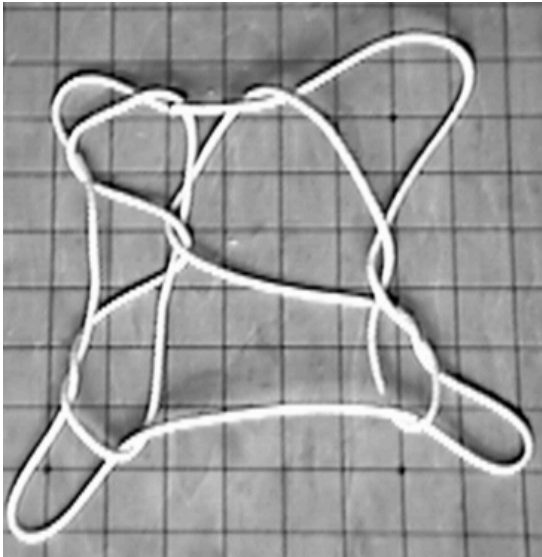


$+ \frac{1}{2} + \frac{1}{2}$

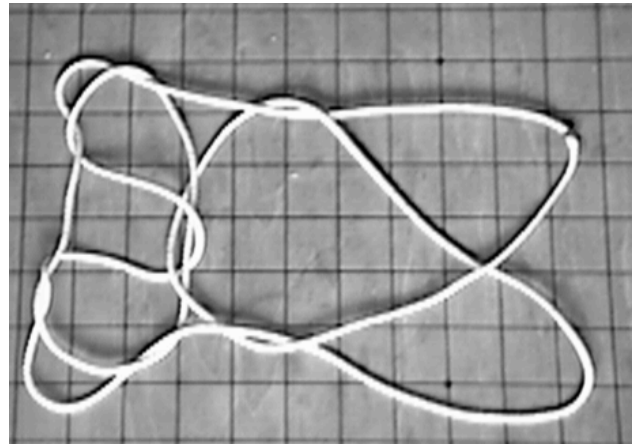


$+ \frac{1}{2} - \frac{2}{2}$

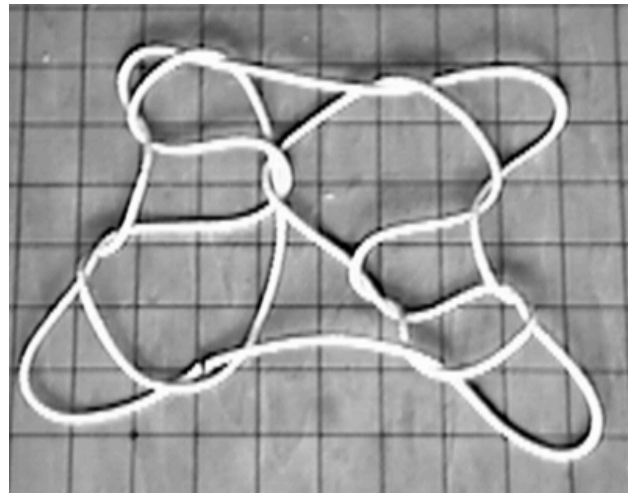
| first pick up | second pick up |
|-----------------|----------------------|
| $+ \frac{1}{2}$ | near 0 |
| $+ \frac{1}{2}$ | near $+ \frac{1}{2}$ |
| $+ \frac{1}{2}$ | near $- \frac{1}{2}$ |
| $+ \frac{1}{2}$ | near $+ \frac{2}{2}$ |
| $+ \frac{1}{2}$ | near $- \frac{2}{2}$ |



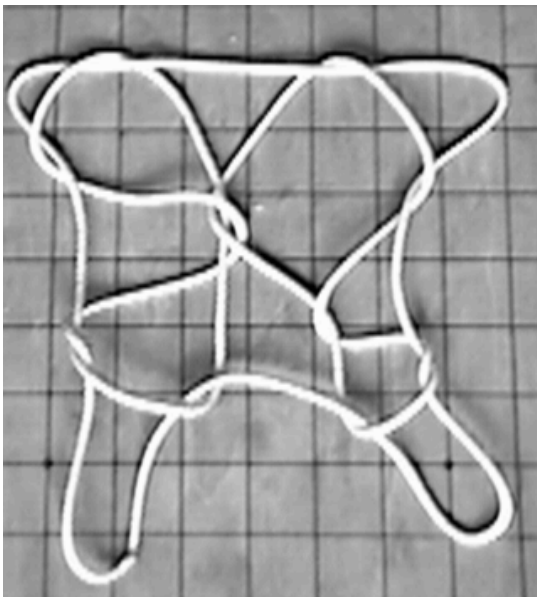
$+ \frac{1}{2}$ near 0



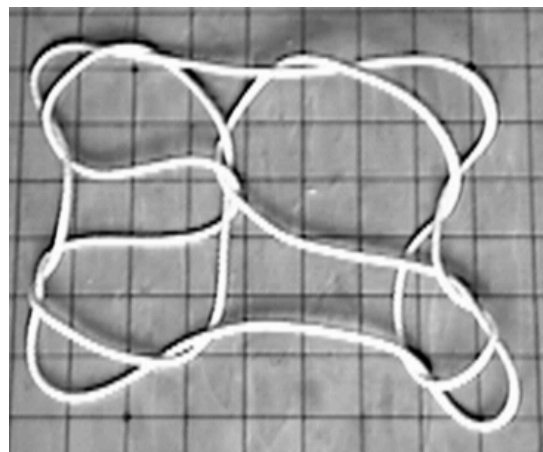
$+ \frac{1}{2}$ near $- \frac{1}{2}$



$+ \frac{1}{2}$ near $+ \frac{2}{2}$

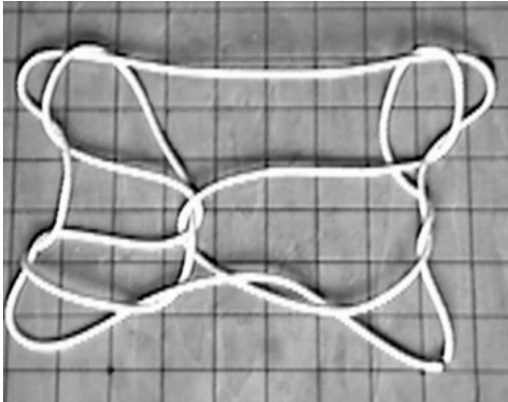


$+ \frac{1}{2}$ near $+ \frac{1}{2}$

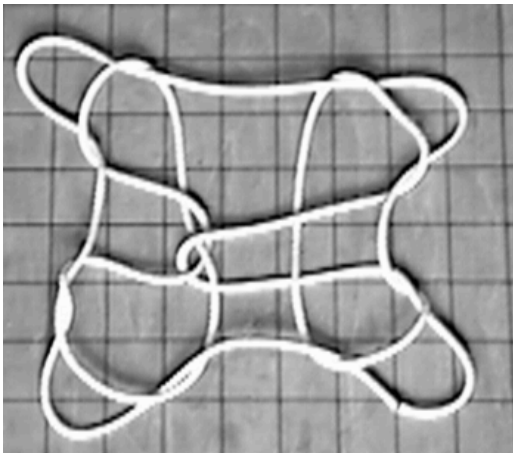


$+ \frac{1}{2}$ near $- \frac{2}{2}$

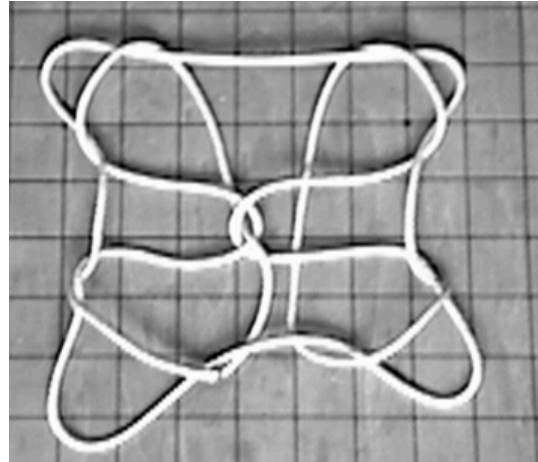
| first pick up | second pick up |
|-----------------|---------------------|
| $+ \frac{1}{2}$ | far 0 |
| $+ \frac{1}{2}$ | far $+ \frac{1}{2}$ |
| $+ \frac{1}{2}$ | far $- \frac{1}{2}$ |
| $+ \frac{1}{2}$ | far $+ \frac{2}{2}$ |
| $+ \frac{1}{2}$ | far $- \frac{2}{2}$ |



