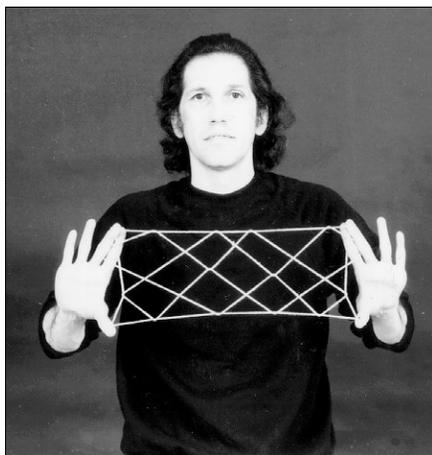


# Using String Figures to Teach Math Skills

## Part 2: The Ten Men System

by

JAMES R. MURPHY (INOLI), *Whitestone, New York*



*James Murphy with 'Ten Men' — a Pacific Islands string figure.  
Photo by Jeff Wang.*

### ABSTRACT

*String figures teach persistence, concentration, and assuredness as to eventual success. This article presents the second of four string figure “systems” developed by the author for teaching math students how to think logically. The weaving sequence of the parent figure — Ten Men — is first broken down into various phases. The author then illustrates how each of the phases can be altered systematically to create literally millions of different designs. The author also describes how string figures can help students better comprehend various fundamental math concepts (reciprocals, additive inverses, matrices).*

## INTRODUCTION

Mathematics is another “language”, and certainly not one learned in an “unconscious” natural way. It is approached as a “memorizable” discipline. Addition, subtraction, multiplication, and division are memorized as “tables” of combinatory results until the “answers” are ready to tongue or to hand when called forth. The idea is to practice until the answers come naturally without thought.

A “good” student can thus be said to be one who is adept at putting into an indelible memory bank the basic tables of information necessary to make a useful language of ideation out of math, science, poetry, history, etc. That is to say that they will sweat their way to the place of conversational ability in several complex matrices of descriptive thought.

Most students in the public school system rarely achieve this ability and consequently never learn how to learn enough to become adept at any intellectual discipline. This is the underlying problem of the school system.

What i feel is needed to combat this situation is not more of the same, but a radical difference in approaching the first “school learning” experiences. And if this experience can be made to be explosively successful then it will naturally become a part of the way every student will approach their future learning tasks.

Learning string figures as a set of mathematical systems of exploration and conjecture has all of the prerequisites of such a successful experience:

- a. It is fun.
- b. It is 100% successful.
- c. It overwhelmingly ensures a success beyond one’s fondest dreams.
- d. It brings with it an appreciation of the strengths of patience.
- e. It demonstrates the especial power of dwelling on the mass of initial information needed to be “memorized” until it becomes one with the thinker/user of the language, until fluency is attained.

The following material is from Chapter 2 of a book i am writing. 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 last year’s Bulletin (Murphy 1997). Chapter 2 presents the Ten Men System.

The book itself is arranged around only four figures, and is thus a radical departure from the usual book on string figures which tends to be a hodge podge of many figures, each of which has to be learned separately. This means that by the time you are learning the twentieth figure, you are tired of the whole process of learning. My approach is radically different. Once you

have learned one of the figures i describe you will immediately be able to form many more by simple changes in the way you make the figure, and these changes are arranged into a system which is easily understood. This means you will be able to create your own figures almost immediately and be able to write down how to make them again so you will never have to forget them.

Remember that the most difficult part of learning how to make string figures is learning the first few figures. It is frustrating and must be worked at until forming the figures becomes an easy habit. That, by the way, is why most people never learn mathematics well. It's never practiced long enough to become a thinking language. Everyone always translates between systems and the thought process is slow, cumbersome, and fraught with error (and the way that most math teachers deal with errors is through punishment, which only induces fear!). Errors aren't bad. They are merely indicators of areas where more practice is needed.

String figures make practice a joy so people tend to get good at them. The entire secret of becoming a good student and learning difficult subjects well is to find a way to make learning them a joy. Even acting like it is fun will often help. i often tell my students "Remember, you are smart enough to become good at anything, but it takes practice to get good." Homework is a nasty word — i prefer practice.

## **TEN MEN - A SIMPLE THREE-LOOP SYSTEM**

### LESSON 1: LEARNING THE TEN MEN FIGURE

During the first lesson students are taught how to make the Ten Men figure (Ten Men was first described in 1906 by Caroline Furness Jayne, — see pages 150-156). Something can be immediately discerned concerning the digital resourcefulness of each student (i.e., which ones have intelligent hands, and which ones have trained hands). There are subtle differences, just as there are nuances we as teachers perceive in the verbal development of our students along several vectors (memory, diction, depth of perception, logicity of approach, style of expression, writing ability, aptness of metaphor or analogy, facility and felicity). All these are evident in the students' hands as they struggle to make accurate and quick the formation of their figures.

Before attempting to weave any of the figures described in this article, i suggest that you read the lessons through to get the gist of the development tree. See if you can follow the perverse logic of the unfolding mysteries of forming different, more complex figures. And always keep in mind that i have found no student, repeat *no student*, in my fifteen years of constantly teaching string figures, who did not only succeed in making the figures, but revelled in their sophistication of result. Inevitably the student is made stronger by their overcoming frustration on this level.

To help my students assimilate the Ten Men figure, i divide its construction sequence into five distinct phases: *Forming the Loom*, *Weaving*, *Resetting the Loom*, *Weaving Again*, and *Extending the Figure*:

*Forming the Ten Men Loom*

- Begin with Opening A (fig. 1, Step 1).
- With your mouth reach over all the strings and return with the far little finger string (Step 2).
- With your right index reach over the right mouth string, pick up the left mouth string and return (Step 3).
- With your left index pick up the right mouth string and return (Step 4).
- Release the mouth loop and the loop on each thumb and extend (Step 5). You now have the Ten Men Loom. The upper and lower near index strings should run directly from hand to hand without crossing. These two strings will become the frame lines of the finished pattern.

*Weaving* (first iteration)

- With each thumb reach under both index loops, pick up the near little finger string, and return (Step 6). This step constitutes the **FIRST PART OF THE WEAVE**.
- Now **FINISH THE WEAVE**: With each thumb pick up the upper near index string, keeping it above the loop already on the thumb (Step 7).
- Navaho the thumb loops (Step 8).

