

# Using String Figures to Teach Math Skills

## Part 3: The North American Net System

by

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*James Murphy with 'Inuit Bowl' (Photo by Jeff Wang)*

### ABSTRACT

*String figures are wonderful tools for introducing students to abstract written languages like those used in math. This article presents the third of four string figure “systems” developed by the author for teaching math students how to think in abstract terms. The weaving sequences of three parent figures — the Inuit, Navaho, and Klamath Nets — are first broken down into various phases. The author then illustrates how each of the phases can be altered, spliced, and iterated to add complexity and richness to the designs. In the final section, the author shows how to write and manipulate generalized formulas that capture the essence of each weaving sequence.*

## INTRODUCTION

Math is a superset of abstract, rational, manmade languages describing pattern. In describing and contemplating these patterns man gets pleasure, often aesthetic pleasure of the sort many of us experience when we hear music, see art, or watch someone dance.

But for me this “seeing,” “feeling,” “doing,” or “making visual” the patterns of higher mathematics has always been difficult, because i resisted the mathematicians’ languages of perceiving pattern when i was young. i was intimidated into thinking i couldn’t understand them. i felt i couldn’t be as smart as it took to be good at math. Now i know this to be wrong, and i wish i could have those early years back so i could learn the languages that i should have.

String figures are excellent tools for introducing students to the pleasures of contemplating and working with patterns. There aren’t many basic figures which must be learned in order to become quite proficient at making figures of astounding beauty. Once these basic figures are mastered a simple algebra can be developed for generating variations. This often leads into detailed inventiveness with wild and exciting patterns emerging on the hands.

The following material is from Chapter 3 of a book i am writing on how to teach math skills to reluctant students using string figures. The book is based on lecture notes i prepared for my “String Figures” course, which i taught at La Guardia High School of Music and the Arts in New York City for over a decade. Excerpts from Chapter 1 (The Diamonds System) appeared in volume 4 of this Bulletin (Murphy 1997), and most of Chapter 2 (The Ten Men System) appeared in last year’s edition (Murphy 1998).

## NORTH AMERICAN NETS

While developing my ‘Ten Men’ system in the early 1980s, a friend of mine became interested in finding ways for me to show the world what I could do with string figures. One of the things he did was to promise the *International Institute of Photography* that i could give a lecture on Eskimo string figures in six weeks time. And he not only said i could do it, but negotiated a \$200 honorarium for my time and trouble. Well, i found myself in an interesting situation, and ran to get help.

Immediately i went to the Museum of the American Indian at 155th and Broadway and found that they had a library in the north Bronx which might have some books on string figures as formed by Native Americans, including the Inuit (which is what the Eskimo call themselves). i went up there on the subway and found a book by Diamond Jenness which was a record of an expedition into Inuit country in the years 1913-18. In this record was a description of 156 string figures he had collected during the expedition. i

learned about twenty of them in time for my professional debut as a string figure expert and was warmly received by the audience.

Mastering the technical language Jenness used for recording methods of manufacture (that of Rivers and Haddon) was hard work — i spent three days trying to make my first Inuit figure. But in the early part of this century nearly all anthropologists used this language and provided nothing more than a single drawing of the completed figure at the end. Today you can still go to the 42nd Street Library and find articles in anthropology journals about places once perceived as strange and the string figures they made there. i've done that, and have spent many long hours trying to understand their terse instructions. Eventually I would succeed, but was frustrated by the fact that each method of manufacture had to be memorized individually in a painstaking, laborious, manner that forestalled the learning process — these figures were not something my students would assimilate easily. For this reason i developed my own approach for learning string figures and teaching them to others, a systematic approach in which the method of manufacture is broken down into distinct phases, each of which can be altered to create new designs. In Chapter 3 of my book i present the 'Inuit Net' (a figure i learned for my lecture at the *International Institute for Photography*) and two other closely related string figures: the 'Navaho Net' and the 'Klamath Net.'

A great deal of time should be devoted to learning the three basic nets — as if memorizing multiplication tables — so that each becomes indelibly fixed in their minds. During this time students need to correlate what their eyes see with what their hands feel and what their mouths say as they recite the key words of the weaving sequence aloud. All these mind and hand activities need to become automatic and fully integrated for an unconscious ease of thinking to occur.