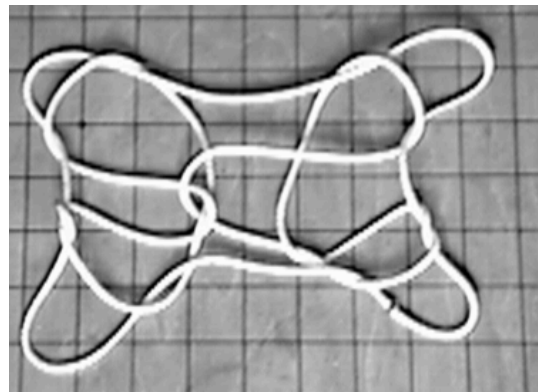
$+ \frac{1}{2}$ far 0



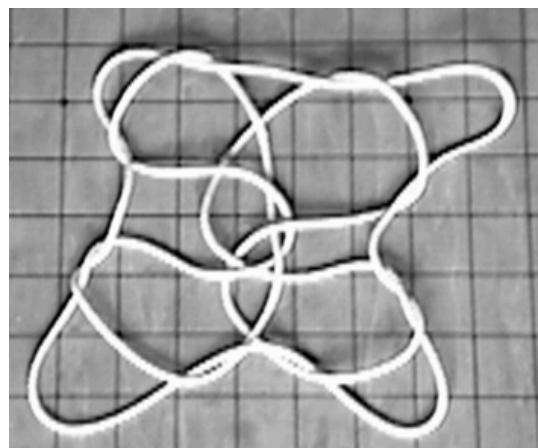
$+ \frac{1}{2}$ far $+ \frac{1}{2}$



$+ \frac{1}{2}$ far $- \frac{1}{2}$

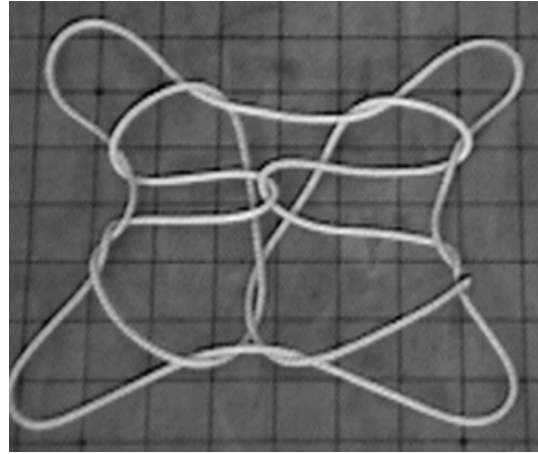


$+ \frac{1}{2}$ far $+ \frac{2}{2}$

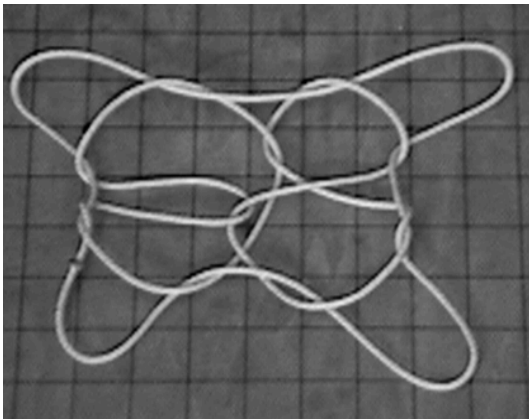


$+ \frac{1}{2}$ far $- \frac{2}{2}$

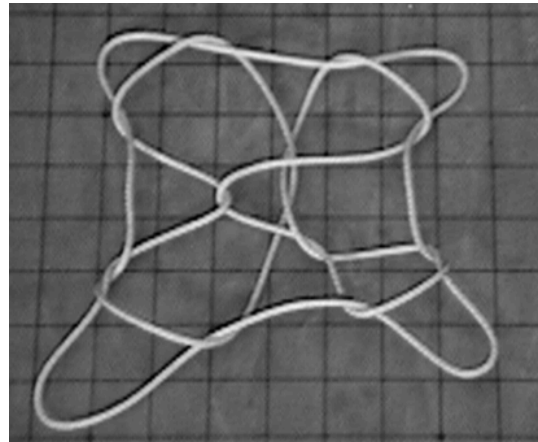
| first pick up | second pick up |
|----------------|----------------|
| $-\frac{1}{2}$ | 0 |
| $-\frac{1}{2}$ | $+\frac{1}{2}$ |
| $-\frac{1}{2}$ | $-\frac{1}{2}$ |
| $-\frac{1}{2}$ | $+\frac{2}{2}$ |
| $-\frac{1}{2}$ | $-\frac{2}{2}$ |



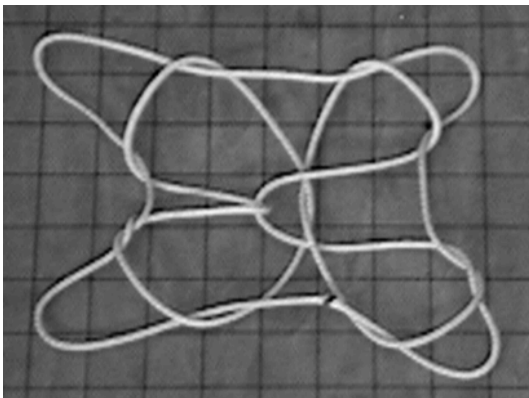
$-\frac{1}{2} - \frac{1}{2}$



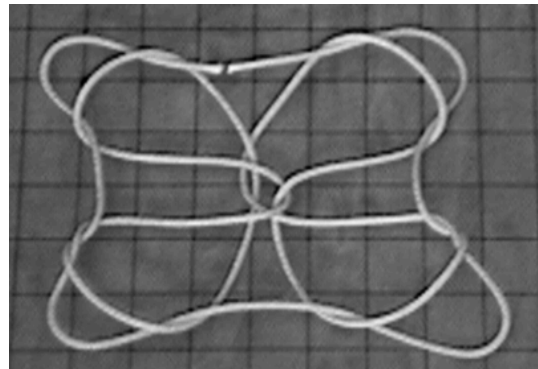
$-\frac{1}{2} 0$



$-\frac{1}{2} + \frac{2}{2}$



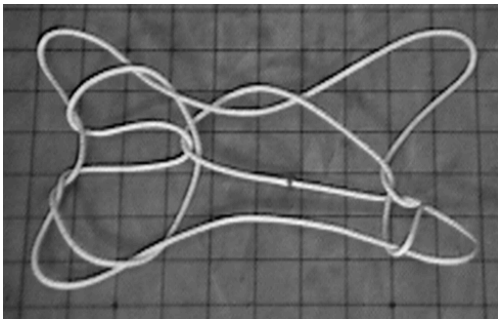
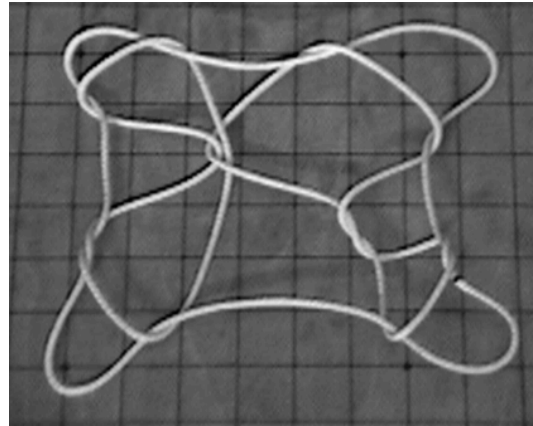
$-\frac{1}{2} + \frac{1}{2}$