*Resetting the Loom*

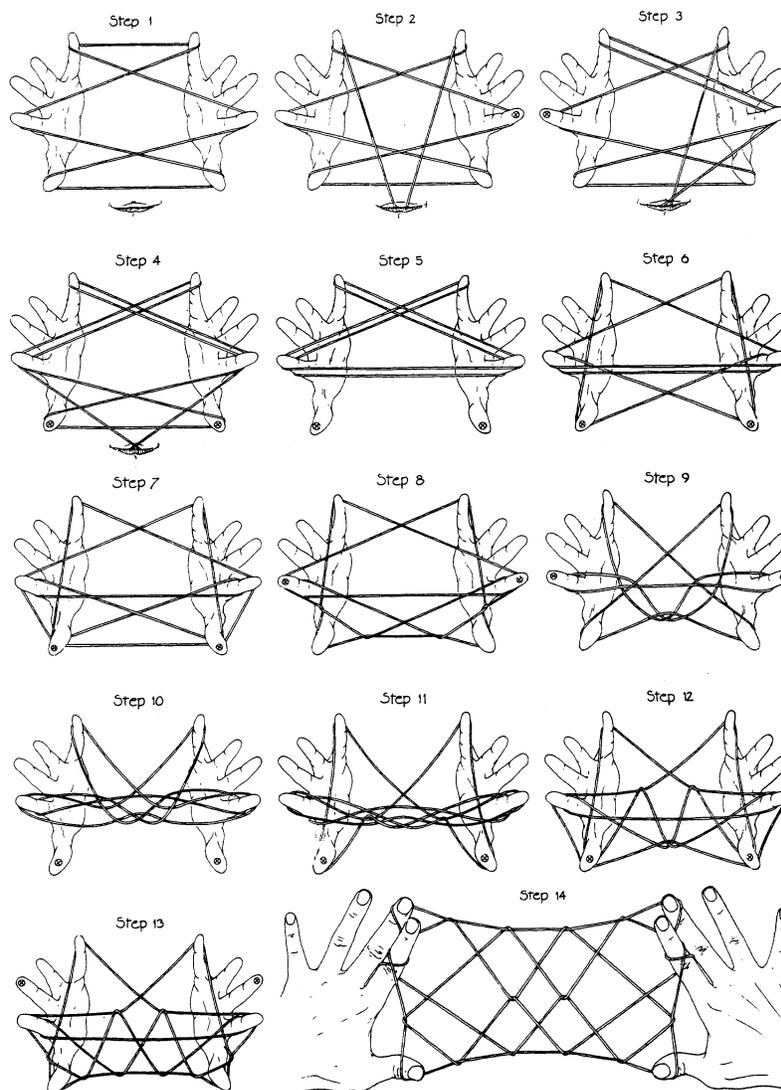
- On each hand release the upper index loop and extend (Step 9).
- On each hand transfer the thumb loop to the index finger (without inverting or twisting the loop), keeping the transferred loop above the loop already on each index (Step 10).

*Weaving* (second iteration)

- **FIRST PART OF THE WEAVE**: With each thumb reach under both index loops, pick up the near little finger string, and return (Step 11).
- **FINISH THE WEAVE**: With each thumb pick up the upper near index string, keeping it above the loop already on the thumb (Step 12).
- Navaho the thumb loops (Step 13).

*Extending the Figure*

- With each middle finger reach over the upper far index string and pick up the (lower) near index string.
- Release the little finger loops and extend with palms facing away from you (Step 14).



**Fig. 1** - Stages in the manufacture of 'Ten Men' from an article by Jearl Walker in *Scientific American* (May 1985). Method by Phylis Morrison. Drawings by Michael Goodman. Used with permission.

When extended you should have a web or net formed between your hands with ten X's in it. Each of these X's represents a man doing a side-straddle hop exercise and that is the derivation of the name Ten Men. Instruct your students to practice this figure until they have memorized how to form it. It is the heart of the system i am proposing .

As the students practice making the figure, i emphasize the division of the sequence into phases (setting up the loom, weaving, resetting the loom, weaving again, and extending). The reason for this division is to introduce the concept of systematically altering each phase — a technique which leads to an almost infinite series of different designs.

## ALTERING THE WEAVING PHASE

### LESSON 2: CREATING SIMPLE VARIATIONS OF TEN MEN

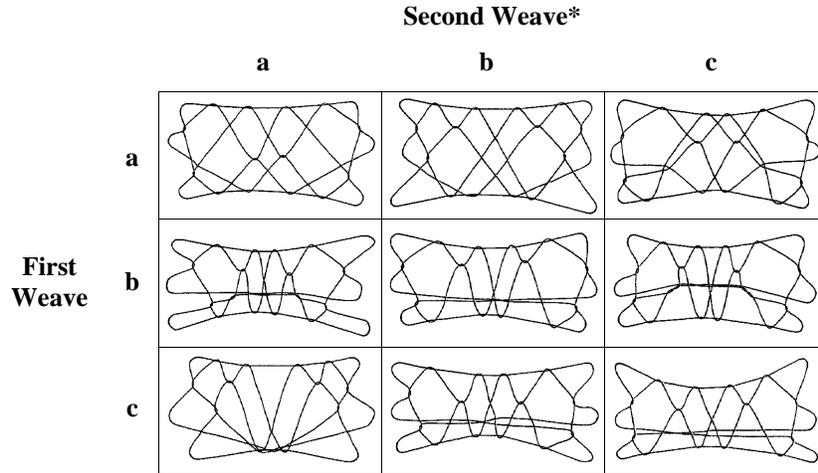
Once my students have mastered the parent figure, i teach them how to alter the weaving phase using a variety of techniques. These techniques include altering the string retrieved by the thumbs, altering how this string is retrieved, and altering the path taken by the thumbs prior to retrieving the desired string. Also, i introduce the concept of repeating the weaving phase more than twice.

Suppose you forgot which little finger string to pick up with your thumbs when beginning your first weave and picked up the *far* little finger string instead of the *near* little finger string. Remarkably, a different figure results (i.e., the design does not collapse). Retrieving the far little finger string during the second weave (or during the first *and* second weaves) also gives rise to new designs. Perhaps we should pause and consider how to organize our search for different patterns as our creative play progresses:

Consider the following three simple weaves (here i use a single lowercase bold letter as shorthand notation for indicating which string is retrieved by the thumb during each weaving phase and how it is retrieved):

- a** (pick up the near little finger string as in Ten Men)
- b** (pick up the far little finger string under the near little finger string)
- c** (pick up the far little finger string over the near little finger string)

Now consider how many different two-weave patterns you can make. Using my shorthand notation, the original Ten Men figure would be written as **a a**. Another figure would be **a b**, with a third being **a c**. Now consider weaving **b** first or **c** first. You can see it gets complicated to store the results in your head. In class i encourage my students to use a simple matrix to explore these possibilities. The result of each combination can be sketched within the squares of a matrix:



You might wish to think about repeating the weaving phase more than twice. There is no reason to limit yourself to two weaving phases except for habit and lack of imagination. So try **a a a**. A fine pattern results (fig. 2).

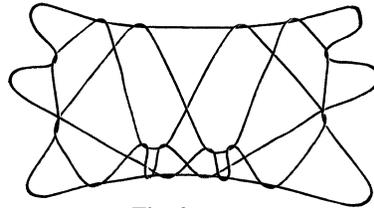


Fig. 2 - a a a

Next, try **a a b** (fig. 3), or **a b a** (fig. 4), or other three-weave combinations.