To help my students assimilate and comprehend the interrelatedness of the three North American Net figures i examine in Chapter 3, i divide each of their construction sequences into four distinct phases: *Loom Phase*, *Weaving Phase* ('First Weave' and 'Second Weave'), *Loop Shifting Phase*, and *Finishing Phase* ('Fixing the Bottom' and 'Cleaning the Top'). In the *Loom Phase* (a building phase), three loops are established on each hand. This is followed by two distinct sets of weaves in which strings are drawn through loops, thus forming the heart or center of the evolving design. In the *Loop Shifting Phase* that follows, various loops are either released and/or transferred to different fingers so that they can be further manipulated. In the first half of the *Finishing Phase* (which i call 'Fixing the Bottom'), the string destined to become the lower frame string of the design is drawn through various loops in a complex manner, thus creating a more stable configuration in the lower regions of the design. In the second half of the *Finishing Phase* (which i call 'Cleaning the Top') the string destined to become the upper frame string is drawn through a loop which is subsequently released, thus

leaving two loops on each hand, each of which has a transverse string. When drawn taut, an intricate net appears.

#### LESSON 1: THE INUIT NET

This string figure from Alaska was first described by Diamond Jenness (1924:56B-57B). His informant called it ‘Fish Net.’

##### *Forming the Loom*

- Begin with Opening A (fig. 1A).

##### *First Inuit Weave (I-1)*

- Pass each thumb away from you *over* the near index string and *under* the far index string, then pick up the near little finger string and return (fig. 1B).
- Pass each middle finger toward you over both index strings and down through the upper thumb loop (i call this “dipping into the well”), then pick up the lower far thumb string and return (fig. 1C).
- Drop both thumb loops and extend (fig. 1D).

##### *Second Inuit Weave (I-2)*

- Pass each thumb away from you over the near index string and under all other strings (fig. 1E), then pick up the far little finger string and return (fig 1F).

##### *Shifting the Loops*

- Drop the *index* loop (fig. 1G);
- Transfer<sup>1</sup> the middle finger loop to the little finger (fig. 1H);
- Transfer both little finger loops to the index, maintaining their relative order (fig. 1I);
- Transfer the thumb loop to the ring and little finger<sup>2</sup> (i.e., insert the ring and little finger into the thumb loop from below, close the near thumb string to the palm, and withdraw the thumb, fig. 1J).