$-\frac{1}{2} - \frac{2}{2}$

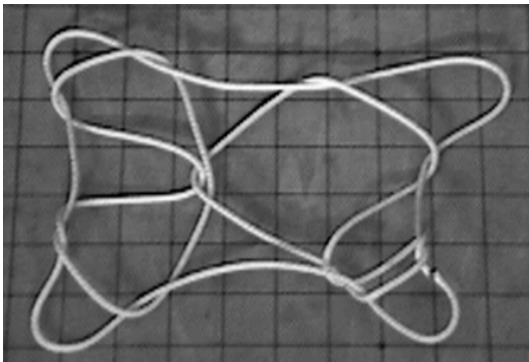
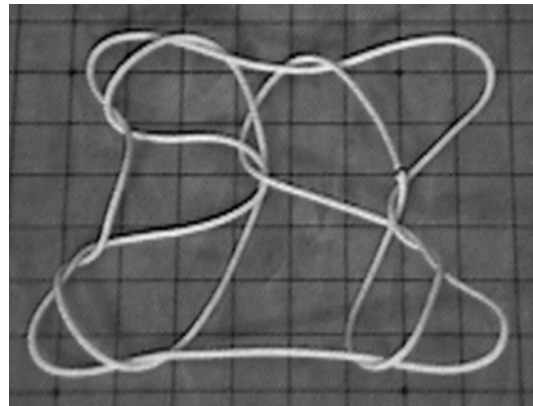
| first pick up | second pick up |
|----------------|---------------------|
| $-\frac{1}{2}$ | near 0 |
| $-\frac{1}{2}$ | near $+\frac{1}{2}$ |
| $-\frac{1}{2}$ | near $-\frac{1}{2}$ |
| $-\frac{1}{2}$ | near $+\frac{2}{2}$ |
| $-\frac{1}{2}$ | near $-\frac{2}{2}$ |

$-\frac{1}{2}$ near $-\frac{1}{2}$



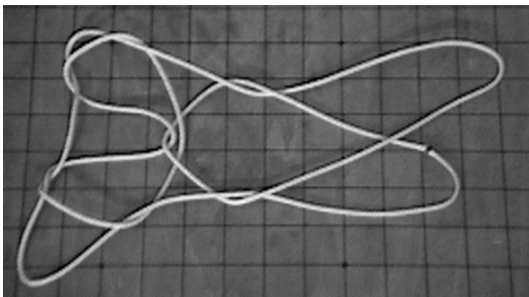
$-\frac{1}{2}$ near 0

$-\frac{1}{2}$ near $+\frac{2}{2}$

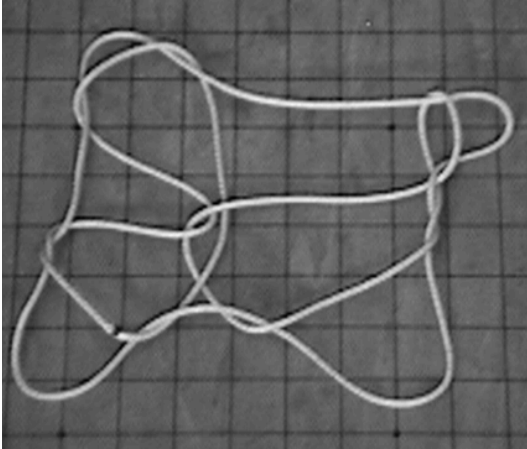


$-\frac{1}{2}$ near $+\frac{1}{2}$

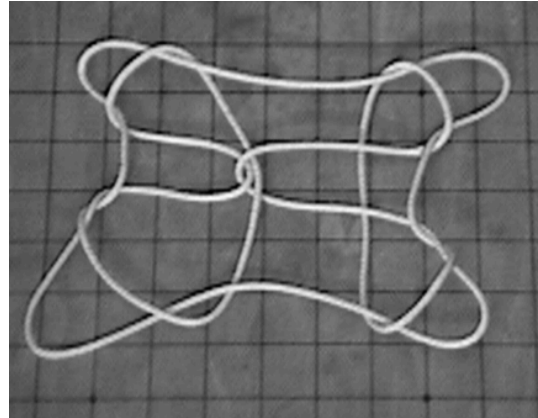
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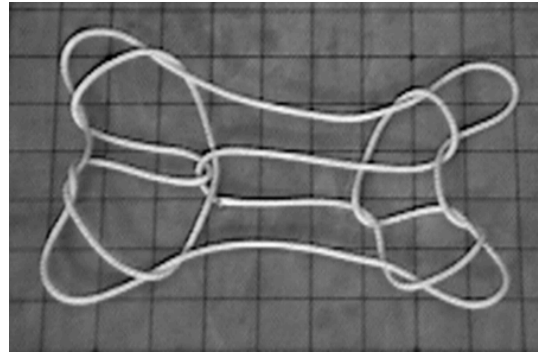
| first pick up | second pick up |
|----------------|--------------------|
| $-\frac{1}{2}$ | far 0 |
| $-\frac{1}{2}$ | far $+\frac{1}{2}$ |
| $-\frac{1}{2}$ | far $-\frac{1}{2}$ |
| $-\frac{1}{2}$ | far $+\frac{2}{2}$ |
| $-\frac{1}{2}$ | far $-\frac{2}{2}$ |