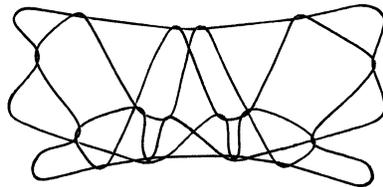


Fig. 3 - a a b

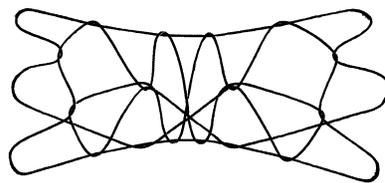


Fig. 4 - a b a

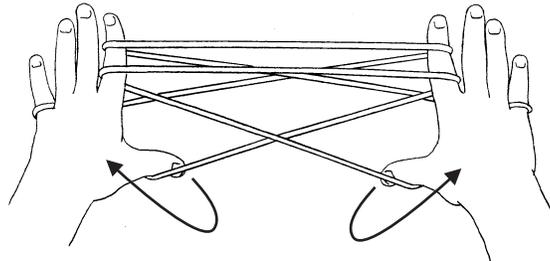
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\* Editor's Note: Most of the line drawings in this article were prepared by scanning specimens mounted on sheets of paper. To facilitate mounting the upper index loops were released and the lower index loops untwisted so that the figure would lay flat. The central design was then arranged.

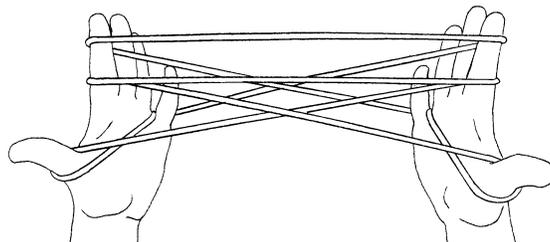
To explore all these combinations you would need three matrices:

		<b>Third Weave</b>								
		a	b	c	a	b	c	a	b	c
<b>Second Weave</b>	a									
	b									
	c									
		First Weave: a				First Weave: b				First Weave: c

Now comes a new imaginative difference which leads to a real mystery. Suppose you didn't pick up the near little finger string with the thumb in the regular way but instead "downflipped" it by placing your thumb on top of the near little finger string and curling your thumb down and toward you as you returned (fig. 5). The resulting thumb loops now have a half twist in them (fig. 6). This weave I call **a'** (a-prime). That is because it is the *reciprocal* or *inverse* of the **a** weave.



**Fig. 5** - Thumbs downflipping the near little finger string



**Fig. 6** - First part of an **a'** weave — the reciprocal of an **a** weave

To illustrate what I mean by *reciprocal*, try the following experiment: First do an **a** weave (i.e., pick up the near little finger string on the back of the thumb, pick up the upper near index string, and navaho the thumb loops), then reset the loom (i.e., release the upper index loops and transfer the thumb loops to the indices). Now do an **a'** weave (same as **a**, but downflip the near little finger string), and again reset the loom. You should have reverted back to the original loom (fig. 1, Step 5). The two weaves cancel themselves out when both are woven and reset in either order. Now think of the possible three-weave patterns for figures starting with the **a** weave. You would need a 6-by-6 matrix to record the outcome of each combination:

		Second Weave					
		a	b	c	a'	b'	c'
First Weave	a						
	b						
	c						
	a'						
	b'						
	c'						

Take special note of the row beginning with **a'**. For each figure in this row an incomplete design results (nothing encircles the upper frame string) since the first and second weaves cancel each other (i.e., weaving **a a' a** is the same as weaving only **a** — see fig. 7).

You should also note that you will have to find a method of “downflipping” the **c** weave artificially. The thumb can’t curl down, toward you, and back up without also picking up the near little finger string along with the far little finger string. Therefore, you will need to practice pulling a **c** weave and then adjusting the loop on each thumb to create what would have been a downflip of the **c** weave if it had been physically possible. Per-

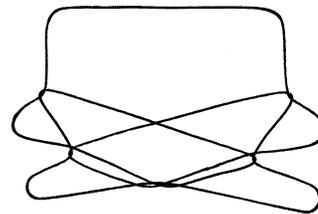
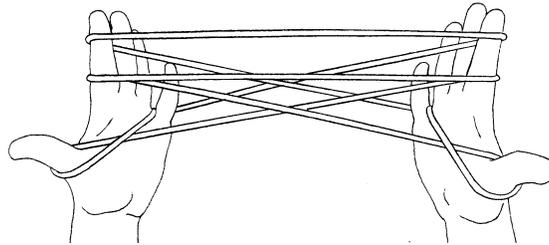


Fig. 7 - a a' a

haps the easiest way is to simply lift the new loop off each thumb, rotate the loop half a turn away from you, reset the loop on the thumb, then finish the weave (i.e., pick up the upper near index string and navaho thumbs).

There is also a method of flipping the string which is not as natural, but which must be thought of in order to round out the possible differences in our weaving patterns. In the inverse weaves described above, we artificially formed the “downflip” of the **c** weave by rotating the new thumb loop half a turn away and then resetting it. The *anti-inverse* would be formed by rotating the new loop half a turn towards you (fig. 8). Finishing the weave would then result in a running half-hitch in the figure. And obviously all the weaves described so far will have an inverse and an anti-inverse (a prime and a double prime in my notational system). However, i haven't found any real use for anti-inverse weaves except for introducing a half-hitch into the design.



**Fig. 8** - First part of an **a''** weave (an anti-inverse weave)

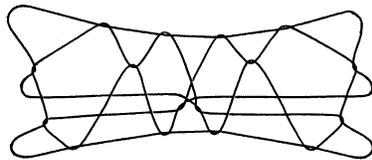
There are actually ten simple weaves in my system. In addition to the **a**, **a'**, **b**, **b'**, **c**, and **c'** weaves, i also introduce my students to the **d**, **d'**, **e**, and **e'** weaves. The reason for these is as follows: Note that one can think of the **b** weave as accomplishing a  $+1/2$  rotation of the little finger loop (i.e., if you release the little finger loop after picking up the far little finger string *under* the near little finger string, the net result is a half rotation of the loop away from you). Likewise, one can think of the **c** weave as accomplishing a  $-1/2$  rotation of the little finger loop. To accomplish a  $-2/2$  rotation (i.e., a full rotation of the loop towards you), a **d** weave is required, and for a  $+2/2$  rotation, an **e** weave. To do these weaves, i use my middle finger and my thumb to wrap the near little finger string around the far little finger string before catching the near little finger string on the back of each thumb. The two weaves are accomplished as follows:

- d** (pass each thumb under both index loops, then use it to push the near little finger string under the far little finger string; pass your middle finger over the far little finger string and catch on its back the string being pushed by the thumb; now pass each thumb under both index loops again and insert it, from below, into the middle finger loop;

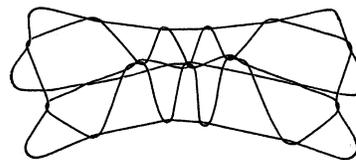
transfer the middle finger loop to the thumb and return under both index loops)

- e** (with the tip of each middle finger push the near little finger string away from you, over the far little finger string, then down so that the string lies below the far little finger string; now pass each thumb under both index loops, then under the string being pushed down by each middle finger tip, and catch this string on the back of the thumb, returning under both index loops)

The two-weave pattern **d a** is shown in fig. 9. The result of weaving **e a** is shown in fig. 10.



**Fig. 9 - d a**



**Fig. 10 - e a**

The inverse weaves are also defined. Note that you may need to do the downflipping artificially, like you do with the **c'** weave.

