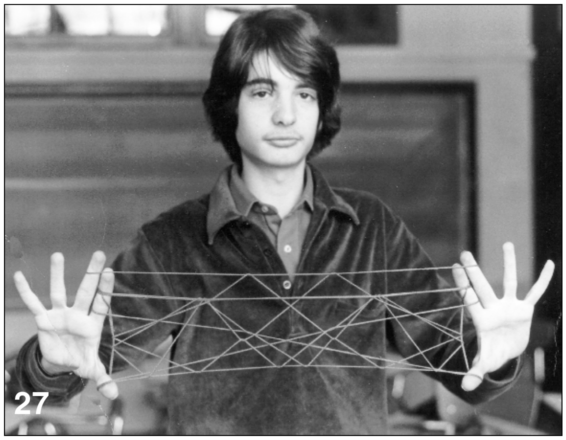
Jasmine Crowell:	**a' d b' Aa e | e Aa b' d a' | Aa a' Bb b' | c' d e' b' a' a' | a' a' b' e' d c'**
Sarah Woozley:	**c a' b' Na | c Ra c' c a Vc' | Qa Ia | a Ta' Pa | b a d a**
Christine Giacona:	**Bb c b' | Ac Ba Ab | a' b' c' | a' a' a' | b b a'**
Imelda de la Cruz:	**Aa Aa c' | Aa c' a | d b Ba | d c' Ca | d Ba a''**
Nancy Namias:	**a Aa | Ac b' Ca' | Cc Aa Bb a c | a b | Ab c' a'**
Erik Torrente:	**a a b' a | c b a | a b Ab' d | a' Aa b'**;
Cucu:	**a c a | d Ba a' | Bb c' a | Aa d c | Cb Ac Bb**
Steven Oquendo:	**a d b' c | d a c e b' | b' c a | e b d a | c b a b'**
Chip Shelby:	**e a a Aa b | Aa a' Bb b' Cc c' | Bb DDd a b e | Aa b Cc d Nb' | d Aa Ra Na' e**
Doris Fuentes:	**b e' c c a | a b a b a | Aa a' a | a c b | a a'**
Ricardo Liriano:	**b e c c a | a c b | Bb b' a c a | Aa' a**
Clare Spigner:	**a' c a | b' a' c | a b b | b d a' | a b a**
Faith Anderson:	**a Bb a' c | Ca b' Bb' a |Ad a c' e' | a c Cb d | e' Bc c' d**
Girelli Gillett:	**a b' d' c | d' a c c' | e a b' c | a' b' c' d' | b' c a b**
Tyrone Hall:	**Bb c a b | Aa a c a' |Ca b c' c | Da Aa Ba c' | a' c' b d'**
Cynthia Cortez:	**Aa Bb b e | Aa a Bb c | Aa Aa Aa b'**
Murphy:	**kt a c Aa a | kt a Cc Aa' | kt a Cc Ba | kt Va Nc a | kt b on index a a Aa' b' | Ca b c' Ab c | Aa Bb Cc c' b | a c b' Bc d | Aa d a' Aa | Aa Cb' Aa**
Jithro Hangad:	**b b a a | Aa Aa b | Ca Ca a a | Ba Aa Ba | Ab Ab Ba**
Janet Li:	**a e c a' | Aa e b b a | Ba c a' e | Ab a' b a | Ca b' c e**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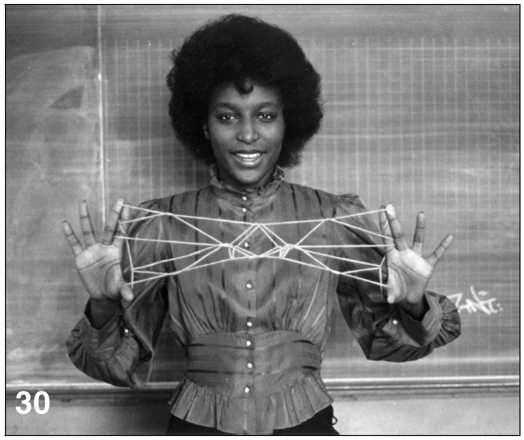

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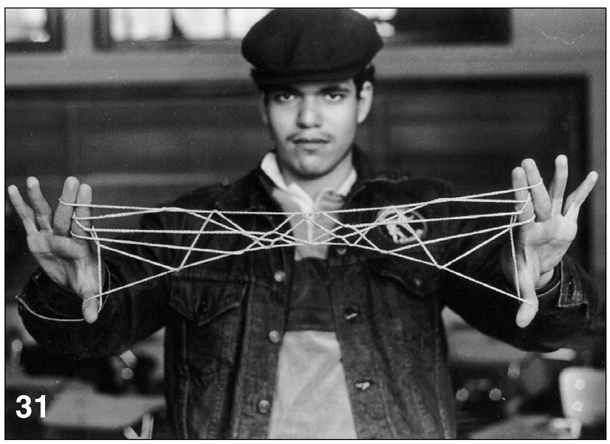

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MOUNTING YOUR CREATIONS

By default we extend our Ten Men creations using three fingers: the thumb, the index, and the middle finger. The result is a rectangle which encases a web of some sort. But for many Ten Men variations there's lots of beauty hidden in the design which can only be revealed by mounting the pattern on a board using nails (fig. 33). With nails you can draw out various segments of the upper and lower frame strings to create all sorts of interesting designs that you can't display on your hands. With a little practice you can create designs that resemble butterflies, bats, or birds in flight.