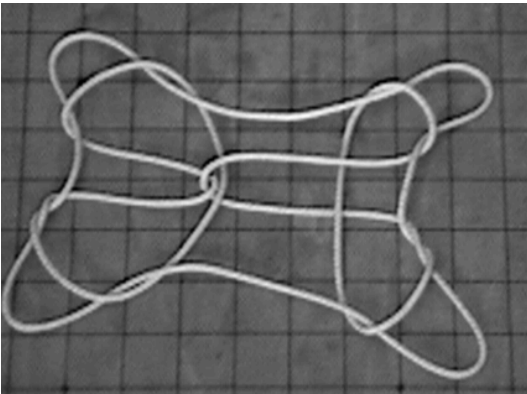
$-\frac{1}{2}$ far 0



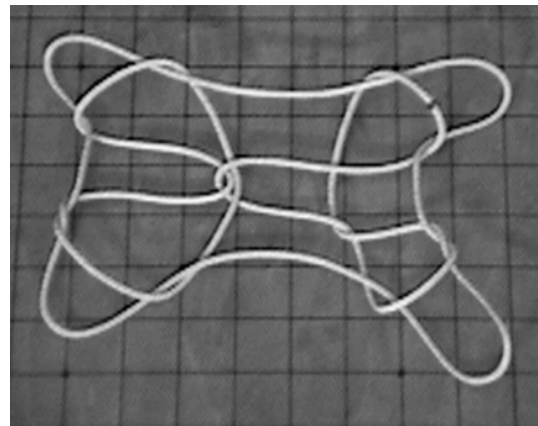
$-\frac{1}{2}$ far $-\frac{1}{2}$



$-\frac{1}{2}$ far $+\frac{2}{2}$

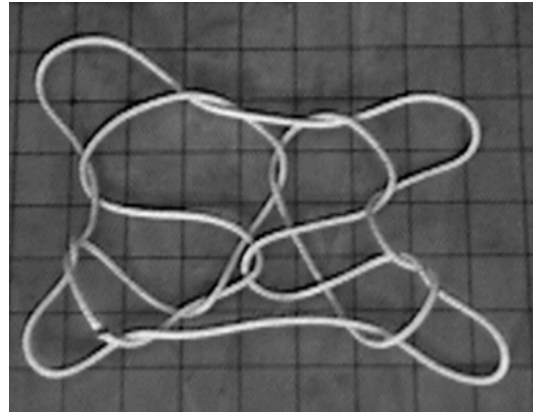


$-\frac{1}{2}$ far $+\frac{1}{2}$

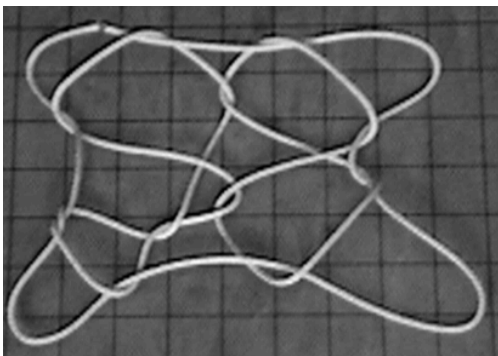


$-\frac{1}{2}$ far $-\frac{2}{2}$

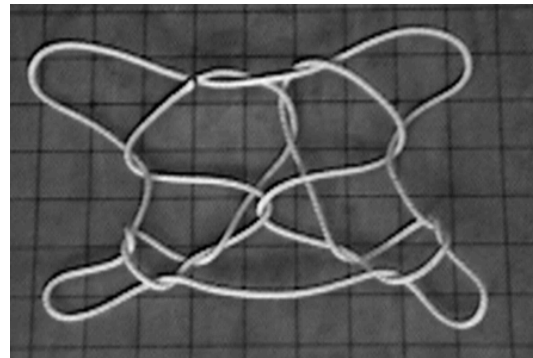
| first pick up | second pick up |
|---------------|----------------|
| $+ 2/2$ | 0 |
| $+ 2/2$ | $+ 1/2$ |
| $+ 2/2$ | $- 1/2$ |
| $+ 2/2$ | $+ 2/2$ |
| $+ 2/2$ | $- 2/2$ |



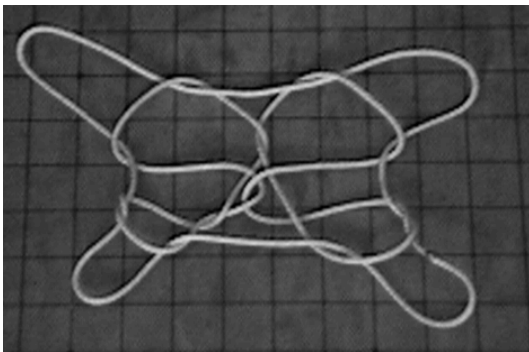
$$+ 2/2 - 1/2$$



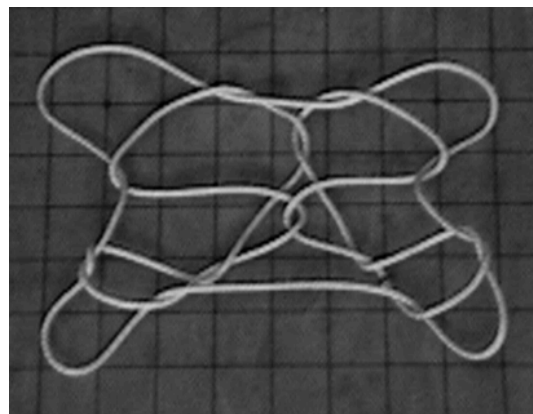
$$+ 2/2 0$$



$$+ 2/2 + 2/2$$

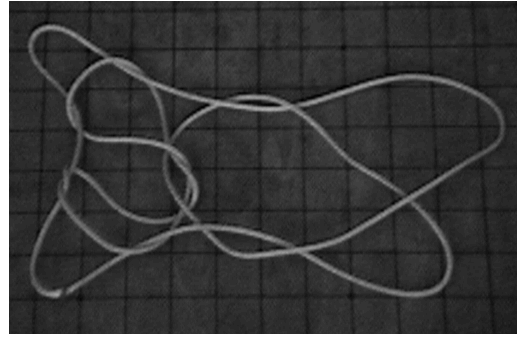


$$+ 2/2 + 1/2$$

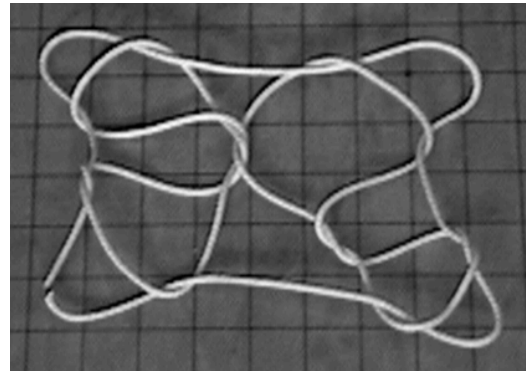


$$+ 2/2 - 2/2$$

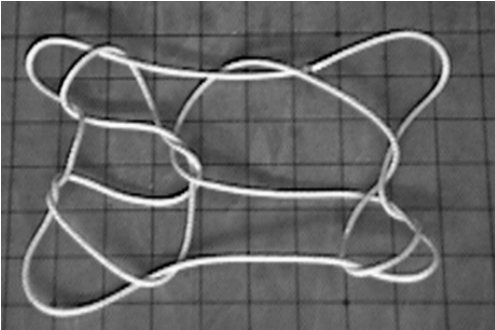
| first pick up | second pick up |
|---------------|----------------|
| + 2/2 | near 0 |
| + 2/2 | near + 1/2 |
| + 2/2 | near - 1/2 |
| + 2/2 | near + 2/2 |
| + 2/2 | near - 2/2 |