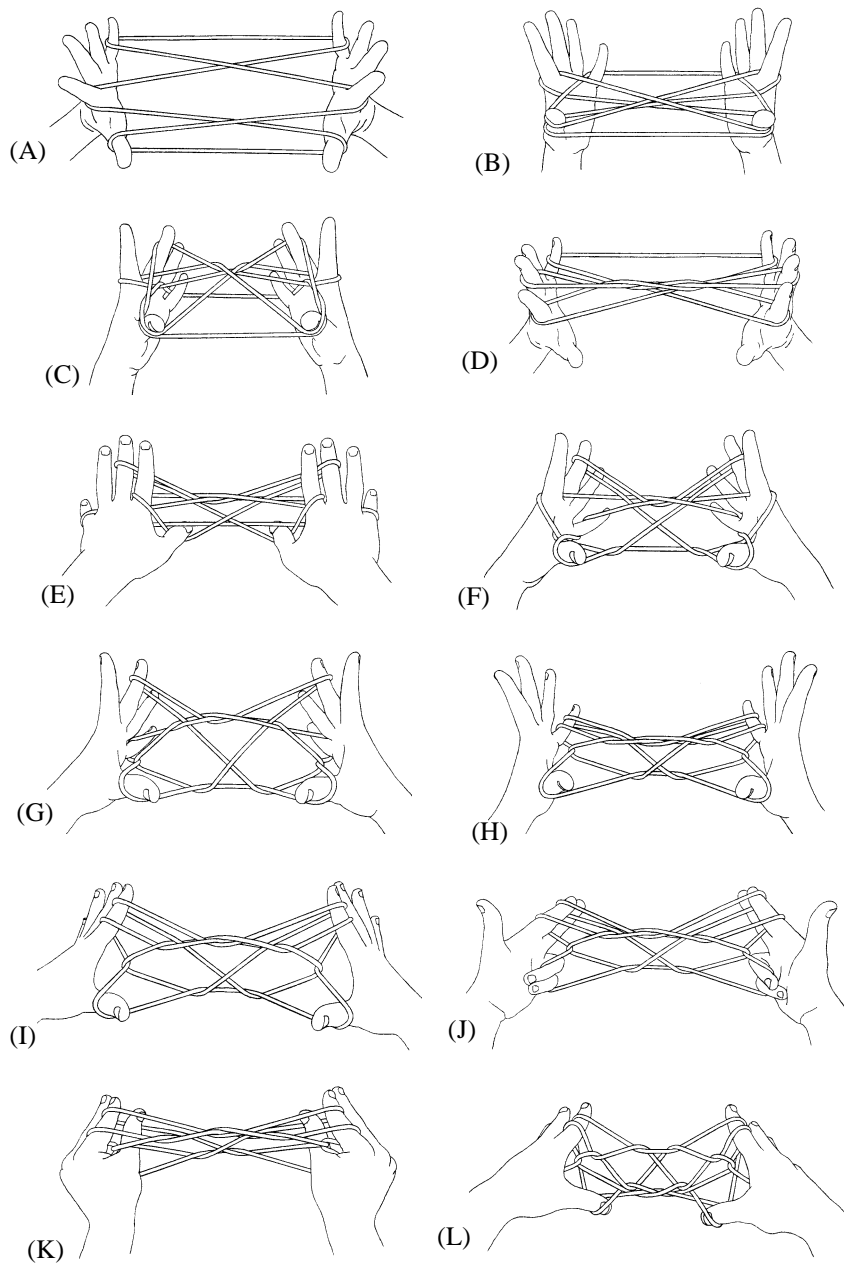
##### *Fixing the Bottom*

- Pass each thumb under both index loops and away from you through the ring-little finger loop (i call this “passing through the hole”), then pass the thumb up behind the strings and insert it, from below, into the upper index loop (fig. 1K);

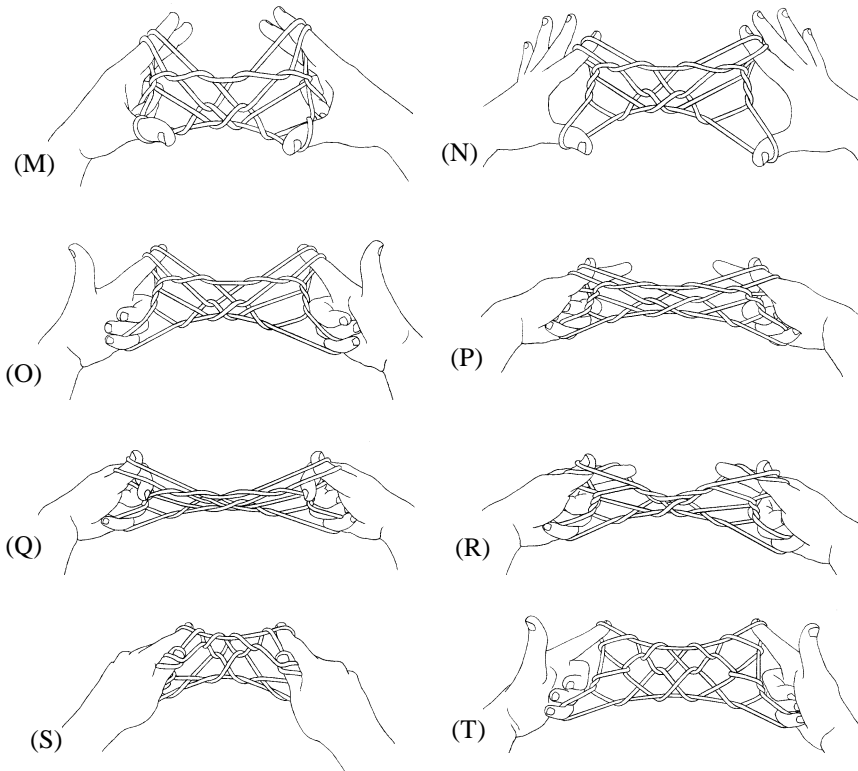
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<sup>1</sup>During loop transfers, insert fingers from below unless otherwise stated.

<sup>2</sup>It really doesn’t matter which of the three lesser fingers you use here — any combination will do. Jenness’s informant used the ring and little fingers.



**Fig. 1** - Stages in the manufacture of 'Inuit Net.' Illustrations are from the March 1999 issue of *String Figure Magazine*.



**Fig. 1, continued** - Final stages in the manufacture of 'Inuit Net.'

- With each thumb hook down the upper far index string and draw it down through the ring-little finger loop (i.e., “through the hole”) until the thumb is below the far little finger string (fig. 1L), then with each thumb pick up the far little finger string and draw it through the loop on each thumb, which slips off as you return (fig. 1M).
- Drop the ring-little finger loop and extend (fig. 1N).