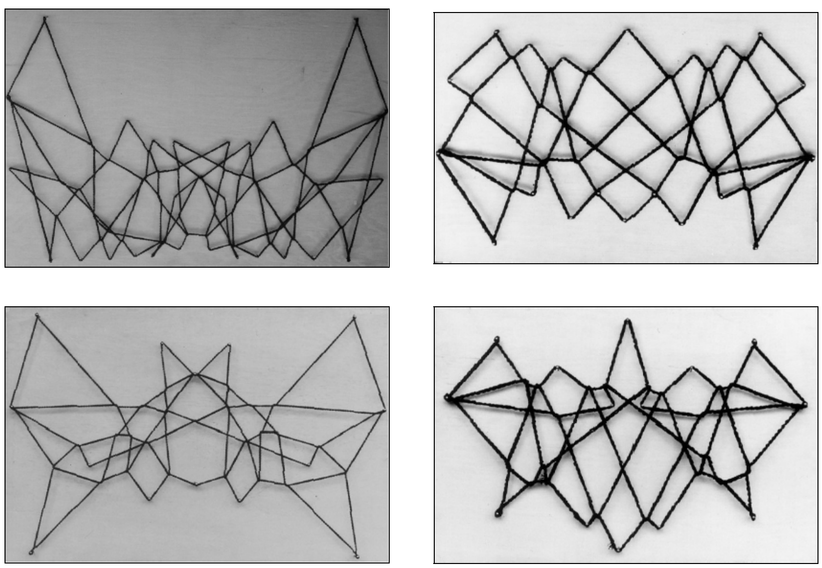

Fig. 33 - *Ten Men variations arranged and mounted on boards with nails*

WEAVING WITH A TWO-COLOR LOOP

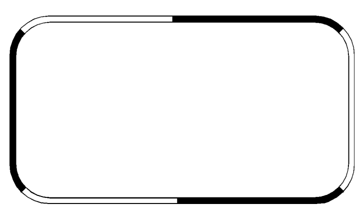

Fig. 34 - *Hexagonal loop*

Recently i've introduced my students to the concept of weaving with a two-color loop (see Murphy 1997:69-73). Since the basic Ten Men loom has three loops, you need a "hexagonal" two-color loop (i.e., a six-segment loop with 60º arcs that alternate in color, see fig. 34). You can make such a loop by purchasing two different colors of nylon string, cutting six segments of equal length (three of each color), and fusing the segments using a candle flame.

Once made, form the Ten Men loom and arrange it so that the string changes color as it winds around each finger (fig. 35). Then weave Ten Men or a variation of it. The result is quite surprising! The colors segregate so that the upper half of the design is one color and the lower half is another color (fig. 36). Also try arranging the loom so that the color changes occur midway between the hands. Can you guess what happens to the final design?

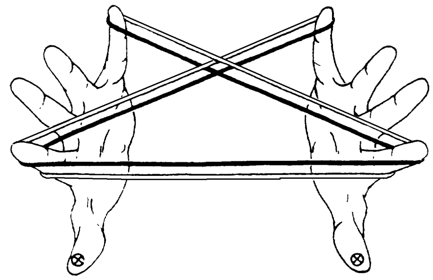

Fig. 35 - *Ten Men loom with two-color loop*

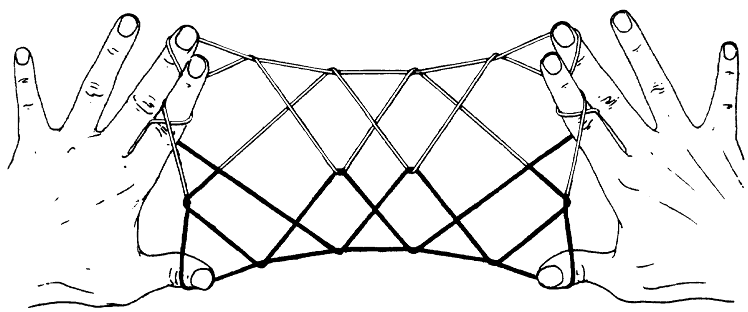

Fig. 36 - *Ten Men woven with a hexagonal two-color loop*

One final note: if you're making a Ten Men figure that starts with a loom in which the upper or lower index loops have been katilluiked, you'll need an octagon loop (i.e., an eight-segment loop with alternating 45º arcs). For figures beginning with a double-katilluik loom, you'll need a decagon loop (i.e., a ten-segment loop with alternating 36º arcs).

ADVANCED TECHNIQUES

Backweaving

As i mentioned previously, many figures derived from **opening 2** are degenerate, meaning that the web collapses onto the lower frame string leaving a large hole in the center of the design (try, for example **opening 2 a a**). It was at this time that i chanced upon the idea of weaving *backwards* as a means of pulling the mesh back up onto the upper frame string. One of the most pleasing patterns to evolve from this technique has the sequence **opening 2**, **a**, **BWCa**, **a**, where **BW** stands for backweave (fig. 37). Here's how it works:

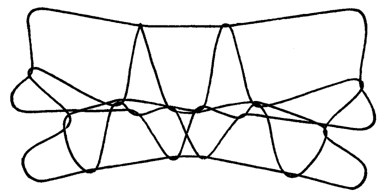

Fig. 37 - Opening 2, a, BWCa, a

- Do opening 2, then do a complete **a** weave.
- Start to reset your loom by releasing the upper index loops, but *do not* transfer the thumb loops to the indices. Rather, transfer the little finger loops to the tops of the indices.
- You now have a “backwards” loom, and the subsequent weave (**Ca**) should be done as if your little fingers were your thumbs and vice-versa: Pass each little finger towards you over the lower far index string and the lower near index string (this is the mirror image of the C-Universe weave), then pick up the far thumb string (this is the mirror image of an **a** weave).
- To complete the backweave, each little finger picks up the upper far index string (again, little fingers acting like thumbs); then navaho little finger loops. This finishes the backweave.
- Now reset the loom for a normal weave: Transfer the thumb loops to the tops of the index fingers.
- You are now ready to do the final **a** weave (forward version, not backward version!) and the extension phase, as if you were making Ten Men from the second weave to the end.

Mastering backweaving requires practices. You must remember to transfer the little finger loops to the tops of the indices just before encountering the **BW** symbol. Then simply imagine that you are looking at your hands reflected in a mirror. Pretend your thumb is your little finger and vice-versa. Remember that everything is backwards: near and far are defined relative to your little finger, not your body. In other words, to do a Universe-A move (thumb over lower *far* index string), you would need to pass each little finger over the lower index string that is farthest from it (the string we normally call the lower *near* index string).