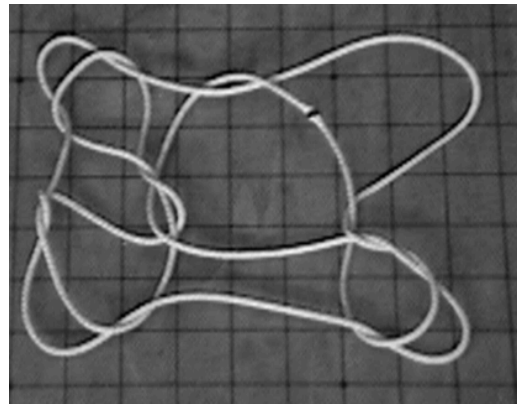
+ 2/2 near - 1/2



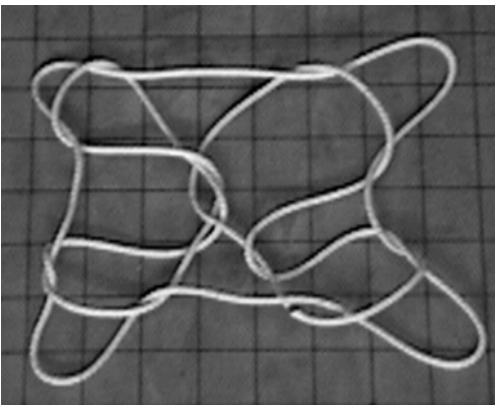
+ 2/2 near + 2/2



+ 2/2 near 0

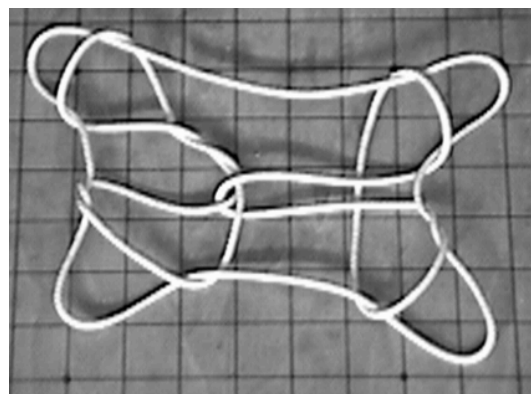


+ 2/2 near - 2/2

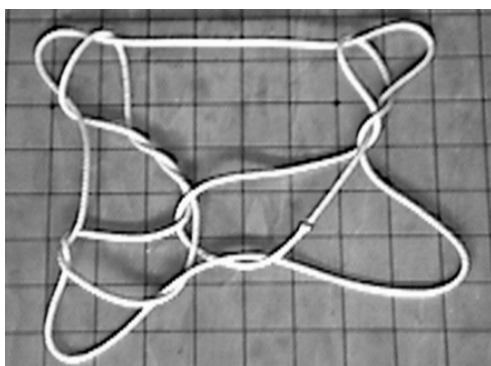


+ 2/2 near + 1/2

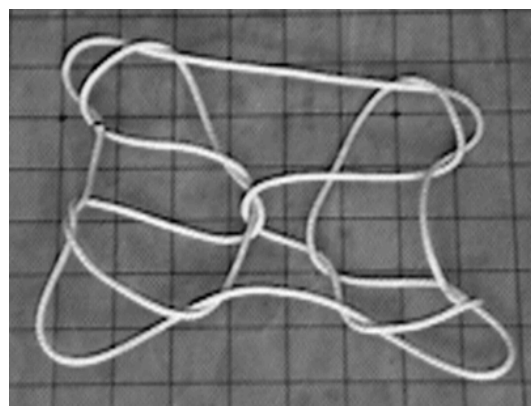
| first pick up | second pick up |
|---------------|----------------|
| + 2/2 | far 0 |
| + 2/2 | far + 1/2 |
| + 2/2 | far - 1/2 |
| + 2/2 | far + 2/2 |
| + 2/2 | far - 2/2 |



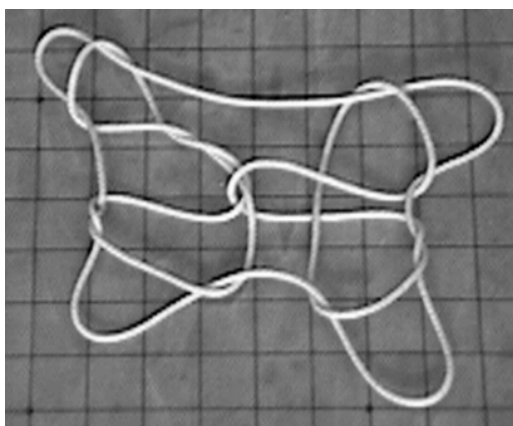
+ 2/2 far - 1/2



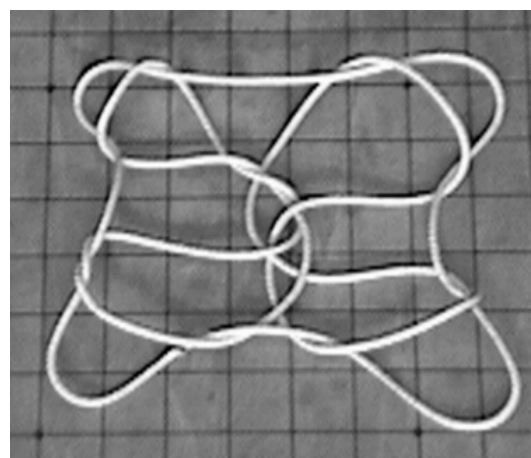
+ 2/2 far 0



= 2/2 far + 2/2

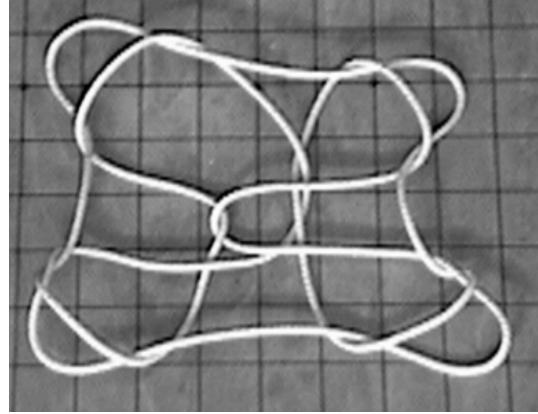


+ 2/2 far + 1/2

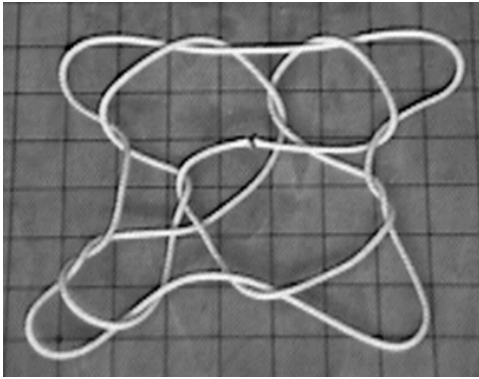


+ 2/2 far - 2/2

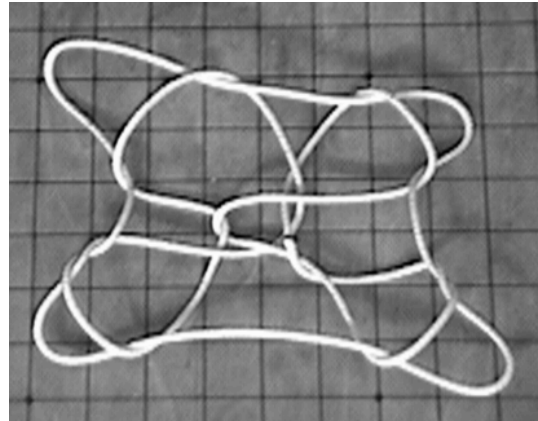
| first pick up | second pick up |
|---------------|----------------|
| - 2/2 | 0 |
| - 2/2 | + 1/2 |
| - 2/2 | - 1/2 |
| - 2/2 | + 2/2 |
| - 2/2 | - 2/2 |



