Sprang: Exploring an Ancient Form of Textile Weaving Through Handwork, Movement, and Poetry

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Abstract

In this hands-on workshop, participants will be introduced to the technique of sprang, one of the oldest forms of weaving dating back over 3000 years, and arising in many cultures around the world. Basic fixed-end sprang interlinking uses only warp threads in a tensioned multiple 'brickwork' netlike fabric, very much like chain link fence, and weaves simultaneously from the top and bottom of the work with mirror-image chirality. We will experiment with sprang weaving on a small, individual scale, and at large scale as a coordinated dance, to explore its structure in relation to braid groups, chirality, and as a reflected doubled form, and its potential for generating a highly elastic cloth, a movement sequence, and a combinatoric poetic form.

Introduction to Sprang

Sprang weaving or braiding is a process for making fabric using the interlinking of parallel vertical warp threads with no horizontal weft threads woven through. The resulting fabric is very elastic in the horizontal direction, and not elastic in the vertical direction (see Figure 1). The structure of basic interlinked sprang fabric is identical to the structure of chain-link fence, although the process of their making is usually quite different. More sophisticated sprang fabric designs can incorporate lace-like structures, beading, and fancy chevron and braiding patterns by related interlacing and intertwining techniques.

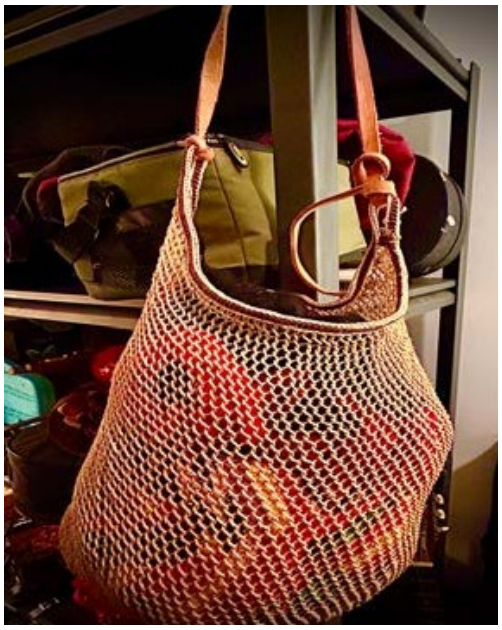

Figure 1: *Contemporary Central American sprang bag. Sprang is highly elastic, allowing it to fit curved forms, in clothing, hammocks and bags. (It does not make good fishnet because holes can be stretched!) Photo credit: Gerofsky.*

Sprang is one of the most ancient of textile arts, dating back at least to about 1400 BCE, from an archaeological discovery of a sprang women's hair net from a burial site in Jutland, Denmark. Sprang bags and caps were also found in an archaeological site in central Peru, dating to approximately 1100 BCE, and in Coptic graves in Egypt dating from approximately 400 CE [2]. Sprang fabric has been since documented in many cultures all over the world, including in Indigenous cultures in the Americas (including Chippewa, Hopi and Navajo nations in the US, in Mexico, Guatemala, Belize, Guayana, Venezuela, Columbia and Peru); in Central and South Asia and the Middle East (in countries including Iran, Afghanistan, Pakistan, India, and Libya); and in Europe (including Croatia, Romania, the Czech Republic, Spain, the Netherlands, Estonia, Denmark, Finland), and elsewhere [2]. It is still commonly used to weave hammocks and bags in Central and South America, and to weave sashes (*azarband* or *nala*) in traditional Punjabi culture [7]

Although the practice of sprang textile making has been so widely known worldwide over at least the past 3400 years, it has, paradoxically, been outside the awareness of most weavers and textile scholars even up to the present. A slow and partial revival of knowledge and interest in sprang technique has taken place since the finding of the Early Danish Bronze Age hairnet in the late 19th century, and two textile scholars, Peter Collingwood (UK, 1922-2008) [2] and Carol James (Canada, b. 1955) [6] have published the main sourcebooks on sprang. We hope that this Bridges workshop will bring interest in this ancient weaving pattern and its mathematical structure to the mathematics and arts community.