The V-Universe

One of the most interesting weaves in my notebook is the *V-Universe-a* weave (**Va**), which i use when making ‘Jaguar’. Although i’ve already presented it in my list of Universe moves, here is a more detailed description of the **Va** weave. First set up the Ten Men loom then proceed as follows:

- Pass each thumb under both index loops and pick up the near little finger string.
- With each middle finger pick up the far little finger string.
- Pass each thumb over the lower near index string and down through the

lower index loop, then pick up the short far middle finger string and return through the lower index loop *and* the original thumb loop, which will slip off (the original thumb loop is the one you created by picking up the near little finger string).

- Again pass each thumb over the lower near index string and down through the lower index loop, then up into the middle finger loop. Transfer the middle finger loop to the thumb and return through the lower index loop. You now have two loops on each thumb (fig. 38).

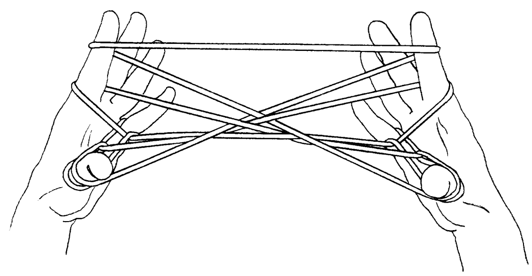

Fig. 38 - *First part of the* **Va** *weave*

- Now you can finish the weave as you would any other weave: With each thumb pick up the upper near index string, then navaho the thumb loops (double lower loop over upper single loop).

Now you can either reset the loom by releasing the upper index loops and transferring the thumb loops to the indices, or proceed directly to the extension phase if you wish to end with **Va**.

ADVANCED TEN MEN VARIATIONS

Here are a few designs that me and my students have stumbled upon over the years. Many combine altered looms with altered weaves and altered extensions.

The Jaguar (fig. 39)
This figure reminds me of the abstraction of a jaguar's face which could have been carved on a stele in Teohuatican. Its sequence is:

opening 2: a, a, a, Va, extend

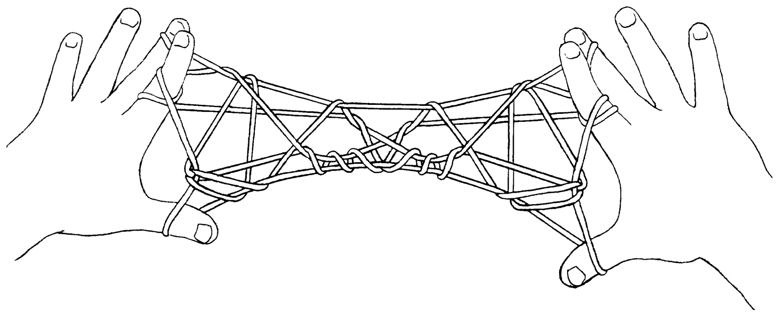

Fig. 39 - *The Jaguar*

Two Fishes (fig. 40)
This is a simple variation of Jaguar that uses **opening 3** instead of **opening 2**.

opening 3: a, a, a, Va, extend

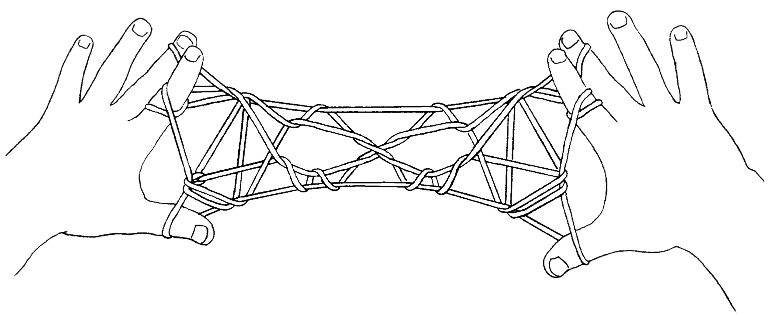

Fig. 40 - *Two Fishes*

Five-pointed Star (fig. 41)
This is one of my most treasured figures. Use a long, thin string.

- Ten Men Loom.
- Katilluik the lower index loops.
- Rotate the double lower index loop a full turn towards you (again, you will need to temporarily store the upper index loop on your middle finger).
- Rotate the upper index loop (and only the upper index loop) a full turn *away* from you. From now on treat the double lower index loop as if it were a single loop.
- **opening 2** (thumb picks up lower near index string; finish the weave and reset the loom).

- **Aa** (pass thumb up through the lower index loop and return with the near little finger string).
- **opening 3** (thumb picks up far lower index string under near lower index string; finish the weave and reset the loom). You now have an extensively altered loom.
- Now do the following weaves: **a**, **a**, **Va**, **extend**.
- To reveal the *Five-Pointed Star* we use an altered extension that is similar to the one we use for extending our three-dimensional Ten Men variations: With each ring finger hook down the single transverse string that crosses the center of the figure (the string created by the lower index loop katilluik move), then catch this string on its backs by rotating the ring finger away and up. The central transverse string becomes a new upper frame string. Extend with palms facing away from you. In summary, the sequence for this figure is:

  Ten Men Loom: katilluik bottom index loops, lower index loops –2/2, upper index loops +2/2, opening 2, Aa, opening 3, a, a, Va, extend, lift central transverse with ring fingers.

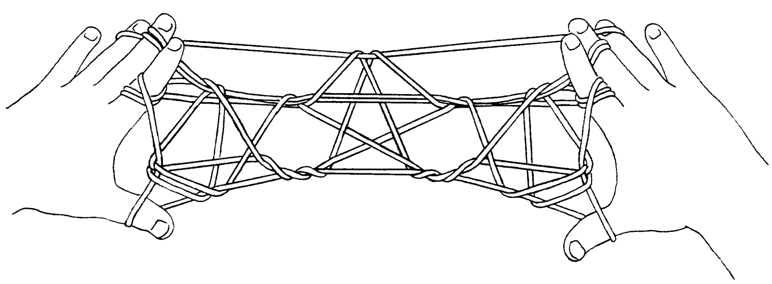

Fig. 41 - *Five-Pointed Star*

Dancing Diamond (fig. 42)
My students love this animated figure. Only very subtle hand movements are needed to make diamond 'dance'.