- d'** (do **d** with a downflip)
- e'** (do **e** with a downflip)

#### SUMMARY OF THE TEN "SIMPLE" WEAVES

- a** (pick up near little finger string)
- b** (pick up far little finger string under near little finger string)
- c** (pick up far little finger string over near little finger string)
- d** (make near little finger string go under then over far little finger string, then pick up with thumb)
- e** (make near little finger string go over then under far little finger string, then pick up with thumb)
- a'** (same as **a** except the thumb downflips the string)
- b'** (do **b** with downflip)
- c'** (do **c** with downflip)
- d'** (do **d** with downflip)
- e'** (do **e** with downflip)

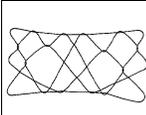
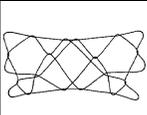
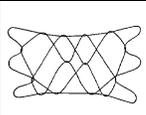
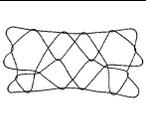
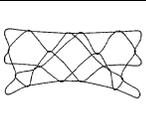
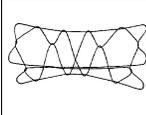
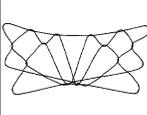
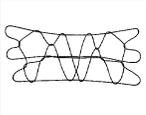
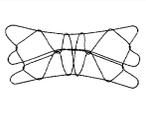
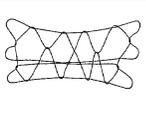
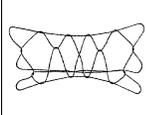
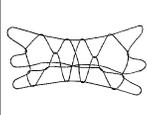
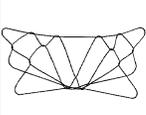
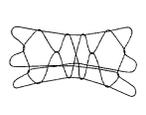
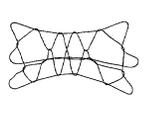
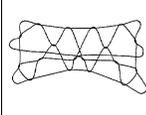
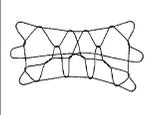
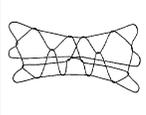
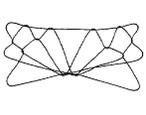
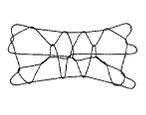
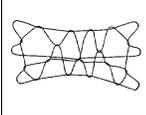
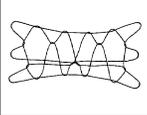
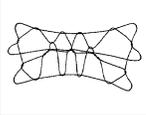
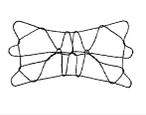
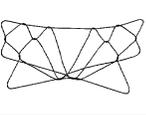
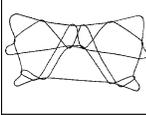
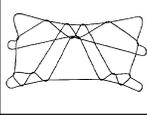
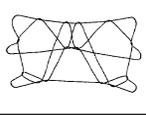
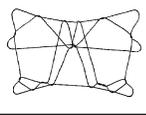
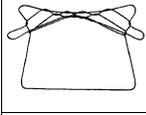
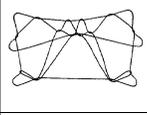
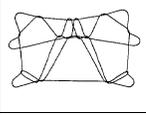
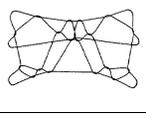
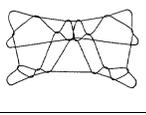
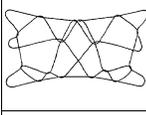
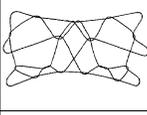
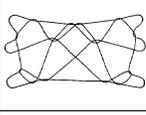
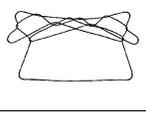
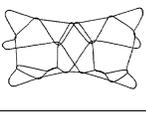
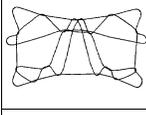
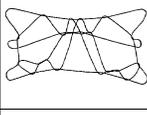
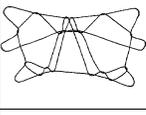
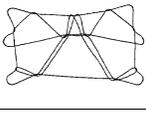
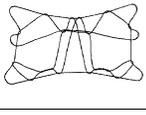
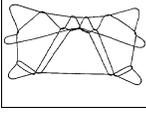
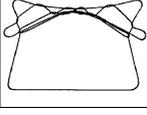
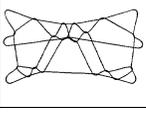
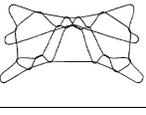
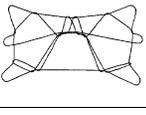
At this point the students are encouraged to fill in the squares of a 10-by-10 matrix with sketches of each figure:

**Second**

	a	b	c	d	e
a					
b					
c					
d					
e					
a'					
b'					
c'					
d'					
e'					

**First Weave**

### Weave

a'	b'	c'	d'	e'
				
				
				
				
				
				
				
				
				
				

## LESSON 3: INTRODUCTION TO NON-SIMPLE WEAVES

Once the students have mastered the ten basic weaves and can use each of them with some facility, i teach them how to alter the path the thumbs take before retrieving one of the little finger strings during the first or second weave.

First, i review how the parent figure is made (set up loom, do an **a** weave, reset the loom, do another **a** weave, and extend), and remind them that the shorthand notation for this sequence is **a a**.

Then i ask “What would happen if during the first weave you passed each thumb up through the lower index loop (i.e., over the far lower index string) before retrieving the near little finger string and completing the **a** weave?” The result would be a new figure!

In fact, one can envision doing any of the ten simple weaves (**a-e'**) after first passing the thumb up through the lower index loop, which means that ten new figures are easily created. In other words, by altering the thumb’s pathway during the initial part of the weave, you enter a “parallel universe” populated by another entire set of figures equal in size to the original set.

For this reason, i refer to this set of weaves as “A-Universe weaves” and use a bold uppercase **A** to indicate that the thumb should pass over the far lower index string before doing any of the ten simple weaves. The result of weaving **Aa** followed by **a** is shown in fig. 11. The ten non-simple weaves in the A-Universe series are therefore written as:

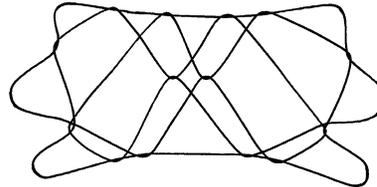


Fig. 11 - Aa a

**Aa, Ab, Ac, Ad, Ae, Aa', Ab', Ac', Ad', Ae'**

One can also imagine passing each thumb *down* through the lower index loop (i.e., over the lower near index string) before doing any of the ten simple weaves. Again, the result would be ten more unique figures (**Ba a** is shown in fig. 12). The ten non-simple weaves in the B-Universe are written as:

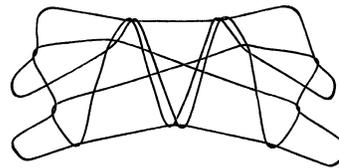


Fig. 12 - Ba a

**Ba, Bb, Bc, Bd, Be, Ba', Bb', Bc', Bd', Be'**

If one simply passes the thumb over both lower index strings before retrieving a little finger string, one has entered the C-Universe (see fig. 13 for the

result of weaving **Ca a**). The corresponding series would be:

**Ca, Cb, Cc, Cd, Ce,  
Ca', Cb', Cc', Cd', Ce'**

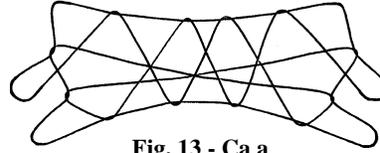


Fig. 13 - Ca a

Now let's increase the complexity a bit: First pass each thumb under the lower near index string, pick up the lower far index string and return. Now pass each thumb over the lower near index string (pushing it down) and retrieve one of the little finger strings (i.e., do one of the ten simple weaves, **a-e'**). As you return you will need to draw the retrieved string through the "hole" (i.e., the space between the intertwined lower near index and lower far index strings). See fig. 14 for the two-weave pattern **Da a**. This set of weaves is D- Universe:

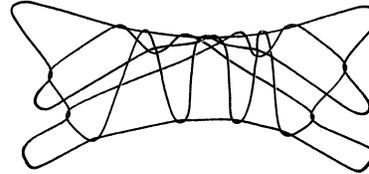


Fig. 14 - Da a

**Da, Db, Dc, Dd, De, Da', Db', Dc', Dd', De'**

In a D- Universe weave, you make the lower far index string go under then over the lower near index string (analogous to a simple **d** weave in which you make the near little finger string go under then over the far little finger string). Can you guess how to do an E- Universe weave? — make the lower far index string go over then under the lower near index string. Here's how it's done: Pass each thumb over the lower near index string and pick up the lower far index string, gently withdraw the thumb and reinsert it in the opposite direction (use the tip of your middle finger to temporarily hold the loop during the reinsertion), then retrieve one of the little finger strings (i.e., do one of the ten simple weaves, **a-e'**). As you return you will need to draw the retrieved string through the "hole" (i.e., the space between the intertwined lower near index and lower far index strings). In fig. 15 you'll find the result of weaving **Ea a**. This set of weaves is E- Universe:

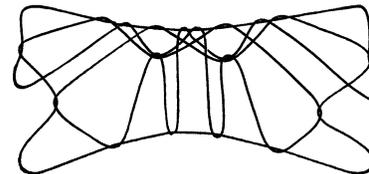


Fig. 15 - Ea a

**Ea, Eb, Ec, Ed, Ee, Ea', Eb', Ec', Ed', Ee'**

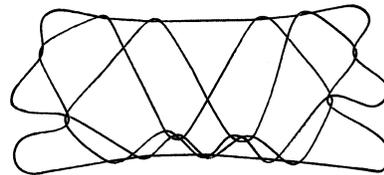
What this means is twofold. First you now have fifty more weaves (ten in each Universe) with which to weave different patterns. That is mindboggling

enough when you think that with the sixty weaves we can now form:

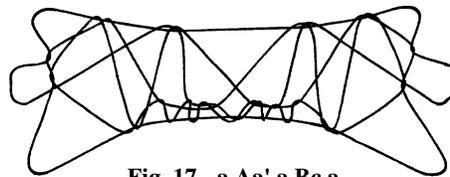
**60 x 60 = 3600** two-weave patterns, and  
**60 x 60 x 60 = 216,000** three-weave patterns

Weaving this many figures would take several school years to complete! But it is the second consequence that i find most interesting. Try forming the three-weave figure **a a a** on your hands. You should notice that the last two **a**'s merely add small loops to the lower frame string (fig. 2).

You should then conclude that any further **a**'s will only add more loops. But now form **a Aa' a** on your hands and you should notice that there is a richness introduced into the figure by blocking the "collapse" of the two reciprocal weaves (**a a'**) with an A-Universe move. This is, in fact, why i invented the Universe moves — i tried to see what an "almost collapse" of the figure would achieve, and i was pleasantly surprised. In summary, Universe moves are useful for (1) blocking reciprocal weaves; and (2) pulling the web back up onto the top frame string in cases where the design has collapsed. This could best be shown by forming the following two figures (a rather long string is required):



**Fig. 16 - a Aa' a a**



**Fig. 17 - a Aa' a Bc a**

**a Aa' a a** (fig. 16)  
**a Aa' a Bc a** (fig. 17)

You should be surprised at the result. The **Bc** weave is a crucial one in some of the higher order figures i form in the Ten Men series. But don't be deterred from experimenting and finding your own special weaves among the Universes. i haven't begun to scratch the surface of having tried them all. i've merely imagined the large number of possible differences i can try. The final word on Ten Men figures will probably never be written!

i conclude this section with a few additional Universe moves for you to experiment with. The phrase "do any of the ten basic weaves (**a-e'**)" means do the **FIRST PART ONLY** (i.e., do not **FINISH THE WEAVE** until you've completed the instructions):

- DD-Universe*: A combination weave — do any of the ten basic weaves (**a-e'**), but as you return also catch the lower far index string.
- EE-Universe*: Another combination weave, but this time also catch the lower near index string.
- F-Universe*: Pass thumb over lower far index string and do any of the ten basic weaves (**a-e'**), but as you return also catch the lower near index string.
- G-Universe*: Pass thumb over lower near index string and do any of the ten basic weaves (**a-e'**), but as you return also catch the lower far index string.
- H-Universe*: Pass thumb over lower far index string, do any of the ten basic weaves (**a-e'**) and return, then pass thumbs over lower near index string and pick up the remaining little finger string so that each thumb now has two loops (i.e., don't allow the first string to slip off).
- I-Universe*: Pass thumb over lower near index string, do any of the ten basic weaves (**a-e'**) and return, then pass thumb over lower far index string and pick up the remaining little finger string so that each thumb now has two loops (i.e., don't allow the first string to slip off).
- J-Universe*: Do any of the ten basic weaves (**a-e'**), return, then pass thumb over lower near index string and pick up the remaining little finger string so that each thumb now has two loops.
- K-Universe*: Do any of the ten basic weaves (**a-e'**), return, then pass thumb over lower far index string and pick up the remaining little finger string so that each thumb now has two loops.
- L-Universe*: Do *D-Universe*, then pass thumb over lower far index string and pick up the remaining little finger string so that each thumb now has two loops.
- M-Universe*: Do *E-Universe*, then pass thumb over lower near index string and pick up the remaining little finger string so that each thumb now has two loops.
- N-Universe*: Do any of the five simple prime weaves (**a', b', c', d', e'**), then pass thumb over lower far index string and pick up the remaining little finger string; navaho thumb loops, then finish the weave normally (i.e., pick up upper near index string and navaho thumbs again). *N-Universe* is usually done last since it adds finishing loops to the design.
- O-Universe*: Same as *N-Universe* except pass thumb over lower near index string.
- P-Universe*: Do any of the ten basic weaves (**a-e'**), then pass thumb over lower far index string and pick up the remaining little finger string, drawing it “through the hole” (i.e., the space between the lower far index string and the first little finger string you retrieved) as you return so that each thumb now has one loop.
- Q-Universe*: Do any of the five non-prime weaves (**a, b, c, d, e**), then pass

thumb over lower near index string and downflip the remaining little finger string, drawing it “through the hole” (i.e., the space between the lower near index string and the first little finger string you retrieved) as you return so that each thumb now has one loop.