The co-authors share a deep interest in arts-based ways of experiencing mathematical patterns, especially through music, poetry, textile arts and movement [4][8]. Both are musicians, teachers and researchers, currently collaborating on a research project, Re-storying Mathematics Through Embodied Arts.

The Structure of Sprang

Sprang is a technique of multiple strand fabric weaving based on the interlinking of tensioned warp threads. It is similar to braiding (and incorporates elements of braiding) but is not necessarily identical to typical braid patterns familiar to weavers. Sprang work is usually carried out with the weaver working from one end to the other of an even number of warp threads, creating a fabric that is as wide as the warp structure. The warp threads are typically fixed at both ends, often to two rigid bars, with the result that two rows of weaving are created simultaneously at one pass: one row growing downward from the upper bar, and a mirror-image row growing upward from the lower bar. The warp threads are worked until the space between the upper and lower woven sections are too close together to allow for further interlinking, and the work is finished off in the middle by one of several techniques to keep it from unwinding. The looped warp threads may be either left on the bars or removed and finished at the ends.

The process of basic sprang interlinking consists of pairs of woven rows (see Figure 2): a plait row and an over-plait row. Warp threads wrapped around the top and bottom fixed bars of the loom separate into pairs, one 'up' and one 'down', and the action of weaving is named by lifting up the bottom warp threads and sinking down the top warp threads – a process that twists the lifted up warp(s) around the sunken down one(s). Each plait row canonically follows a pattern (typically right to left) of "2 up, 1 down; 1 up, 1 down; [...]; 1 up, 2 down". It is followed by an over-plait row of "1 up, 1 down; [...]; 1 up, 1 down". The plait row shifts the warp threads one place to the left, linking each thread with its lefthand neighbor; the over-plait row that follows links each warp thread with its righthand neighbor, creating a chiral, horizontally elastic, netlike fabric.

In this workshop, participants learn basic sprang interlinking, first through a guided activity in warping and weaving a small sample piece of fabric, and then by 'dancing' a large piece of sprang into being on a room-sized loom, where each participant holds one thread and moves in concert with it – offering two different embodied modalities of experiencing the mathematical structure of sprang. We also develop a method of combinatoric poetry creation based on the geometry of sprang, and experiment with creating Sprang Poems with participants working in groups or individually. A more detailed description of workshop activities is offered below.