- Ten Men loom.
- Do an **a** weave (thumb picks up near little finger string; finish the weave and reset the loom).
- Now do a complex weave: Pass each thumb under the near lower index string and pick up the far lower index string (so far this is like **opening 3**); with the tips of each middle finger push the upper far index string toward you, under the upper near index string (and over the lower near index string), then push it down through the thumb loop; on each hand hook your thumb over the string pushed down by your middle finger (at

this stage you can release your middle finger), then *downflip* this string and draw it through the thumb loop, which slips off.

- Now finish the weave (with each thumb pick up the upper near index string, navaho the thumb loops) and extend the figure (middle finger picks up lower near index string, release little fingers, turn palms away). Care must be taken to lift the proper lower near index string since it becomes somewhat entangled by the procedure. You now have a double-walled diamond flanked by coiled strings.
- To make the diamond 'dance', shift your hands back and forth ever so slightly (tilt all ten fingertips to the right, then to the left). Only very small hand movements are required to make the diamond dance.

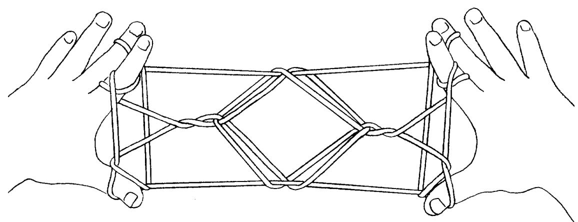

Fig. 42 - *Dancing Diamond*

Colossal Caribbean Creature (fig. 43)

This figure was invented recently during a leisurely cruise through the Caribbean.

- Set up the Ten Men loom and katilluik the upper *and* the lower index loops.
- Do an **Aa** weave, but during the A-Universe part pass each thumb over the non-transverse lower far index string only (not both lower far index strings). Finish the weave and reset the loom, but during the last step, transfer the little finger loops rather than thumb loops to the tops of the indices, since the next weave is a *backweave*.
- Do a **BWBa** weave, but during the B-Universe part pass each little finger over the non-transverse lower far index string only, and during the **a** weave part, pick up the non-transverse far thumb string only (in both cases i'm using *far* in the traditional sense, i.e., "farthest from your body" to avoid confusion).
- Do a **d** weave, **c** weave and **b'** weave, then extend (middle finger picks up the double lower near index string). To complete the figure, lift the central transverse string with each ring finger as in *Five-Pointed Star*. The formula for this figure is:

Double katilluik loom, **A(nt)a**, **BWB(nt)a(nt)**, **d c b'**, **extend**, **lift out t with ring**. (Here, nt=non-transverse and t=transverse).

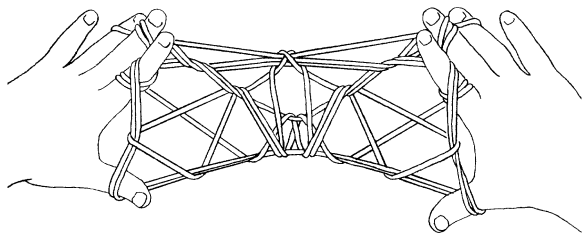

Fig. 43 - *Colossal Caribbean Creature*

Devil's Cage (figs. 44, 45, and 46)
This three-dimensional figure opens with a left-handed spiral version of Opening B, otherwise known as a DNA opening (see Ornstein 1994). Mark Sherman named this figure *Devil's Cage* because of its fiendish difficulty.

- First, form the DNA opening: Start with Opening B (same as Opening A, but pick up the right palmar string first); release the thumb loops; insert the left thumb, *from above*, into the right index loop and return with the right near index string (rotate thumb toward you and up); insert the right thumb, from below, into the left thumb loop and extend. You know have a left-handed spiral opening (If you point your left hand away from you while keeping your right hand upright, none of the crossing strings should touch).
- Now add another spiral to the loom: Pass the left index away from you over all the strings, then hook up the right far little finger string (rotate the left index towards you and up as you return); insert the right index, from below, into the upper left index loop and extend.
- Transfer the upper index loops to the thumbs, inserting the thumbs from below.
- Transfer the remaining index loops to the ring fingers, inserting the ring figures *from above*. Keep the transferred loop near the base of the ring finger.
- Transfer the upper thumb loops back to the tops of the indices, inserting the indices from below.
- Again add another spiral to the evolving loom: insert the left thumb, *from above*, into the right index loop and return with the right near index string (rotate thumb toward you and up); insert the right thumb, from below, into the left upper thumb loop and extend.
- Transfer the index loops to the ring fingers, inserting the ring figures

from above. Keep the transferred loop near the top of the ring finger.

- Transfer the upper thumb loops to the middle fingers, inserting the middle fingers from below; transfer the remaining thumb loops to the index fingers, inserting the index fingers from below.
- Katilluik the index loops.
- Transfer the middle finger loops to the index fingers, inserting the index fingers from below, to create upper index loops. Now you are ready to start weaving! (all this turmoil furnishes three loops for weaving and an extra transverse string for the 3-D extension).
- Do an **a** weave with the upper near ring finger string (pass thumb under both index loops and up between both index loops and both ring finger loops; pick up upper near ring finger string and return); finish the weave (thumb picks up upper near index string, navaho thumb loops) and reset the loom (release upper index loops, transfer thumb loops to index fingers).
- In a similar fashion, do an **a'** weave with the lower near ring finger string; finish the weave and reset the loom.
- Now do a regular **a** weave with the near little finger string; finish the weave and reset the loom.
- The last weave is complex: Pass each thumb under the index loops and insert it, from below, into the little finger loop and both sets of ring finger loops; with the thumb hook down the upper far ring finger string, drawing it down through the lower ring finger loop (use the tip of your middle finger to help you do this), then pick up on the back of the thumb the lower far ring finger string and return through the little finger loop (the hooked string will slip off); gently release the thumb loop, then reinsert the thumb from the opposite side; pass the thumb under all the strings, pick up the far little finger string and return, drawing this string through the thumb loop (which slips off); artificially downflip this string (i.e., rotate the thumb loop half a turn away from you), so as to form an inverse weave; finish the weave (pick up the upper near index string, navaho thumb loops) but *do not* reset the loom (you are now ready to extend the figure).
- With each middle finger pick up the lower double near index string, but don't release the little finger loops yet. Instead, find the single transverse lower far index string (the one you created with the katilluik move), and hook it down to the palm with your ring fingers, drawing the string through the double loop on each ring finger, which slips off as you close the ring finger to the palm; release the little finger loops and extend to absorb the slack; insert each little finger into the ring finger loop and likewise close the finger to the palm.
- Transfer the thumb loops to the ring fingers, inserting the ring fingers from below; again close the ring fingers to the palm.