*R-Universe*: Same as *Q-Universe* but pass thumb over lower far index string.

*S-Universe*: Do *Q-Universe*, then pass thumb under lower near index string, over lower far index string, and pick up near little finger string so that you have two loops on each thumb.

*T-Universe*: Do an **a** weave (first part only); pass thumb up through lower index loop (i.e., over lower far index string), pick up far little finger string and return; pass thumb over lower near index string and under lower far index string (lift with middle finger if necessary) then up into little finger loop and return with far little finger string again. You should now have three loops on each thumb. Navaho lower thumb loop over both upper loops, then finish the weave.

*U-Universe*: Do an **a** weave (first part only), then with middle finger pick up far little finger string; pass thumb up through lower index loop (i.e., over lower far index string), pick up far middle finger string and return “through the hole” (i.e., the space between the far lower index string and near little finger string); then pass thumb up through lower index loop again (over far lower index string) and up into middle finger loop; transfer middle finger loop to thumb and return through lower index loop. You should have two loops on each thumb.

*V-Universe*: Same as *U-Universe* except thumb goes *down* through lower index loop both times. See “Advanced Ten Men Variations” for a full description.

*W-Universe*: Same as *U-Universe* except thumb goes *over* lower index loop and up through *upper* index loop (i.e., over upper far index string). Useful only as a finishing move.

*X-Universe*: Do any of the ten basic weaves (**a-e'**) but also pick up lower far index string as you return; with middle finger pick up remaining little finger string; pass thumb over lower near index string and pick up far middle finger string, and draw it “through the hole” (two strings slip off each thumb as you return); pass thumb over lower index loop and transfer middle finger loop to thumb so that you have two loops on each thumb.

## ALTERING THE LOOM

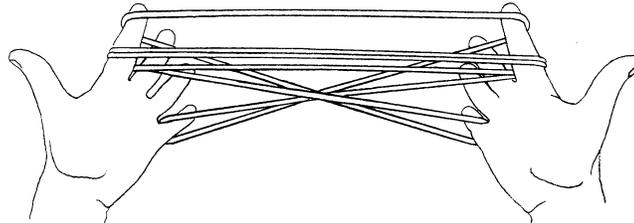
### LESSON 4: CREATING THREE-DIMENSIONAL VARIATIONS

There is a fairly simple method of forming three-dimensional figures in the Ten Men system. The necessary preparation is merely to *katilluik* the bottom

index loops after you have formed the loom and before you weave.

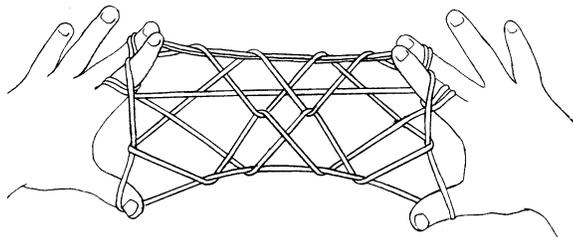
*Katilluik* is an Inuit word meaning to bring together, and it is accomplished (from the Ten Men loom position) as follows:

- Transfer the upper index loop to the middle finger so you can work on the lower index loop.
- Bring the hands together and slide the right index finger up through the left index finger loop and lift it entirely off the left index.
- Re-insert the left index finger, from below, into both loops on the right index finger and slowly separate the hands. You should now have two loops on the index fingers with two near transverse strings (i.e. strings that run straight across the figure), one far transverse string, and one pair of non-transverse strings (i.e., strings that run into the figure and cross). This complex doubled loop is now the bottom index loop and is treated as a single loop when weaving.
- Transfer the loop stored on the middle finger back to the top of the index finger. Make sure the transverse string is nearest you (i.e., don't invert the loop during the transfers). See fig. 18.



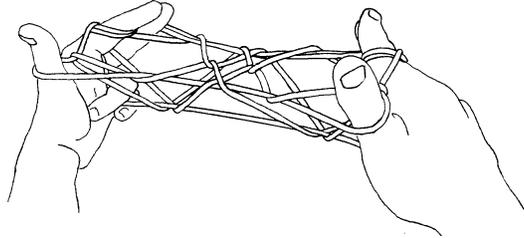
**Fig. 18** - *Ten Men loom with lower index loops katilluiked*

Now you are ready to weave. Any simple two-weave pattern (without introducing any Universes) can now be formed and extended in the regular fashion, taking note that the extending string is now doubled and both should be picked up with the middle finger. But here is where the third dimension comes in. Note the transverse string running through the middle of the extended figure (fig. 19). Without dropping the figure, hook down this trans-



**Fig. 19** - *Ten Men with central transverse string*

verse string with your ring (or ring and little finger combination) until the figure assumes a three-dimensional shape (fig. 20).



**Fig. 20** - *Three-dimensional version of Ten Men*

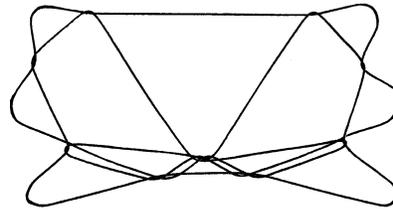
There is, of course, no reason you should not katilluik the upper index loop as well to give a double katilluik loom. This will enrich the figure even more. A simple way to katilluik both index loops without transferring loops to and from the middle finger is as follows:

- After forming the Ten Men loom, slide the right index up through the left upper index loop and lift it entirely off the left index
- Re-insert the left index finger, from below, into both upper loops on the right index finger, and lift them entirely off.
- Slide the right index up through all three loops on the left index (the single lower and the double upper) and lift them entirely off the left index.
- Slide the left index up through all four loops on the right index (the double lower and double upper) and separate the hands.

#### LESSON 5: REARRANGING THE LOOM STRINGS

Suppose for the moment you have the Ten Men loom on your hands and are ready to begin weaving. Perhaps you forget to reach for the near little finger string and instead pick up the lower near index string. This is like applying an **a** weave to the lower index loops rather than the little finger loops. If you then finish this “weave” and reset the loom (i.e., pick up the upper near index string, navaho the thumb loops, release the upper index loop and transfer the thumb loop to the index), you have something that resembles the original Ten Men loom. But if you inspect it carefully, you will note that the string crossings are different. What I think about this maneuver is that you have now formed a completely different loom by applying the logic of an **a** weave to the lower index loops. If we rename the original Ten Men loom **opening 1**, then the new loom described above is appropriately named **opening 2**. If you now form the figure **opening 2 a a** (fig. 21), you should see that it differs from Ten Men (**opening 1 a a**) because of the altered loom.

As a matter of fact, you will find that **opening 2** is “degenerate” in that the figures formed with it tend to collapse onto the bottom frame string and are not pulled up onto the top frame string to form a web. This is where the Universe weaves prove useful — they help lift the pattern up onto the top frame line. Two of my finest creations (*Jaguar* and *Five-Pointed Star*) appeared while attempting to “repair” an **opening 2** figures using Universe weaves.