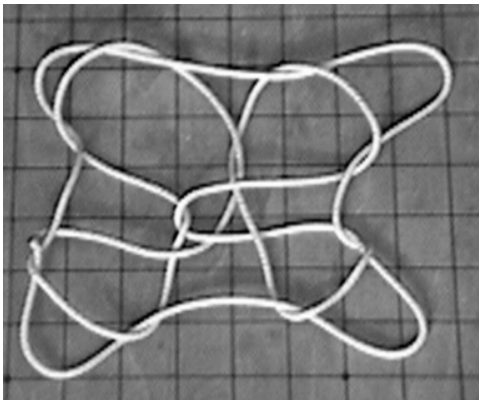
- 2/2 - 1/2



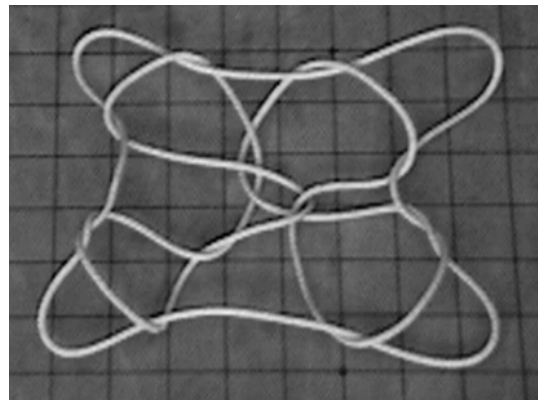
- 2/2 0



- 2/2 + 2/2

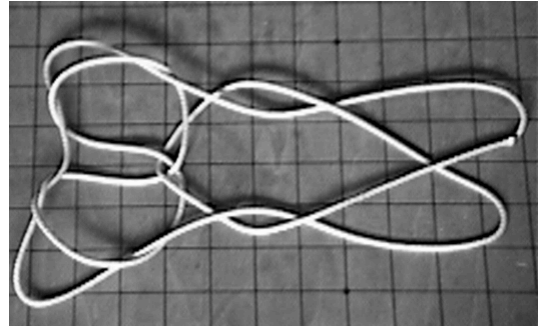


- 2/2 + 1/2

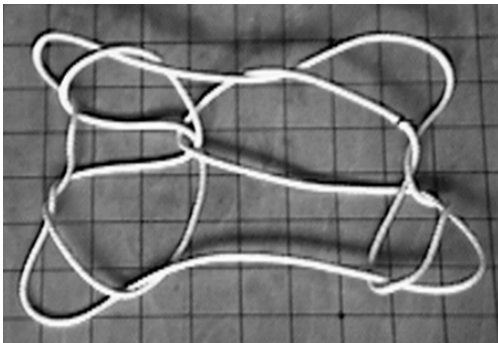


- 2/2 - 2/2

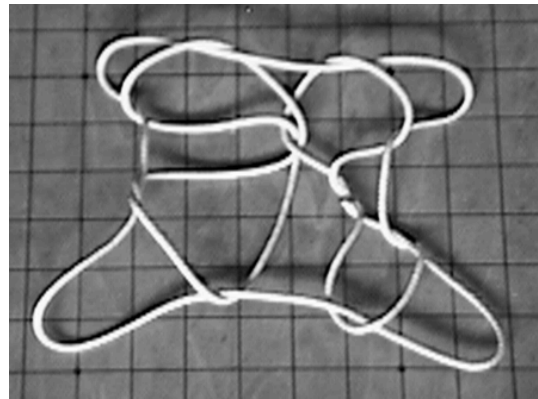
| first pick up | second pick up |
|---------------|----------------|
| - 2/2 | near 0 |
| - 2/2 | near + 1/2 |
| - 2/2 | near - 1/2 |
| - 2/2 | near + 2/2 |
| - 2/2 | near - 2/2 |



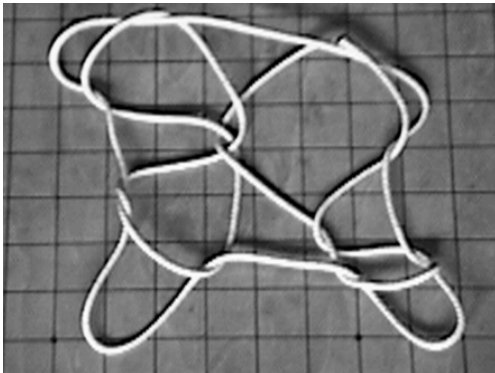
- 2/2 near - 1/2



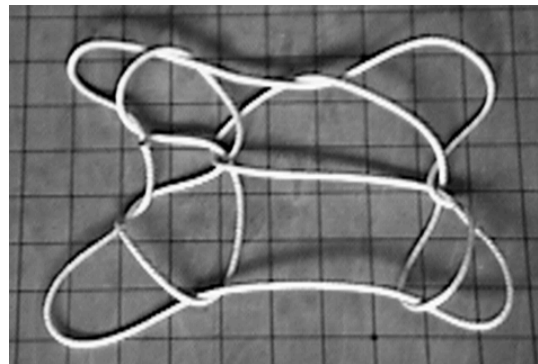
- 2/2 near 0



- 2/2 near + 2/2

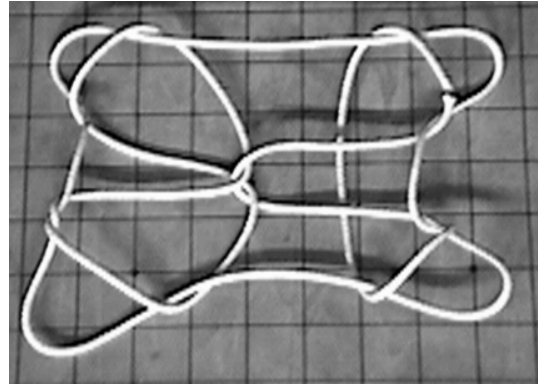


- 2/2 near + 1/2

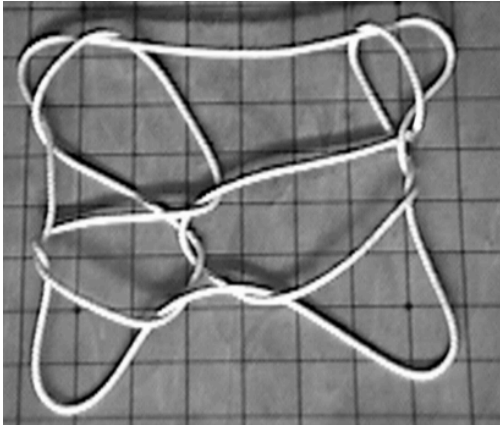


- 2/2 near - 2/2

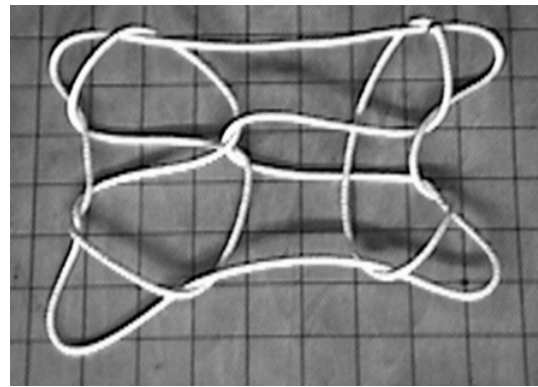
| first pick up | second pick up |
|---------------|----------------|
| - 2/2 | far 0 |
| - 2/2 | far + 1/2 |
| - 2/2 | far - 1/2 |
| - 2/2 | far + 2/2 |
| - 2/2 | far - 2/2 |