- We now perform the last half of *Cleaning the Top*: Gently withdraw each middle finger from the loop surrounding it; locate the upper index loop (the single loop) and transfer it to the thumb, inserting the thumb *from above*; transfer the remaining index loop (the double loop) to the thumb as well, inserting the thumb *from below* (keep the double loop near the tip); insert each index, from above, into the upper (double) and lower (single) thumb loop; pick up the lower near thumb string on its back, drawing it up through the upper thumb loop; now curl your index fingertip around the upper near thumb string (a double 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).
- Release all thumb loops and extend, indices pointing upward, ring fingers and little fingers touching the palms (fig. 44).

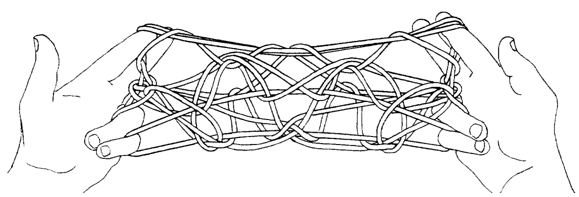

Fig. 44 - *Devil's Cage prior to 3-D extension*

- Now extend in three-dimensions: Insert each thumb, from below, into the ring finger loop and transfer this loop to the thumb. The near thumb string should be a transverse string. Fig. 45 shows a front view and fig. 46 shows a bottom view.
- Congratulations! If you made it this far you've outsmarted the devil (the strings that criss-cross in the center of the figure represent the devil trapped in a prism-shaped cage).

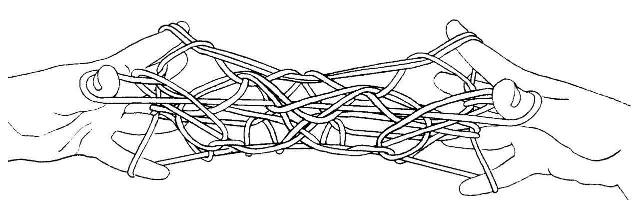

Fig. 45 - *Devil's Cage (front view)*

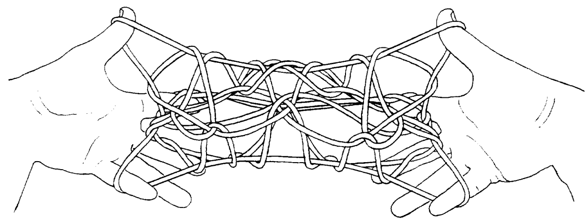

Fig. 46 - *Devil's Cage (view from below)*

i end this section with a list of recent creations, some of which i invented while cruising the Caribbean last February. A long thin string is usually required, and i encourage you to extend these figures using either the *Power Lift*, the *Two-Diamonds Ending*, the *Caroline Extension*, or a combination thereof. (*Editor's Note*: The illustrations show the figure after *Cleaning the Top* and applying the *Caroline Extension*. Only the central design is shown, i.e., the finger loops have been omitted).

1) **Va b'** (fig. 47)
2) **a Ec c' Ab** (fig. 48)
3) **a b (on top) b' Bc a b (on top) b'** (fig. 49)
   [b (on top) is the same as **opening 3**, or doing a **b** weave on the lower far index string. Lately i've been using this terminology whenever i use this move as a weave and not as a means of forming an altered loom. The reason i call it "on top" is because the index loops lie above the little finger loops when you point your fingers away from you in preparation for doing this move. **Bc** is a move designed to lift the complexity back onto the top frame string. It is a constant motif in my figures]
4) **a b' a Bc a b'** (fig. 50)
5) **b b (on top) b'** (fig. 51)
6) **c b (on top) c'** (fig. 52)
   [compare 5 and 6 and look for meaningful differences]
7) **double katilluik loom a e Aa c** (fig. 53)
8) **a Hc'** (fig. 54)
   [during the H-Universe weave, pick up the second string near the center of the figure, then downflip both of the strings you retrieved]
9) **a Hd' Dd'** (fig. 55)
10) **a Hd' Dd' c b'** (fig. 56)
    [best when extended using the *TwoDiamonds Ending* plus *Power Lift*]
11) **opening 2 a Va Aa' a** (fig. 57)
12) **katilluik top index only a c Aa** (fig. 58)
13) **a BWa Aa a'** (fig. 59)

[recall that **BWa** is “backweave **a**”; after finishing the first **a** weave the loom is reset by transferring the little finger loops to the tops of the indices. You then imagine that the little fingers are your thumbs and your thumbs are your little fingers. Also remember that *near* and *far* are defined relative to your little fingers rather than your body while backweaving (important for doing Universe moves correctly). Once you finish **BWa**, reset the loom by transferring the thumb loops to the indices and complete the remaining weaves normally. Note that you cannot extend from the backweave position — your hands don’t work that way!]