**Fig. 21 - Opening 2 a a**

As mentioned above, **opening 2** is basically an **a** weave applied to the lower index loops rather than the little finger loops. Using the same logic, one can devise additional new looms by applying **b**, **c**, **a'**, **b'**, and **c'**-type weaves to the lower index loops of the original Ten Men loom, thus arriving at the following list:

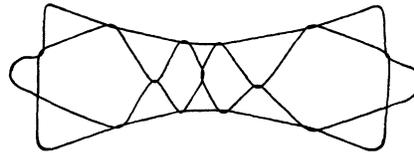
- opening 1** Original ten men loom.
- opening 2** Thumbs pick up lower near index string; finish weave and reset loom (essentially a lower index loop **a** weave).
- opening 3** Thumbs go under lower near index string and pick up lower far index string (essentially a lower index loop **b** weave).
- opening 4** Thumbs go over lower near index string and pick up lower far index string (essentially a lower index loop **c** weave).
- opening 5** Same as opening 2 but downflip the lower near index string (essentially a lower index loop **a'** weave).
- opening 6** Same as opening 3 but downflip the lower far index string (essentially a lower index loop **b'** weave).
- opening 7** Same as opening 4 but downflip the lower far index string (essentially a lower index loop **c'** weave).

In each case you will need to finish the weave (pick up upper near index string, navaho thumbs) and reset the loom (release upper index loops, transfer thumb loops to indices) to generate the new loom. Additional altered looms can be created by rotating one or both of the index loops, or by threading various loops up or down through other loops:

- opening 8** Rotate both index loops a full turn toward you (store the upper loop on your middle finger while rotating the lower loop).
- opening 9** Rotate both index loops a full turn away from you (store the upper loop on your middle finger while rotating the lower loop).
- opening 10** Rotate the upper index loop a full turn toward you.

- opening 11** Rotate the upper index loop a full turn away from you.  
**opening 12** Rotate the lower index loop a full turn toward you.  
**opening 13** Rotate the lower index loop a full turn toward you.  
**opening 14** Pass little finger loop down through lower index loop and reset it on the little finger.  
**opening 15** Pass little finger loop up through lower index loop and reset it on the little finger.  
**opening 16** Pass thumb up through both index loops, transfer upper index loop to thumb, return through lower index loop, bring thumb toward you, then transfer the loop back to the top of the index (this gives the same result as **opening 2**).  
**opening 17** Pass thumb up through both index loops, transfer upper index loop to thumb, return through lower index loop, pass thumb away from you, then transfer the loop back to the top of the index.  
**opening 18** Do **opening 16** followed by **opening 17**.  
**opening 19** Do **opening 17** followed by **opening 16**.

One can also create new designs by weaving *only* the lower index loop strings (i.e., by omitting the normal **a-e'** weaving of the little finger loop strings) or by mixing lower index weaves with little finger weaves. For example, the following two-weave sequence, which uses only lower index loop weaves, gives a pleasing pattern with interlocking diamonds:



**Fig. 22** - Two **b** weaves on lower index loop only

Ten Men loom, lower index loop **b** weave, (finish weave, reset loom), lower index loop **b** weave, (finish weave, but do not reset the loom), extend (fig. 22). Note the odd number of wraps in this figure.

Indeed, the distinction between what constitutes an alternative *loom* and what constitutes an alternative *weave* begins to blur as you continue to experiment within the Ten Men system.

Another technique for rearranging the original Ten Men loom involves using the thumbs to manipulate the little finger loops. This concept was inspired by **opening 14** and **opening 15**. The picture you must make in your mind is that of lifting the little finger loop off the little finger, using your thumb to carry it around and about the two index loops, then resetting the little finger loop back onto the little finger. Here I use bold upper case Roman numerals to symbolize these types of openings. Below are a few to experi-

ment with. First set up the Ten Men loom, then do the following:

- I** Pass little finger loop up through lower index loop, then away, and reset the loop on the little finger.
- II** Pass little finger loop up through lower index loop, then toward you, then away under lower index loop, and reset.
- III** Pass little finger loop up through upper index loop, then away, and reset.
- IV** Pass little finger loop up through upper index loop, then toward you, then away from you between the upper and lower index loops, then reset.
- V** Pass little finger loop up through both index loops, then away, and reset.
- VI** Pass little finger loop up through both index loops, then toward you, then away under both index loops and reset.
- VII** Pass little finger loop toward you under the index loops, then down through the lower index loop, then away, and reset.
- VIII** Pass little finger loop down through lower index loop, then away and reset.
- IX** Pass little finger loop toward you between the upper and lower index loops, then down through upper index loop, then away, and reset.
- X** Pass little finger loop down through upper index loop, then away, and reset.
- XI** Pass little finger loop under both index loops, then up in front of them, then down through them, and reset.
- XII** Pass little finger loop over both index loops, down through them, then then away, and reset.
- XIII** Pass little finger loop under both index loops, then away between them, and reset.
- XIV** Pass little finger loop toward you between both index loops, then under them and away from you, and reset.
- XV** Pass little finger loop toward you over both index loops, then away from you between them, and reset.
- XVI** Pass little finger loop toward you between both index loops, then over them and away from you, and reset.
- XVII** Pass little finger loop under both index loops, then up in front of them, then over them, and reset.
- XVIII** Pass little finger loop over both index loops, then down in front of them, then under them, and reset.
- XIX** Figure 8: Pass little finger loop toward you between both index loops, then up and over the upper index loop, then down and toward you between both loops, then down and under the lower index loop, away from you, and reset.

- XX** Reverse Figure 8: Pass little finger loop toward you between both index loops, then down and under the lower index loop, then up and toward you between both loops, then up and over the upper index loop, away from you, and reset.

Once you have established one of the new looms described above, try following it with two **a** weaves applied to the little finger loop and see if you get something interesting. Use a table or matrix to keep track of your findings.

### ALTERING THE EXTENSION PHASE

Most two-weave patterns of the Ten Men family are easy to extend. However, many higher order weaves (three, four, five, and six-weave patterns) will tend to collapse in the center. To help open up the design and reveal its inner complexity try using a long thin string combined with one of three alternative endings: the *Power Lift*, the *Two Diamonds Ending*, or the *Caroline Extension*. All require *Cleaning the Top* of the figure first. Cleaning the Top intertwines the two index loops, thus creating a more stable configuration of the extended design.