*Cleaning the Top*

- Transfer the thumb loop to the little finger (i.e., insert the little finger into the thumb loop from below, close the near thumb string to the palm, and withdraw the thumb, fig. 1O).<sup>3</sup>
- Transfer both index loops to the thumb, maintaining their relative order (fig. 1P).

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<sup>3</sup>Again, you may use only the little finger, or the ring and little fingers, or the middle, ring, and little fingers here, whatever you are comfortable with.

- Insert each index, from above, into the upper and lower thumb loops (fig. 1Q), pick up the lower near thumb string, and draw it through the upper thumb loop (fig. 1R, i call this “kicking away” the string); then curl the tip of each index around the upper near thumb string, drawing this string away from you and up through the index loop, which slips off (fig. 1S).
- Drop both thumb loops and extend to complete the figure (fig. 1T).

#### LESSON 2: THE NAVAHO NET

Otherwise known as ‘Many Stars’ or ‘Starry Skyway,’ this string figure was first described by A.C. Haddon (1903:222), and later appeared in Caroline Furness Jayne’s book (1906:48-53). i have modified the construction somewhat to eliminate the awkward moves that require the assistance of the opposite hand, and have renamed the figure ‘Navaho Net.’

##### *Forming the Loom*

- Begin with Opening A (fig. 2A).

##### *First Navaho Weave (N-1)*

- Pass each thumb away from you *over* the near index string and *over* the far index string, then pick up the near little finger string and return (fig. 2B).
- Pass each middle finger toward you over both index strings and down through the upper thumb loop (dip into the well), then pick up the lower far thumb string and return (fig. 2C).
- Drop both thumb loops and extend (fig. 2D).

##### *Second Navaho Weave (N-2)*

- Pass each thumb away from you over the near index string and under all other strings (fig. 2E), then pick up the far little finger string and return (fig 2F).

##### *Shifting the Loops*

- Drop the *little finger* loop (fig. 2G);
- Transfer the middle finger loop to thumb, inserting the thumb *from below*, then immediately retransfer this loop to the index, inserting index *from above* (fig. 2H, i call this “rolling the middle finger loop +1/2 onto the index finger”)
- Share the upper index loop with the thumb (i.e., with each thumb pick up the upper near index string and return). Close the middle, ring, and little fingers to the palm in preparation for the next move (fig. 2I).