Caribbean creations

14) **Aa BWAa d b'** (fig. 60)
15) **Aa BWAa d Bc a BWa a b'** (fig. 61)

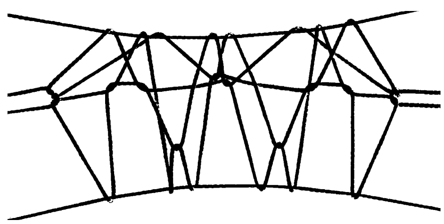

Fig. 47 - Va b'

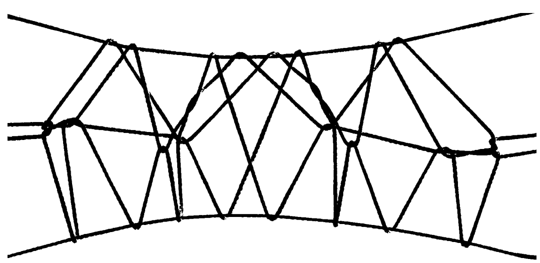

Fig. 48 - a Ec c' Ab

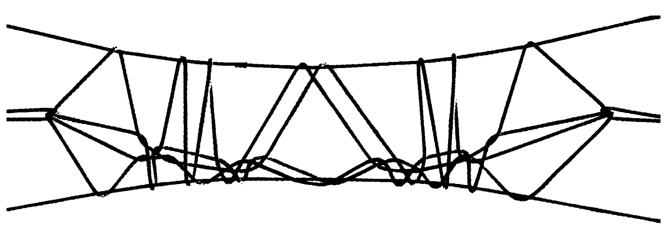

Fig. 49 - a b (on top) b' Bc a b (on top) b'

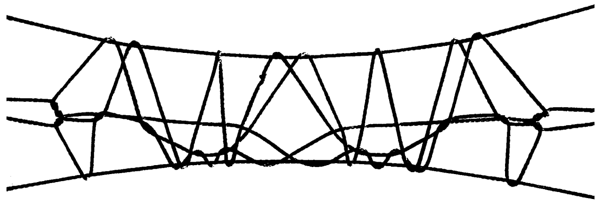

Fig. 50 - a b’ a Bc a b'

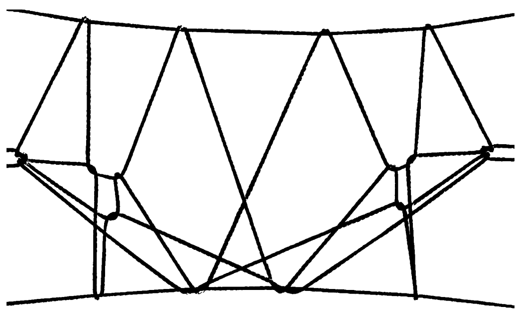

Fig. 51 - b b (on top) b'

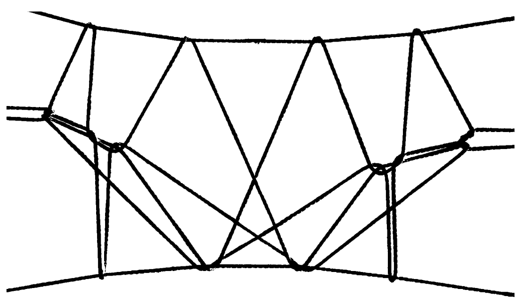

Fig. 52 - c b (on top) c'

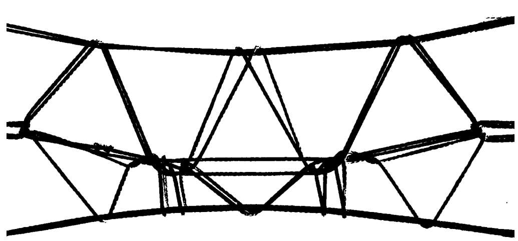

Fig. 53 - double katilluik loom a e Aa c

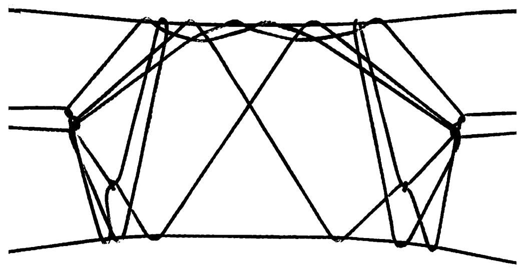

Fig. 54 - a Hc'

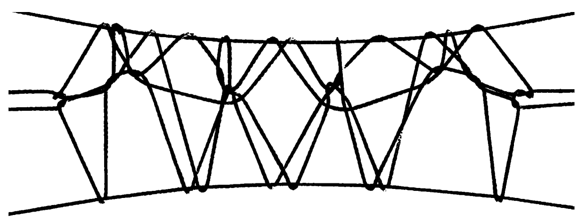

Fig. 55 - a Hd' Dd'

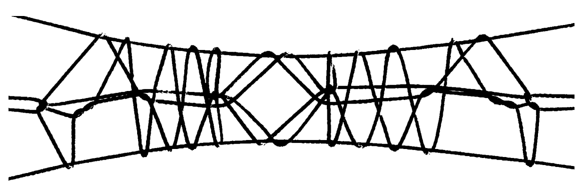

Fig. 56 - a Hd' Dd' c b'

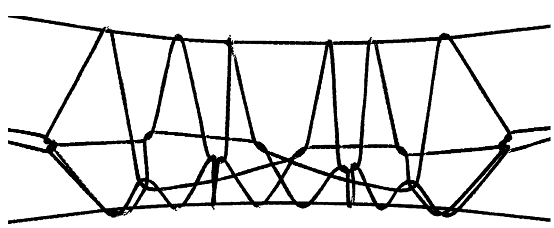

Fig. 57 - opening 2 a Va Aa' a

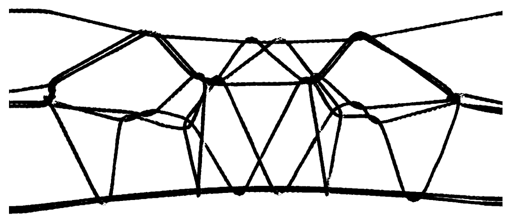

Fig. 58 - katilluik top index only a c Aa

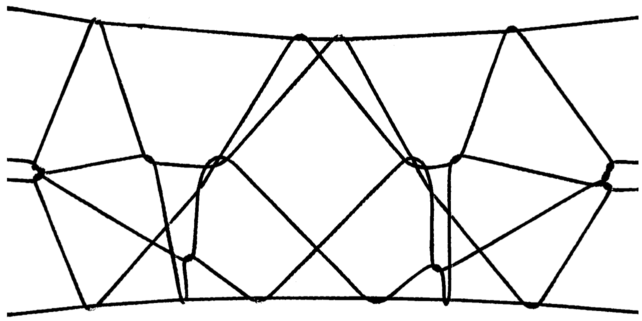

Fig. 59 - a BWa Aa a'