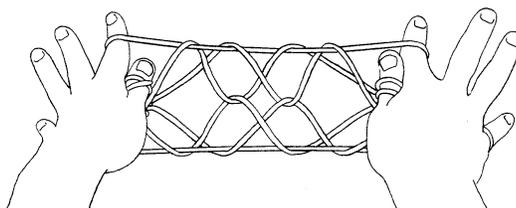
#### *Cleaning the Top*

- After displaying the figure with the standard Ten Men extension, gently withdraw each middle finger to restore the lower index loop, then release the little finger loop.
- Pass each little finger toward you under all the strings, then hook down the near thumb string, closing it to the palm. Release the thumb loop.
- Transfer the upper index loop to the thumb, inserting the thumb *from above* (this inverts the transferred loop).
- Transfer the remaining index loop to the thumb, inserting the thumb *from below* (no inversion). Keep this transferred loop near the tip of the thumb.
- Now perform a move borrowed from the Inuit *Fish-net* (Jenness 1924:56B): Insert each index, from above, into the upper and lower thumb loops; catch the lower near thumb string on its back, drawing the string up through the upper thumb loop; then curl your index finger tip around the upper near thumb string (a transverse string), and draw this string through the loop already on your index finger by rotating the index finger away from you and up (the original index loop will slip off). If necessary you can pinch the transverse string between your index and middle finger if you have trouble curling your index finger around it.
- Release both thumb loops and extend (indices pointing upward, little fingers touching the palms). Now finish the figure by selecting one of the following three endings:

*Power Lift*

There are several good illustrations of this move in my previous article (Murphy 1997:64-65). Here's how to apply it to the Ten Men figure after *Cleaning the Top*:

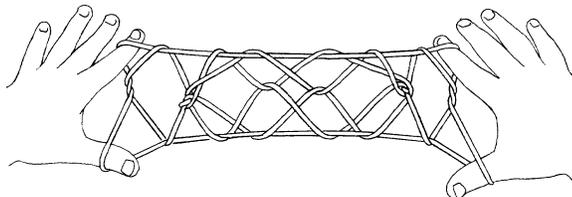
- Transfer each index loop to the thumb, inserting the thumb from below.
- Gently withdraw the little finger from its loop and reinsert it from the opposite side. The figure now lays flat between your hands.
- With each thumb pick up the near little finger string.
- Pass the index and middle fingers toward you over both strings of the upper thumb loop and pinch between them the lower near thumb string, then wrap the string around the tip of the index by rotating the pair away from you and up, lifting the string over the upper thumb loop as you straighten the index and middle fingers.
- To expand the central design, separate the indices and little fingers as far as possible and push the thumbs toward the center of the figure (two ringlets tightly encircle each thumb). See fig. 23.



**Fig. 23** - *The Power Lift applied to Ten Men*

*Two Diamonds Ending*

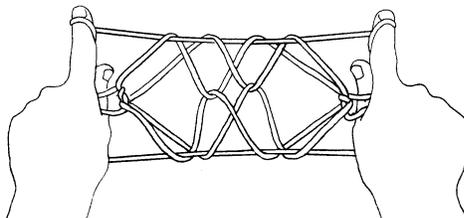
- After *Cleaning the Top*, straighten each little finger and bring it towards you, under the index loop. Transfer the little finger loop to the thumb, inserting the thumb from below.
- Transfer the index loop to the little finger, inserting the little finger *from above* (this inverts the loop).
- Transfer the thumb loop to the index finger, inserting the index finger from below. The figure now lays flat between your hands.
- Now do movements three, four, five, and six of Jayne's 'Osage Two Diamonds' (1962:28-30). These steps are also illustrated in last year's Bulletin (Murphy 1997:58, fig. 1, illustrations D through L). The extension is on thumbs and indices, with palms facing away from you (fig. 24).



**Fig. 24 -** *The Two Diamonds Ending applied to Ten Men*

*Caroline Extension*

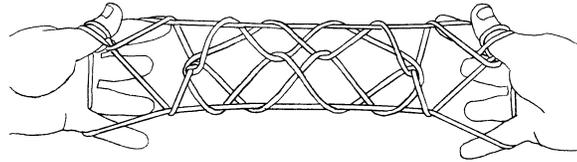
- After *Cleaning the Top*, pass each thumb away from you, under the index loop, and pick up the near little finger string and the far index string; Release the index loops.
- Gently release each little finger loop and reinsert the little finger from the opposite side.
- With the tip of each index pick up the (lower) far thumb string, but as you return press the thumb against the first joint of your index finger to keep the string you just retrieved from slipping. Extend with palms facing away from you (fig. 25).



**Fig. 25 -** *The Caroline Extension applied to Ten Men*

For figures that are really difficult to display, try combining the *Two Diamonds Ending* with the *Power Lift*:

- After completing the *Two Diamonds Ending*, transfer the thumb loop to the little finger by passing each little finger under the index loop, picking up the near thumb string, and releasing the thumb loop.
- Transfer the index loop to the thumb, inserting the thumb from below. The figure now lays flat between your hands.
- Finish by doing the last three moves of the *Power Lift* (fig. 26).



**Fig. 26 - The Two Diamond Ending plus Powerlift applied to Ten Men**

### TEN MEN VARIATIONS CREATED BY MY STUDENTS

Several years ago i took a look at the Ten Men variations my students were making after six weeks in my string figures class. Below is a snapshot of what i found (bars | separate the individual figures). Figs. 27 through 32 show some of my students displaying their creations (photos by Robin Moore).

Mitzi Cruz:	<b>a b' Ba   a' Bb a   Cb Ba a b'   b' a Ba b'   Bb' b a a Aa b</b>
Olivia Bowman:	<b>a Aa b'   d b' e   Ba c d   a d b c   a b b</b>
Celeste Peeple:	<b>kb Aa Ae Ac   Aa e Aa   kb b Ca c   Ca b' a a   kb c b a'   kb a Cc a</b> (kb=katilluik bottom index; kt=katilluik top index)
Noel Wilson:	<b>a Ab   b Aa b'   Aa d a' Aa   a c b' Ac d   Ba d c e</b>
Park Soo Mi:	<b>a a b   b a a   Ba Ba a b   Ba a a b b   a a c</b>
Keisha Gumbs:	<b>Aa e a   Ba b' c d   a b Bb c   a d b Ab   Aa Cc a c</b>
Anthony Anaman:	<b>b e' c c a   a b a b a   Aa' a' a</b>
Heather McCarthy:	<b>d'' a   Aa b e a   c'' a c   c' e a   Ae' Ab'</b>
Tomeka Brown:	<b>Ac a   e d   a Ac Ac</b>
Katherine Harding:	<b>Aa b' c e Aa   c' c' b b Ca a   Bc e' a d Ad   e' d' b c' a   a Ca b b c' c';</b>
Jason Soto:	<b>Ab a Ba b a (earthquake)   a' b Ab a (bat in flight)   c' b Aa a' b a (heartbeats)   c' Ab c' Ab c' Ab</b> (bleeding volcanoes)   c' Aa b (America the Beautiful)   b' Ab a' c Ba a (Presidential Confusion)
Joy Richardson:	<b>Aa' Ba Bb'   Aa Ba' Aa'</b>
Stephanie Chawlasky:	<b>Aa Bb b   Aa Bb a   Bb Aa b   Ab Ab a   Bb Ab a</b>
Nicole Caporale:	<b>Aa d c   e b' Ad Aa   a b b   B' e Aa   Ca b e'</b>
Lorenzo:	<b>a a Aa   a Ab   a a b on index b   a b on index b   a a Ab</b>
Serai Ramos:	<b>e' a c'   a Ab   a b' b   c b c'   Cb a a c</b>
Andrea White:	<b>e' b Ac   Bc d Ca   d Ab b'   Ce a b' Ad   Ec Da b c   Ce a b' d   b' Ba c' a   e' a c'</b>