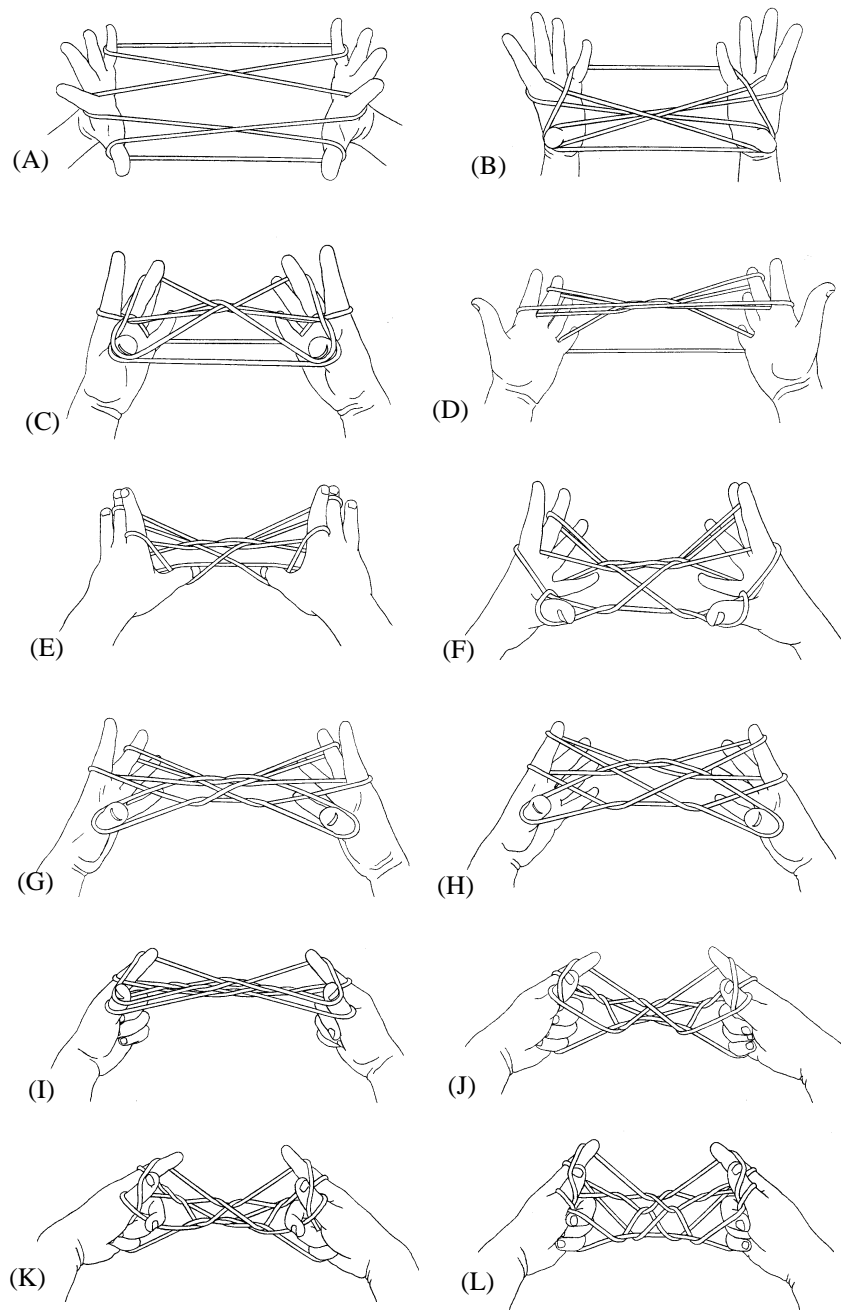
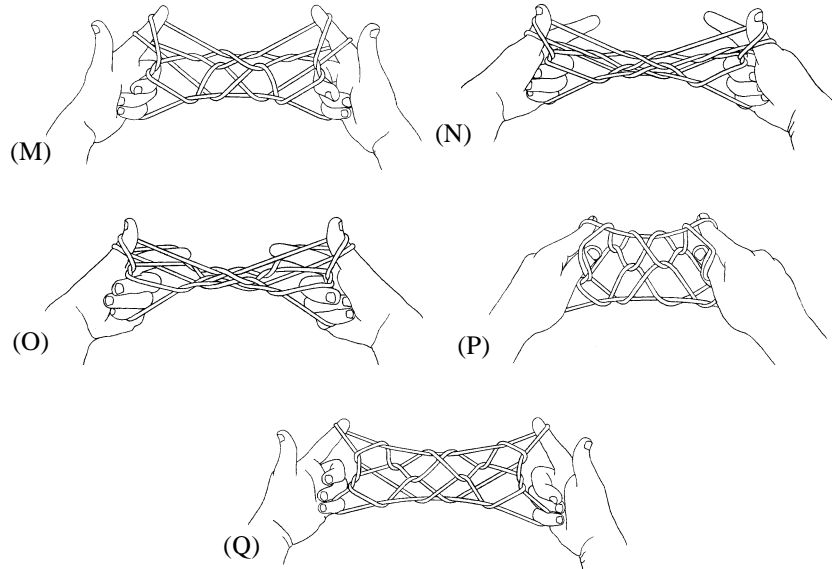


Fig. 2 - Stages in the manufacture of 'Navaho Net.' Illustrations by Mark Sherman.





**Fig. 2, continued** - Final stages in the manufacture of 'Navaho Net.'

*Fixing the Bottom*

- Pass each middle, ring, and little finger (the "three lesser fingers") under both index loops and insert them, from below into both thumb loops; close the upper near thumb string to the palm, drawing it down through the lower thumb loop (fig. 2J).
- Extend the middle finger, pass it toward you under the index loops, and insert it, from below, into the lower thumb loop; curl the middle finger around the lower near thumb string (fig. 2K) and draw it away from you, through the ring-little finger loop, and close the middle finger to the palm; drop the ring-little finger loop and insert these two fingers into the middle finger loop, closing the far middle finger string to the palm (fig. 2L).
- Drop both thumb loops and extend. (fig. 2M).

*Cleaning the top*

- Transfer both index loops to the thumb, maintaining their relative order (fig. 2N).
- With each index pick up the lower far thumb string (fig. 2O), then curl the tip of each index around the upper far thumb string, drawing this string down through the index loop, which slips off as you rotate the index away from you and up (fig. 2P, i call this "curling out the transverse string").

- Drop the thumb loops and extend to complete the figure. To help you compare this figure with the Inuit and Klamath Nets, withdraw the middle and ring fingers from their loop, leaving the figure extended on the index and little fingers only (fig. 2Q).