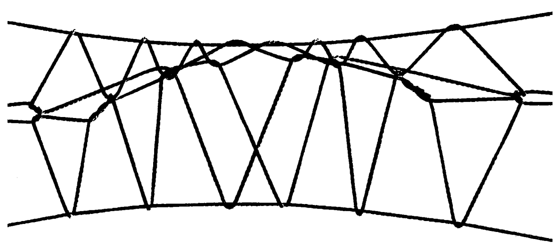

Fig. 60 - Aa BWAa d b'

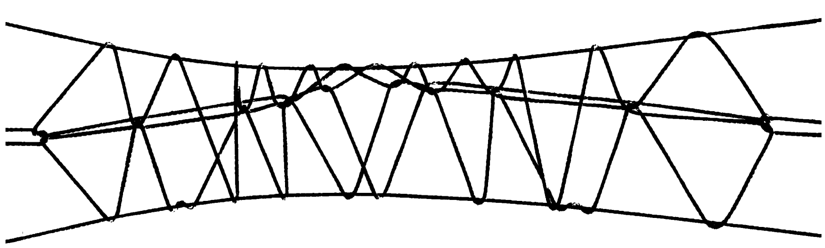

Fig. 61 - Aa BWAa d Bc a BWa a b'

DISCUSSION AND SUMMARY

As a math teacher for the last twenty years (replete with a sojourn as principal of an alternative high school for four years), i have had the repetitive experience of wondering why students do not dwell on, practice, and then internalize fundamental math concepts which can then be used intuitively in problem solving or modeling. This practiced retention of a concept isn't easy when the teacher follows the standard math curriculum and its hide-bound organizational development. Students rarely become naturally mathematical in their thinking.

String figures afford in their introductory phase an opportunity for catching a student's interest, and naturally impelling him or her into a thorough practice of a figure or procedure until it becomes automatic and inculcated into that student's organizational framework of thinking and understanding. They are therefore wonderful windows of opportunity for "catching" a pattern of thought such as the concept of a mathematical "inverse".

In beginning algebra (and often much earlier) students are taught that the *additive inverse* of a number is the same number with the opposite sign. A student is then given various exercises to cement this concept. For this idea you must formulate a beginning number zero which is always the resultant of adding any number and its additive inverse. This is all well and good, but students will stare vacantly three weeks later when asked to describe an additive inverse no matter how intensive the drilling on the concept.

Ditto with the multiplicative inverse. For this one the beginning number is one and if one is multiplied by 3/2 and 2/3 in succession (or indeed if 3/2 and 2/3 are multiplied together), the product is one. Again a blankness when questioned later. And God help you if you ask for both concepts on a single test. The students actually whimper in their fear and frustration. Almost all math teachers will nod in agreement.

In string figures, almost all the figures begin with the procedure known in the literature as opening A. The very first thing i teach a beginning student of string figures is *The Trap* (see Gelvin Stevenson's article in this volume). It is a simple magic trick but it also effects a visceral appreciation by the student as to the reversal or disentanglement involved. This is a use of the concept of an inverse which is for real!! The reason this is the first lesson is that it reinforces practicing opening A until it becomes automatic.

Another example of how the concept of inversion is followed up, but now in a much more mathematically rich setting, is the introduction of idea of the inverse weaves in the Ten Men system of forming figures. In this situation the Ten Men figure itself is carefully learned and the ideas of the original loom position, weaving, resetting the loom, and extending are practiced until they are all easily done, described while doing, and thus understood.

When this figure is thus mastered, it is explained as a simple two-weave pattern of **a a**. This is readily understood since there is a repetitive sequence of moves in the forming of the figure. Then the student is asked to form a three-weave figure **a a a**, which is readily accomplished. Then the student is asked to form a *down-flipped* **a** followed by two regular **a**'s. You can imagine the surprise when the loom position emerges after the second weave!! And at this point it is natural and inevitable to talk about and experience manipulation of the inversion relationship to form the more elaborate and beautiful figures in the Ten Men system. It becomes an ingrained habit of conjecture.

And the inverse relationship of weaving and forming figures occurs throughout all the systems of forming figures in my method of teaching string figures. The indelible experiencing of the disentanglement of the complex buildup of the web of string is a true fixing of the mathematical concept of inversion.

In closing i offer the following poem:

between the cracks
between the web of words
and numbers, the web of ideas
lies the not yet thinkable
the not yet said

and when we learn
to finally say it
to pin it down in chloroformed beauty
for all to see and understand

when we demystify our intuition
we have learned enough to say
this is but a pale human idea
brought to life
made a part of understanding

inoli

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APPENDIX — ADVANCED MATH TOPICS

The Almost Collapse

One of the most interesting things about the Ten Men series of string figures is the existence of reciprocals. You know by now that the **a** weave followed by the **a'** weave finished (that is, with the loom reset for another weave) results in a return to the original loom position or the erasure of the two weaves **a** and **a'**. They can be said to cancel each other. This happens no matter which order they are woven. This is an important fact mathematically speaking since the existence of reciprocals are necessary for a mathematical system to qualify as a *group*. This idea of a group is a sophisticated math term which means a great deal to a mathematically trained person. You might wish to ask a math teacher about this.