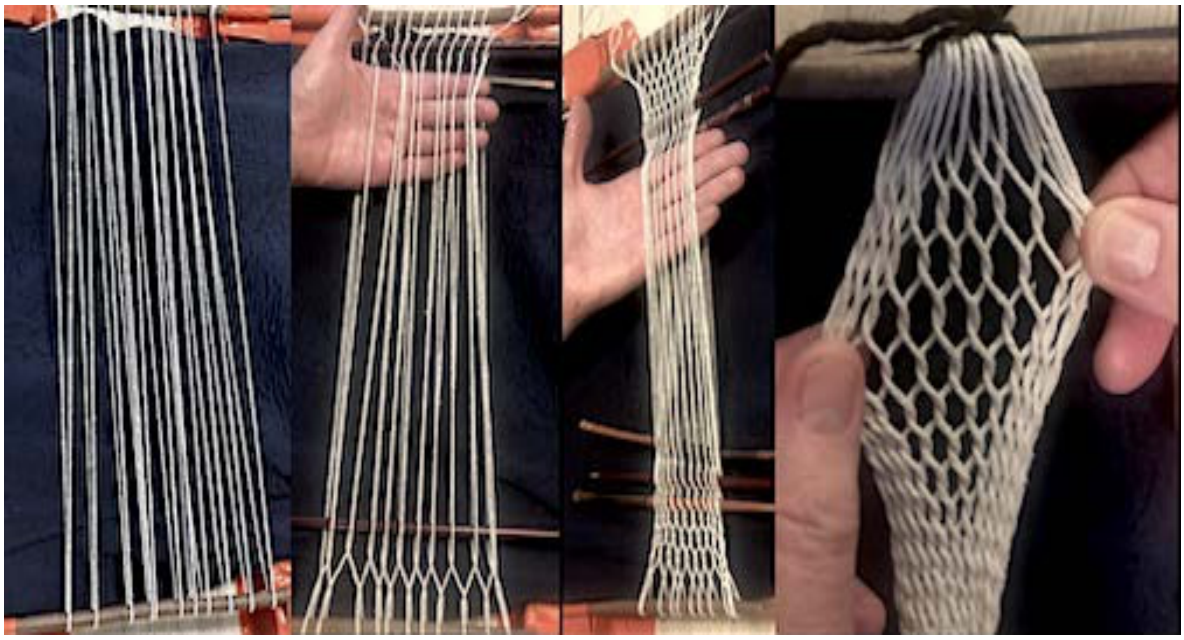

Figure 2: *L-R: warping the loom; results after first plaiting row; partially finished sprang; closeup on sprang elastic netlike structure. Photo credit: Milner.*

Sprang and Its Relationship to Braid Groups

Sprang weaving can be described mathematically in terms of braid theory. A braid ω on n strings is a 1-1 mapping in 3D space of n parallel points a_i , $1 \leq i \leq n$, to n parallel points b_i , $1 \leq i \leq n$, between which various ordered (i.e. chiral) crossings of non-intersecting arcs l_i occur. All braids are made up of compositions of simple braids σ_i wherein one "thread" crosses only its neighbor (l_i over li_{+1}). In a typical braid on n strands, the initial position of a thread does not necessarily correspond to its final position ($a_i \neq b_i$). However, braids whose start points map to the corresponding end points are called pure braids ($a_i = b_i \; \forall \; i$). If two braids "undo" one others' crossings, their composition results in the identity braid.

The initial setting of the warp in a sprang weaving of n strands is the identity braid on n strands. Because of the mirror-like nature of sprang weaving mentioned above, each crossing in the top half of the weaving will correspond with an opposite crossing in the bottom half. Thus a braid-algebraic representation of any basic interlinking sprang weaving consists of some braid ω as well as its inverse ω^{-1} (see Figures 3a and b). Note that, if not bound in some way at the conclusion of the weaving, the structure would simply unravel into the initial set warp, just as the composition of a braid and its inverse equals the identity braid: $\omega\omega^{-1} = e$.

The particular braid of interlinking sprang can be described as follows. Let ω_p be the composition of simple braids which gives the plait row, ω_{op} the composition of simple braids which gives the over-plait row, and m the number of plait rows in the top half of the weaving.) The full weaving, then, is

$$\left(\omega_p \circ \omega_{op}\right)^m \circ \left({\omega_{op}}^{-1} \circ {\omega_p}^{-1}\right)^m$$

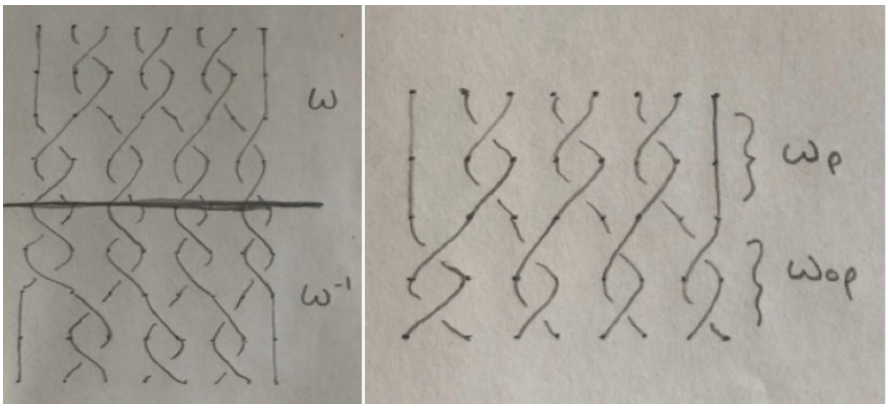

Figure 3: *(a) Braid ω and its inverse ω^{-1} (b) Schematic diagram of sprang weaving. Image credit: Milner*