### LESSON 3: THE KLAMATH NET

This string figure, otherwise known as ‘Owl’s Net’ was first described by Mrs. Jayne (1906:69-74). It was collected from Emma Jackson, an Indian from the Klamath tribe (California-Oregon border). i call it ‘Klamath Net.’

#### *Forming the Loom*

- Begin with Opening A (fig. 3A).

#### *First Klamath Weave*<sup>4</sup> (K-1)

- Pass each thumb away from you *over* the near index string, pick up the far index string, and return. (fig. 3B).
- Pass the tips of each index and middle finger down through the upper thumb loop and pinch between them the lower near thumb string (fig. 3C); draw this string through the upper thumb loop and place it on the back of each index by rotating the index-middle finger pair away from you and up — i call this “curling out the transverse string” (fig. 3D).
- Drop both thumb loops and extend (fig. 3E).

#### *Second Klamath Weave* (K-2)

- Pass each thumb away from you over the lower near index string and under all other strings (fig. 3F), then pick up the far little finger string and return (fig 3G).

#### *Shifting the Loops*

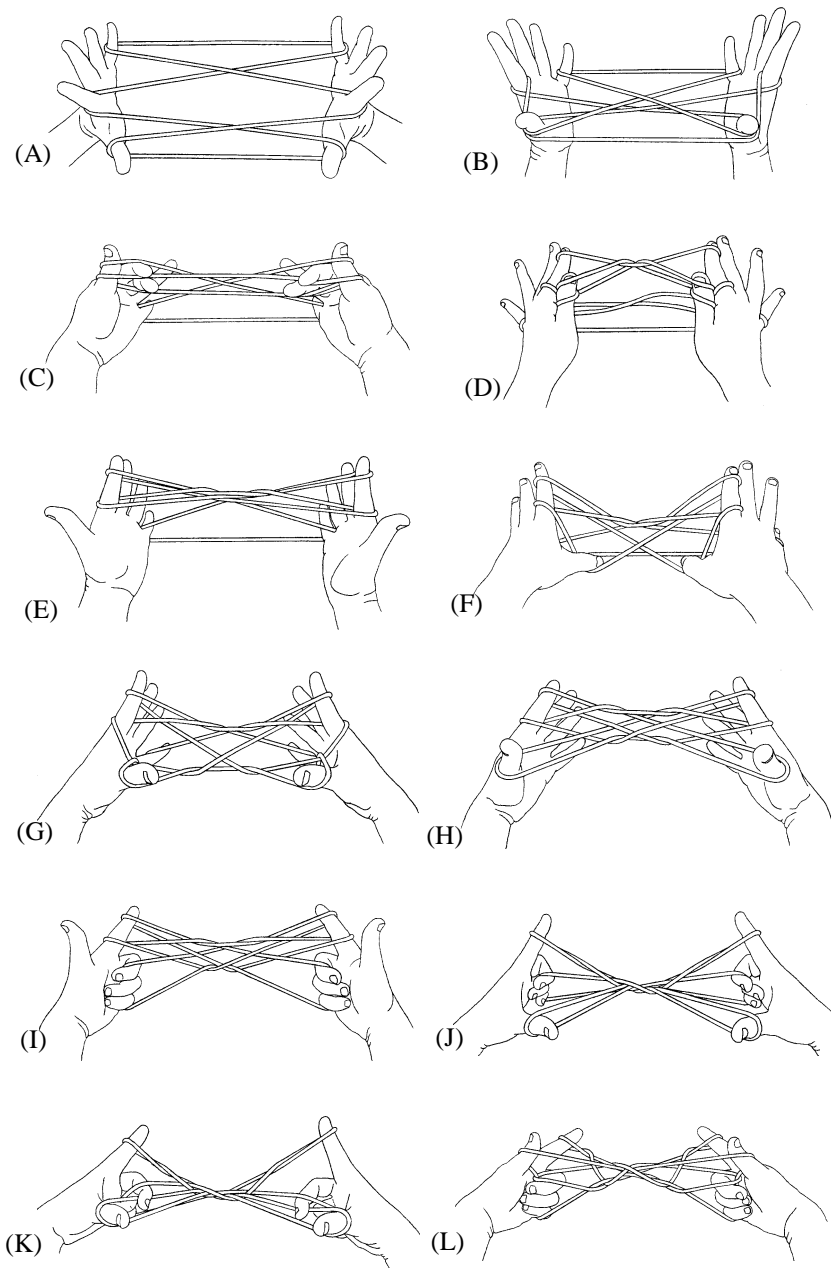
- Drop the *little finger* loop (fig. 3H);
- Transfer the thumb loop to the three lesser fingers (i.e., insert the middle, ring, and little fingers into the thumb loop from below, close the near thumb string to the palm, and withdraw the thumb, fig. 3I);
- Transfer the upper index loop to the thumb (fig. 3J).