But for now i want to talk about the practical applications of the idea of the "almost collapse". If you remember, the Universes **A**, **B**, **C**, **D** and **E** all have the possibility of weaving any of the ten simple weaves **a**, **b**, **c**, **d**, **e**, **a'**, **b'**, **c'**, **d'** and **e'** after you have passed your thumb over the appropriate lower index string or strings. One of the consequences of entering a new Universe is to forestall the collapse of your weaving pattern when you use reciprocal weaves one after the other. For example, Suppose you wish to weave **a a' a**. This would not be a three-weave pattern since the **a** and **a'** would cancel each other and you would succeed only in weaving a single **a** for your trouble. However if you were to change either of the first two weaves to another Universe you would have a legitimate three-weave pattern and it will have an open complexity since it includes an *almost collapse*. The following might be possible patterns for you to try:

a Aa' a	**Aa a' a**
a Ba' a	**Ba a' a**
Aa Ba' a	**Ba Aa' a**

a Ca' a	**Ca a' a**
Aa Ca' a	**Ca Aa' a**
Ba Ca' a	**Ca Ba' a**

And indeed, you may stop the collapsing of any pattern when it would normally do so by using an alternative Universe for one of the paired inverse weaves.

Equivalent Weaving Pairs

There is another series of seeming simplifications with three-weave patterns which hold the key to some very pretty Ten Men figures. They are the result of an amazing set of equivalences which i have investigated thoroughly. The following weaving pairs are the same in their reaction to prime weaves:

a b
b e
d c
c a

And there is an amazing thing which happens because of it. Suppose you were to start with **a'** followed by the pair **a b**. This would result in a simple **b** weave since **a'** and **a** cancel. But amazingly enough **a' b e** or **a' d c** or **a' c a** are also equivalent to a simple **b** weave since **b e**, **d c**, and **c a** are the same as **a b** in their reaction to prime weaves. And since **c' c a** results in a simple **a** weave (the **c** and **c'** cancel), doing **c'** before any of the pairs listed above should also result in a simple **a** weave:

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

Furthermore, the inverse weave can follow the pair with the same result. For example, the following all result in a simple **a** weave:

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

Another thing which is (or at least should be) immediately apparent, is the necessity for the reciprocals of the four equal pairs also to be the same. So the following weaves are all the same:

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

The explanation for this miraculous relationship can be better understood if we examine what the five basic weaves and their inverses accomplish. You can think of the five basic weaves as causing rotations of the little finger loops. For example, in doing a **b** weave we pass each thumb under the near little finger string and pick up the far little finger string. If you were to release the little finger loop, thus transferring it to the thumb, you would discover that the thumb loop is twisted half a turn away from you (+1/2). We can therefore prepare the following table which summarizes the effect of each basic weave:

a = 0 rotation
b = +1/2 rotation
c = –1/2 rotation
d = –2/2 rotation
e = +2/2 rotation

If we now re-examine our list of equivalent pairs (**a b**, **b e**, **d c**, **c a**), we see that the relationship between each member of the pair is +1/2.

The effect of **c' a b** as a series of weaves which collapses to a simple **a** is caused by the fact that weaves **a** and **b** are in the relationship + 1/2 from each other, and when prefaced by an inverse whose value is –1/2 (**c'**) the sum is 0, which equals an **a** weave. And for the same reason, any two weaves which are in the same relationship (+1/2) will result in a simple **a** weave if they are preceded by the **c'** weave. This means that a **b'** weave (+1/2) before a +1/2 relationship pair will result in an **e** (+2/2) since **b e** are the inductive pair. You might also try the following experiment: weave **c'** (–1/2) and then rotate the little finger loops +5/2, do an **a** weave (0), then rotate the little finger loops +1/2, again do an **a** weave (you will feel a reduction in the center complexity!), and then rotate the little finger loops –6/2, do an **a** weave, and extend. You should have Ten Men (**a a**) because of the miraculous relationship of the +1/2 pair following any prime weave.

After you've assimilated this knowledge you might consider how to combine a Universe move with any of the three-weave patterns to keep it from collapsing to a simple weave, but hopefully carrying with it the possibility of being a more open weave, a more pleasing web-like pattern which is not all scrunched up in the center and the detail of the figure is lost in a compact knot. That table might be something like this:

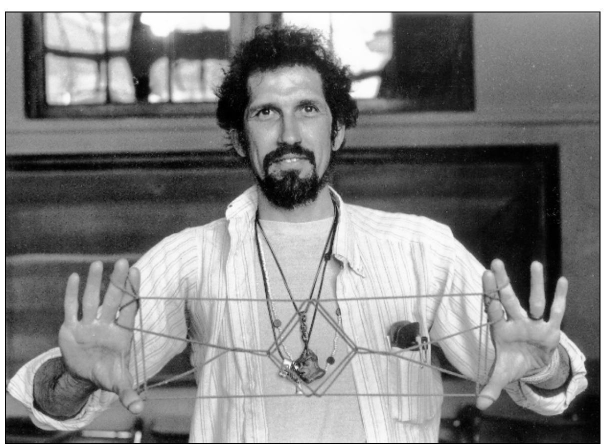
Ac' a b	**c' Aa b**	**c' a Ab**
Bc' a b	**c' Ba b**	**c' a Bb**
Ac' Ba b	**c' Aa Bb**	**Ac' a Bb**
Bc' Aa b	**c' Ba Ab**	**Bc' a Ab** etc.

Can you explain the organization principle of the above array?

Can you extend it further and envision some of the patterns you might form? You might be surprised at what you discover. Some of the patterns i have found to be of interest are listed below. These are my rough field notes. The figures are listed in the order that i tried making them as i tried to devise patterns of the open variety (as opposed to the cramped knotty figures one often gets when trying longer weaving patterns).

a Ab a' c' a
a Ab a' c' a Bc a Aa' a b'
a Ab Da' c' a b'
a Ab Db' Aa' a b'
c Aa b' Bc b Aa' c'
b Aa' c' Bc c Aa b'
Ac a b' Bc b Aa' c'
Ac a b' Ab Aa' c'
Ac a b' Bc b Aa'c' b'

Try these but don’t hesitate to strike out on your own.



A bearded James Murphy with ‘Dancing Diamond’. Photo by Robin Moore.