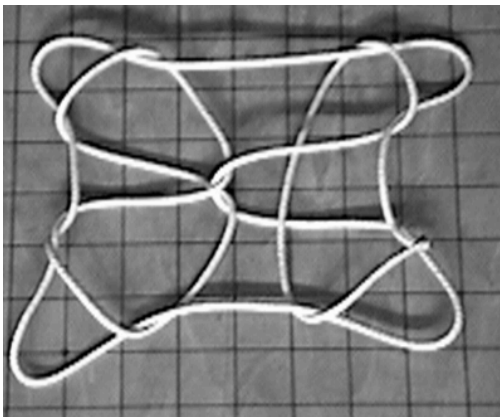
- 2/2 far - 1/2



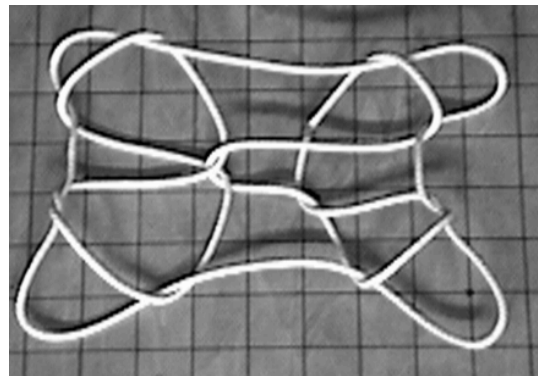
- 2/2 far 0



- 2/2 far + 2/2

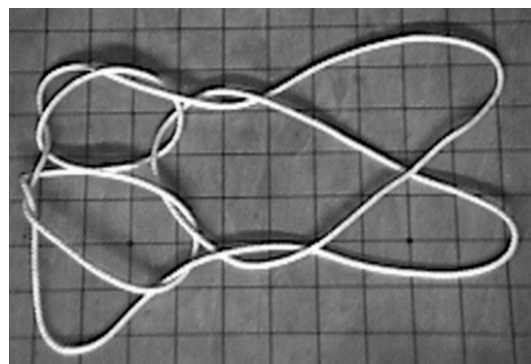


- 2/2 far + 1/2

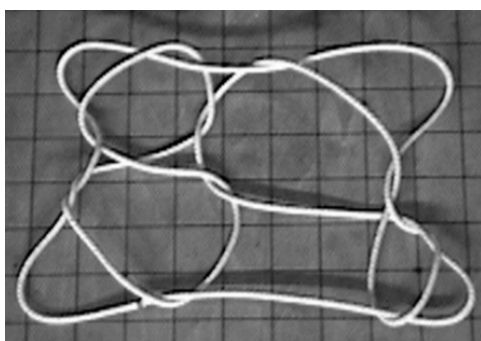


- 2/2 far - 2/2

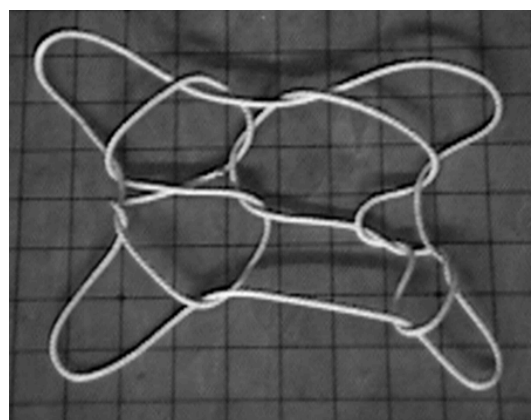
| first pick up | second pick up |
|---------------|----------------------|
| 0 | near 0 |
| 0 | near + $\frac{1}{2}$ |
| 0 | near - $\frac{1}{2}$ |
| 0 | near + $\frac{2}{2}$ |
| 0 | near - $\frac{2}{2}$ |



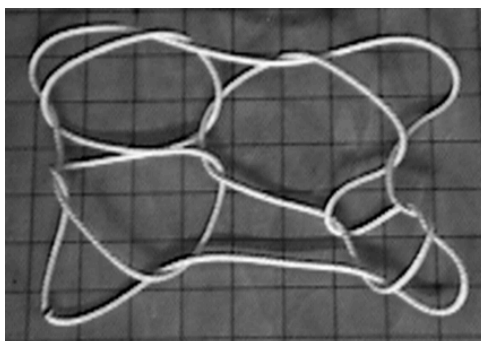
0 near - $\frac{1}{2}$



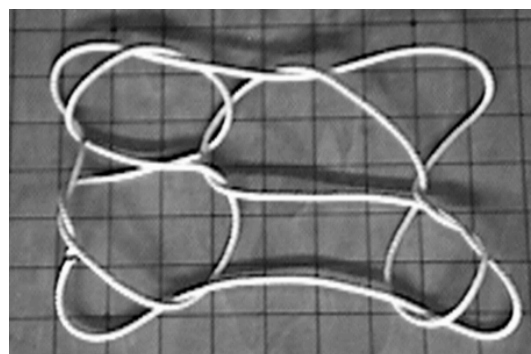
0 near 0



0 near + $\frac{2}{2}$

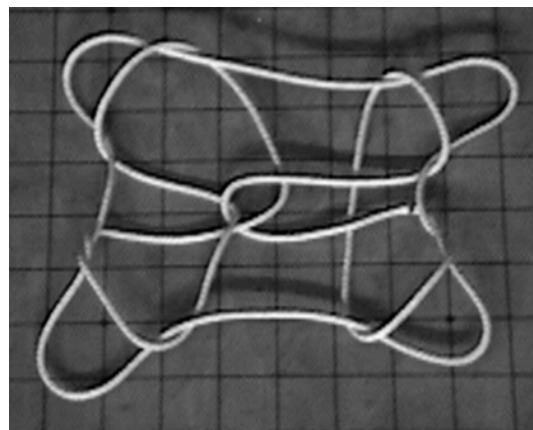


0 near + $\frac{1}{2}$

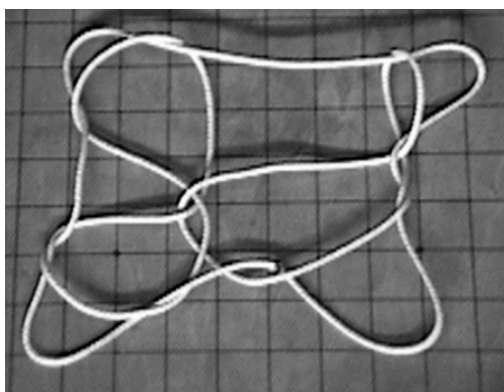


0 near - $\frac{2}{2}$

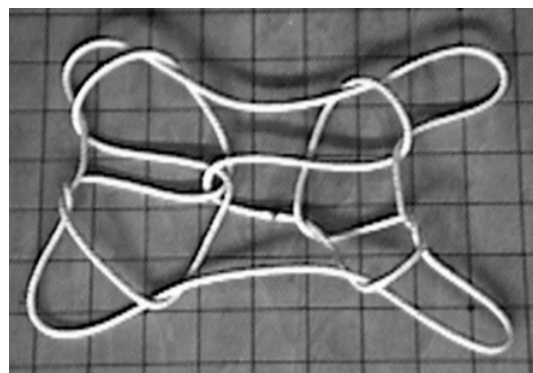
| first pick up | second pick up |
|---------------|---------------------|
| 0 | far 0 |
| 0 | far + $\frac{1}{2}$ |
| 0 | far - $\frac{1}{2}$ |
| 0 | far + $\frac{2}{2}$ |
| 0 | far - $\frac{2}{2}$ |



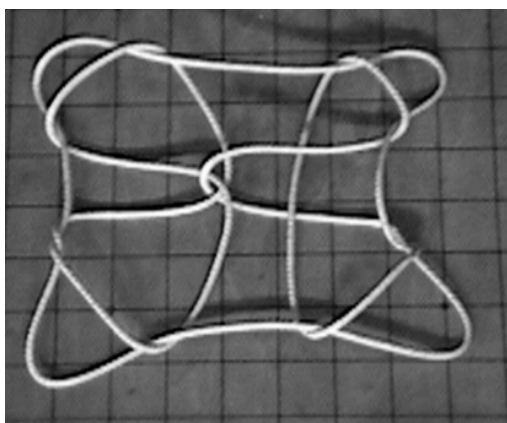
0 far - $\frac{1}{2}$



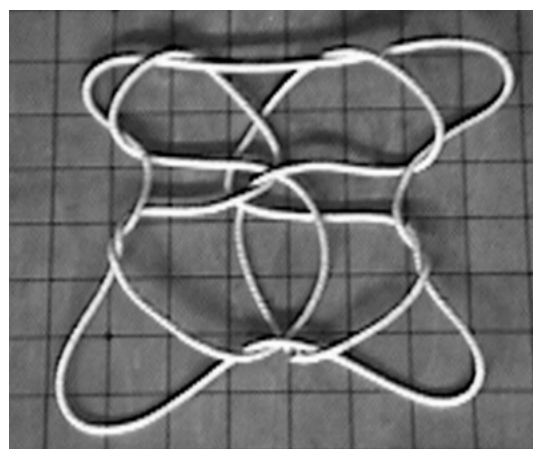
0 far 0



0 far + $\frac{2}{2}$

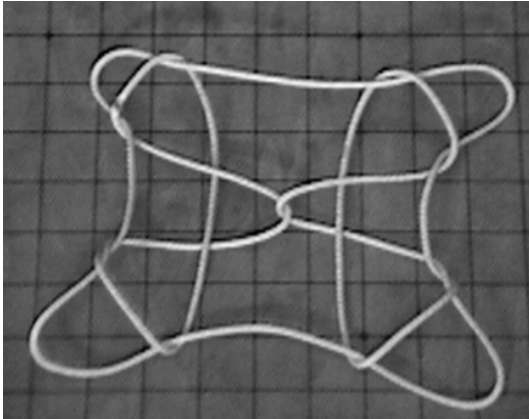


0 far + $\frac{1}{2}$



0 far - $\frac{2}{2}$

While studying the above array of figures, it amused me to consider whether i could improve on the figure - $\frac{1}{2}$ - $\frac{1}{2}$. This figure was intriguing because it had a full split between the two loops wrapped in the front of the figure (as viewed by the maker of the figure) and the two loops wrapped in the back. Could i find a way to