#### *Fixing the Bottom*

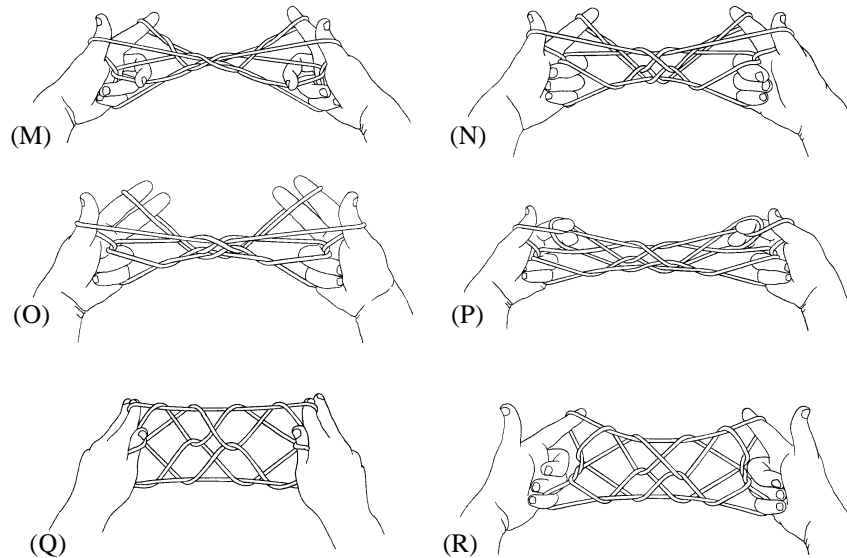
- Without withdrawing the middle finger from the lesser fingers loop, pass

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<sup>4</sup>*In practice, i use a less awkward method for doing the First Klamath Weave: First, i pass each thumb over the near index string and close it to the palm; then with the tip of each index i push the far index string towards my body, over all the strings, then i use my index and middle fingers to “curl out” the near thumb string; at this point i drop the thumb loop and extend.*



**Fig. 3** - Stages in the manufacture of 'Klamath Net.' Illustrations by Mark Sherman.



**Fig. 3** - Final stages in the manufacture of 'Klamath Net.'

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 (fig. 3K) 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 (fig. 3L).

- 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 (fig. 3M), 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 (fig. 3N).

#### *Cleaning the Top*

- Withdraw the middle finger from the lesser fingers loop and insert it, from below, into the index loop (fig. 3O); pinch the near thumb string between the tips of the index and middle fingers (fig. 3P), 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, fig. 3Q).
- Drop the thumb loop and extend to complete the figure. To help you

compare this figure with the Inuit and Navaho Nets, withdraw the ring finger from its loop, leaving the figure extended on the index and little fingers only (fig. 3R).<sup>5</sup>

#### LESSON 4: COMPARING THE THREE NORTH AMERICAN NETS

Before students can start altering and combining various weaves in the Net system, they need to understand the function of each weave and how it affects the final design. By dividing the construction methods of the Inuit, Navaho, and Klamath Nets into phases, similarities and differences are easier to comprehend.

The loom for all three is nothing more than Opening A, a simple three-loop opening in which the near thumb and far little finger strings are transverse. Compare this with the Ten Men three-loop loom (Murphy 1998:163, fig. 1, step 5), in which the two near index strings are transverse.

In the Ten Men system the first and second weaves are the same, but in the North American Net system the two weaves differ. Furthermore, for each of the three North American Nets, part 1 of the first weave differs:

*First Inuit Weave, part 1:* thumb goes down through index loop and retrieves near little finger string.

*First Navaho Weave, part 1:* thumb goes over index loop and retrieves near little finger string.

*First Klamath Weave, part 1:* thumb goes over near index string and retrieves far index string.

For each North American Net, part 2 of the first weave is essentially the same:

Middle and/or index finger goes “into the well” and retrieves one of the lower thumb strings; thumb drops both loops.

The second weave for each North American Net is identical:

Thumb goes through (lower) index loop from above and retrieves far little finger string.