Exploring Sprang as a Chiral and Reflective Form

Sprang interlinking has 'handedness'/ chirality in the same way that twining rope or spinning wool does; the direction of the twist between two strands has either a right-over-left Z twist or a left-over-right S twist (see Figure 4a) [1][3]. This chirality reveals itself in the finished piece with a tendency for the completed weaving to twist in a counterclockwise direction (for a Z twist), or a clockwise direction (for an S) twist. This twisting of the work may be considered desirable or undesirable, depending on its intended use; for example, in South Asian sprang-woven sashes used as the waistband of loose cotton trousers are intended to curl in this way.

Figure 4: *(a) Finished sprang sample illustrating Z twist and S twist on top and bottom reflected sections. (b) Traditional handwoven sprang Pakistani sash. Z and S twist sections tend to curl with opposing chirality. (Thanks to R. Khuram for sharing this sash.) Photo credit: Gerofsky.*

What is more, sprang woven with fixed warp at top and bottom forms two rows of mirror-image weaving, one at the top and one at the bottom of the work. Whatever the twist of the top half of the weaving (S or Z twist), the bottom half of the weaving will have the opposite twist -- and the finished work will tend to curl or twist with the opposite chirality at top and bottom (see Figure 4b). These chiral qualities are a distinctive feature of sprang interlinking, and are interesting in terms of both the mathematics and physics of chirality. Participants who would like their finished piece to lie flat and not to curl are encouraged to experiment with alternating right-hand and left-hand pairs of rows to create alternating Z and S twists.

Educational Considerations: Reading the Action from the Resulting Structure

While weavings are beautiful and useful objects which can last for many (even thousands of) years, in this workshop we are interested in the process or actions of weaving and in the product it creates, and especially the connections between the two. In recent research on computational representations of sprang [9], the authors observe that an algorithmic approach to notating sprang does not capture the embodied knowledge and processual ideation inherent in the practice of hand-weaving. We propose that there is mathematical knowledge embodied in the sprang weaving process, and that individual small-scale sprang weaving involves embodied knowledge somewhat different from that of large-scale group danced weavings.

In a sense, a weaving is a record of movement, of certain actions and interactions, just as certain graphs are records of movements or actions. In the braid theory sense, a completed sprang weaving is a record of crossings, of chiral permutations; it is the composition of each enacted crossing that defines a particular sprang weaving. However, it requires a certain familiarity, initiation, or skill with weaving to look at a finished product and have a strong idea of how it was made or how another could be made. As we weave sprang individually and collectively, we experience and enact in real time the composition of simple braids which together form the sprang weaving. We develop the capacity to look at a finished weaving and imagine the crossings which make it possible, reading backwards from the result.

Figure 5: *Dancing and weaving sprang collaboratively at large scale. Photo credit: N. Yeung*

Workshop Activities

1. Introductory talk on the history and uses of sprang weaving around the world, preliminary discussion of its place in braid group structure, chirality (S and Z twist), and reflective doubling.
2. Small-scale sprang weaving on tabletop looms. The authors will supply all the materials needed to create these simple sprang looms. (See Figures 7 and 8)
3. Large-scale, whole group ‘dancing’ of sprang weaving with a room-sized loom. The authors will supply the materials to facilitate this group activity. (See Figure 5)
4. Composition of sprang poetry as a companion activity to the dancing of sprang weaving. The poem could be much like the 6-strand one described and reproduced below.
5. Demonstration of a sprang music composition by the authors. The authors will demonstrate this live and/or through a video.
6. Concluding discussion and sharing of created pieces.

Sprang Poetry

Several forms of combinatoric poetry have been explored previously by Bridges authors [5][10]. Combinatoric poetic forms engender new ways of thinking about language and poetry and also new and deeper ways of understanding the poems' underlying mathematical structures.