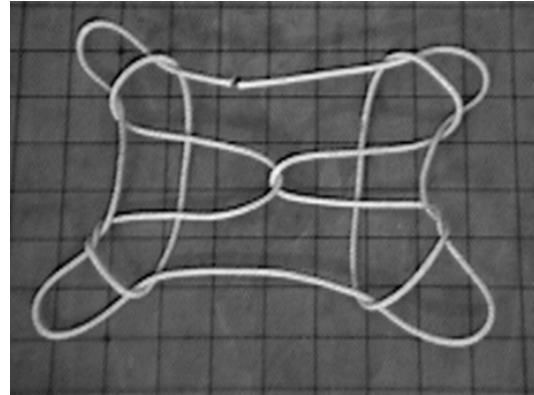


This figure seems to work, but you will notice that the vertical strings in the central area of the figure are captured by the two wrapped loops of the center. This solves the first part of my objective. The loops wrapped in the back of figure - $\frac{1}{2}$ - $\frac{1}{2}$ are now unwrapped, but the division of the figure front and back is not achieved. The preparation of the loom for this figure was:

1. left dna
2. thumb loops carried under index loops and up through little finger loops
3. little finger loops carried under index loops and taken by the thumbs

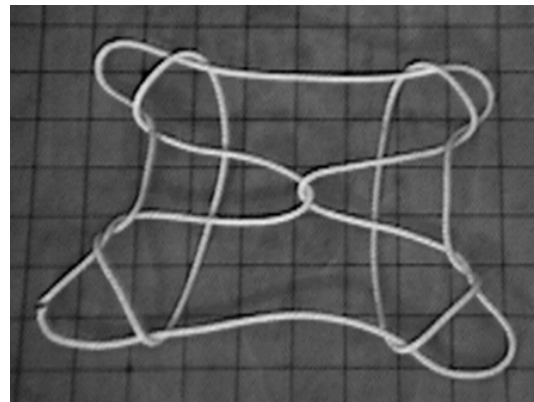
These complex maneuvers effectively switched the thumb and little finger loops on the hands, and immediately suggested investigating all the ways of switching the loops (and even trying the system with the left dna beginning!

make the two figures in the back *not* wrap. The effect should make a pleasant figure, but could i accomplish this using the canonical figure of this paper with a modified opening A procedure? i set to work.



And appropriately enough the next try produced the desired figure. Note both vertical strings are completely behind the wrapped loops. This was accomplished by having the little finger loops come under the index loops and up through the thumb loops while the loops were switched in position.

And i then proceeded to finish the series as follows:

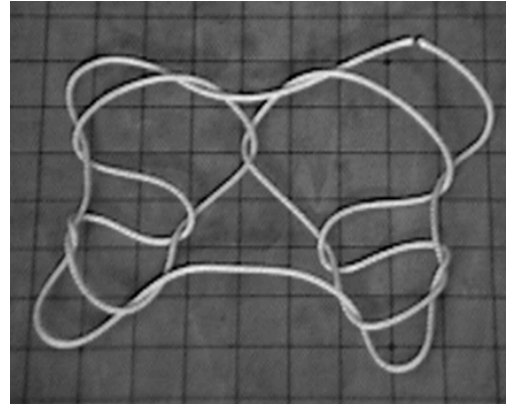


When i made the thumb loops go over the index loops and then down through the little finger loops, i found the figure needed to be “rolled over the hand” in order to simplify the loom sufficiently to correlate with the other figures. So after switching the thumb and little finger loops i rotated the entire loom as follows before i performed the canonical algorithm.

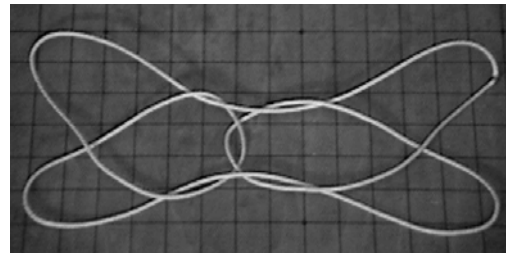
1. middle finger down into the thumb loops and rotate $\frac{1}{2}$ away taking the near thumb strings with them
2. thumbs (thus freed) down under all loops and take the far little finger loops and back to position (freeing the little fingers).
3. little fingers pick up the middle finger loops from beneath (thus maintaining the far transverse)
4. index loops + $\frac{1}{2}$ spin

These four maneuvers I call the iterative move in my short hand. It accomplishes rolling the entire figure $+1/2$ away so the algorithm of choice can be applied “backwards” or from the rear of the original formation of the strings on the hands.

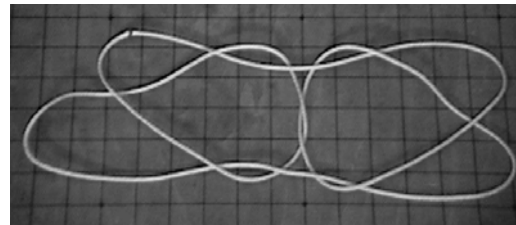
And the following, to round out the investigation.



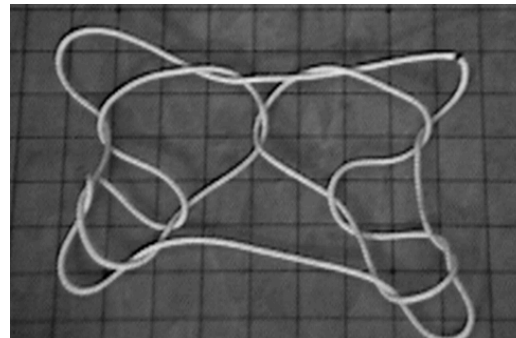
right dna thumb up through



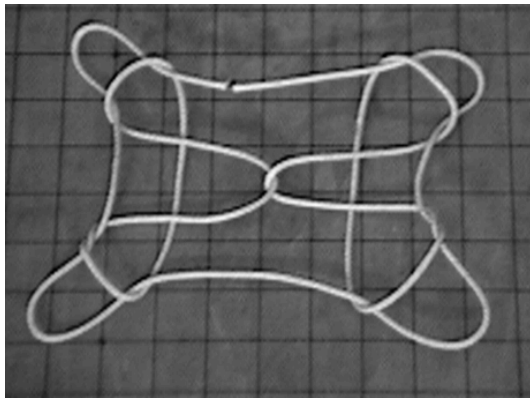
right dna thumb over down through iterate



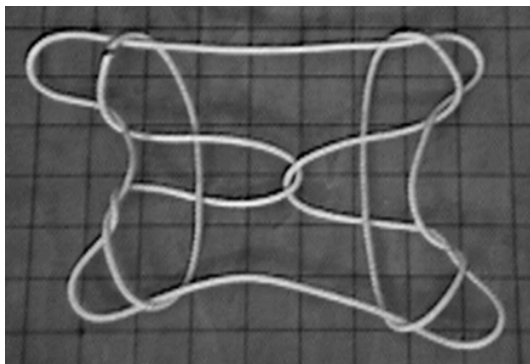
right dna little fingers up through



right dna little fingers over down through iterate



left dna little finger loops up through thumbs



left dna little finger loops over and down through thumbs and then iterate

And that's the end of this little story.