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<sup>5</sup>In practice, i often finish the figure as follows: Do the first half of Fixing the Bottom (through fig. 3L), then Clean the Top. Now go back and do the rest of Fixing the Bottom (i.e., draw the bottom transverse string through the loop on the three lesser fingers, etc.). This modification creates a much sharper extension and allows complex figures like Sunrise over Klamath Bridge to blossom.

During the *Loop Shifting Phase* the methods begin to diverge. In making the Inuit Net, the *index* loop is dropped (which seems like a mistake if you're used to making the Navaho and Klamath Nets!), then the remaining loops are arranged so that the upper near index string and far little finger string are transverse. In making the Navaho Net the *little finger* loop is dropped and the remaining loops arranged so that the lower near thumb string and upper far index string are transverse. In making the Klamath Net, the *little finger* loop is likewise dropped, but the remaining loops are arranged so that the near thumb string and far little finger string are transverse.

For all three nets the methods for *Fixing the Bottom* and *Cleaning the Top* differ significantly, but all produce similar outcomes: in the bottom row, a double wrap fuses the diamond nearest each hand to the palmar string, whereas in the top row, a single wrap occurs at the palmar string.

At first i was bothered by all the similarities i found among the three North American Nets: how could three widely separated culture groups invent complex figures that so closely resembled one another? The answer was revealed to me one day while visiting the Museum of the American Indian in New York with my daughter. The tour guide told us that until 1000 years ago the Navaho people lived in western Canada, just south of land occupied by the Inuit. And just south of the Navaho lived the Klamath people. So the three nets can be thought of as dialects or variations of a parent figure known to the ancestors of all three groups.

#### *Comparing the Cores*

As mentioned above, the first and second weaves give rise to the heart or core of each design. A good way to compare the cores is to complete the first and second weaves, then transfer the loops so that an Opening A-like configuration results<sup>6</sup> and the design lays flat. For reasons that will become obvious later, i call this the *Continuation Move*.

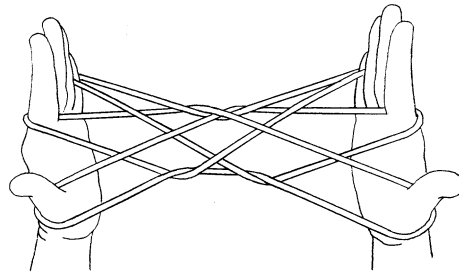
#### *Continuation Move (CM)*

- After completing the first and second weaves of the Inuit, Navaho, or Klamath Net, drop the little finger loop and roll the middle finger loop (or upper index loop in the Klamath case) onto the little finger (i.e., transfer the middle finger loop onto the thumb, inserting the thumb from below, then transfer the upper thumb loop to the little finger, inserting the little finger from above — this accomplishes a +1/2 rotation of the transferred loop).

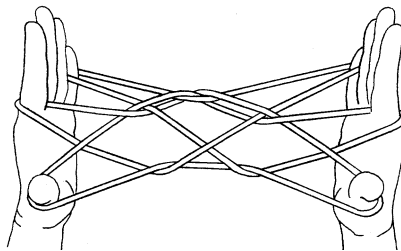
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<sup>6</sup>An *Opening A-like configuration* means you have at least one loop on each thumb, index, and little finger, and the near thumb and far little finger strings are transverse or “straight-across” strings. It is important to understand this definition since i use the term frequently throughout my discussions.

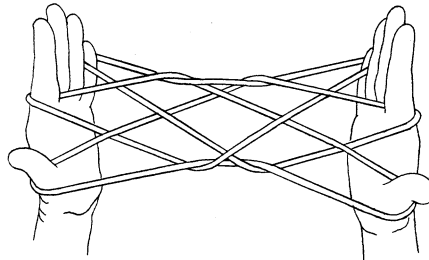
When applied to the Inuit Net, the result is fig. 4; when applied to the Navaho Net, the result is fig. 5; when applied to the Klamath Net, the result is fig. 6. You can further explore the differences by dropping the index loop and extending: the Inuit core dissolves; the Navaho core gives a double-walled diamond with complex crossings at the loop junctions, and the Klamath core gives a double-walled diamond with simple crossings at the loop junctions.



**Fig. 4** - I-1 and I-2 followed by the Continuation Move



**Fig. 5** - N-1 and N-2 followed by the Continuation Move



**Fig. 6** - K-1 and K-2 followed by the Continuation Move