Sprang weaving is an ideal site for poetic inquiry, both in its repetitive, permutational structure and in the double aspect of its construction, wherein two rows of crossings, top and bottom, are added with just one pass over the warp. As with any translator across media, the sprang poet must choose to represent sprang with words in a way that is both faithful to the sprang structure and results in interesting and/or beautiful poetry. Here is an example of sprang poetry written collaboratively by the authors and math-poetry workshop participants, set on a warp of six strands, each strand comprising a list of six related words.

Table 1: *Six vertical strands of related words to create a sprang poem*

1 color	***2 weather***	***3 animals***	***4 emotions***	***5 verb***	***6 modifiers***
white	*cold*	*fox*	*comfort*	*sleep*	*readily*
grey	*windy*	*humpbacks*	*despair*	*shiver*	*slowly*
silver	*hail*	*owls*	*melancholy*	*read*	*drowsily*
bright	*rain*	*ducks*	*hope*	*dig*	*frenetically*
green	*sun*	*robins*	*joy*	*jump*	*afresh*
yellow	*warmth*	*herrings*	*fearful*	*swim*	*awakening*

Since sprang alternates between two states (the initial order of warp threads, and the plaited rows which permute the warp threads to the order 2, 4, 1, 6, 3, 5) (see Figure 6), a sprang poem has two verses ('setting the warp' and 'sprang'). The next row (over-plaiting) restores the threads to their original warp order

One aspect of sprang that is not reflected in this poem is the chiral nature of the crossings of warp threads. As mentioned above, each crossing that occurs at the top of the weaving is mirrored by an opposite crossing at the bottom of the weaving (a Z twist becomes an S twist). It is possible the chirality of sprang weaving can be somehow otherwise represented in poetry, perhaps in the interactions of the meanings of particular words chosen, either between top and bottom halves of the poem or between pairs of horizontally adjacent words crossing each other; perhaps in spacing, line breaks, or other concrete poetic methods; or perhaps in some other way the participants of this workshop may help us invent.

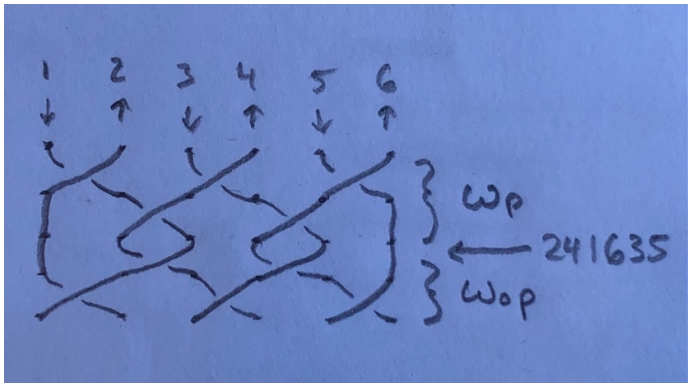

Figure 6: *Schematic diagram of six-strand sprang weaving. Image credit: Milner*

Sprang poem: *Equinox* (inspired by Hornby Island math-poetry workshop participants)

Setting the warp

White cold fox comfort sleep readily
Grey windy humpbacks despair shiver slowly
Silver hail owls melancholy read drowsily

Bright rain ducks hope dig frenetically
Green sun robins joy jump afresh
Yellow warmth herrings fearful swim awakening

Sprang

Cold comfort white readily fox sleep
Windy despair grey slowly humpbacks shiver
Hail melancholy silver drowsily owls read
Rain hope bright frenetically ducks dig
Sun joy green afresh robins jump
Warmth fearful yellow awakening herrings swim

Summary and Conclusions

Sprang is a useful, beautiful, historically and culturally important, and neglected form of weaving that we aim to (re-) introduce to the Bridges Math and Art community. The mathematical and aesthetic qualities of sprang—its weftless braid-like structure, chirality, elasticity, and doubled aspect of its construction—make it a versatile site for exploring embodied, arts-based mathematics. We hope this workshop introduces mathematical artists and educators to experimenting with this form in a variety of media and scales, as an inspiration for new mathematical art and deeper mathematical understandings.

Figure 7: *Learning to weave sprang. Photo credit: Gerofsky.*

Figure 8: *Weaving sprang on a frame. Photo credit: Gerofsky.*

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