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The Parenthetical Notation Method for Recording Yarn Structure

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Parenthetical notation is a formulaic method that was developed by the author to clearly, consistently, and unambiguously record yarn structure. The method is modeled after mathematical expressions, in which nested parentheses dictate a consistent order of operations and are dealt with from the inside out. Like in most formulaic methods for recording yarn structure, the letters “S” and “Z” denote twist direction that is modified by a coefficient signifying the number of yarns that are twisted together.¹

Definitions of yarn, spin, twist, ply, and stage.

A yarn is “the general term for any assemblage of fibers or filaments which has been put together in a continuous strand suitable for weaving, knitting, and other fabric construction” (Emery 1966:10), where a fiber is generally defined as a “slender filament or fine strand of sufficient length, pliability, and strength to be spun into yarns and woven into cloth” (Matthews 1947:23). Spin, also called initial twist as the term is used here, refers to both the process of spinning, which is the original pulling of fibers from the roving into the draft and twisting them into thread or yarn (Emery 1952:255), and the angle or spiral formed by the spun fibers (Figure 1). Twist is more loosely defined as both the process of twisting (which includes spinning) and a description of “the resultant spiral in any phase of yarn- or cord-making” (Emery 1966:10). Thus, spin is a kind of twist, but not vice versa.

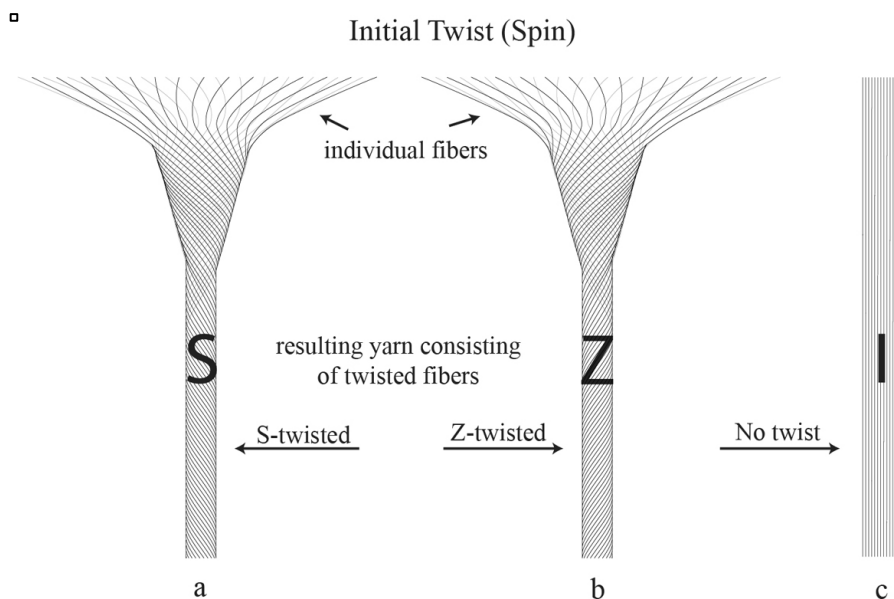


Figure 1. Diagram of Spin

¹ “Unspun” fibers, such as yarns made of filaments, are denoted with the letter “I”. Not only does the letter’s central portion

It should be noted that filaments such as synthetics (e.g., rayons, nylons) silks, and some naturally very long fibers (e.g., horsehair and basts) cannot be spun. This is because a filament is a fiber of continuous length. The process of spinning, by definition, means that fibers are drawn (a process of pulling fibers from the roving into the draft), and this is not possible with filaments, which are theoretically of infinite length. Only fibers can be spun.

Groups of filaments can be twisted but not spun, so their initial twist is not referred to as spin. With this in mind, it should be noted that all drawings of yarns in Figures 1-3 represent idealized forms, in which individual filaments run perfectly parallel and non-breaking throughout the strand. In real-world yarns, the individual fibers would be broken, overlapping, and frayed.

Ply refers to a secondary process, a statement of the number of yarns that are twisted together (Figure 2).² As such, the term single-ply refers to “the basal twisted strand ... as it comes from the spindle or other spinning device” (O’Neale 1948:159). There are problems with this term, however. Ann Pollard Rowe points out that “single-ply,” when referring to ply as it is generally understood, is an oxymoron. Rowe sometimes uses the term unplied but notes that this term is a grammatical negative (Ann Pollard Rowe, personal communication, 2006). Emery used the term “single-ply yarn” as a way to contrast a single yarn with a “multiple-ply yarn” (Emery 1966:13); see also Osborne and Osborne (1954:1096); however, she was not content with this term either, suggesting the term “singles” (Emery 1966:13), as an alternative. Other scholars have suggested the term “single yarn.”

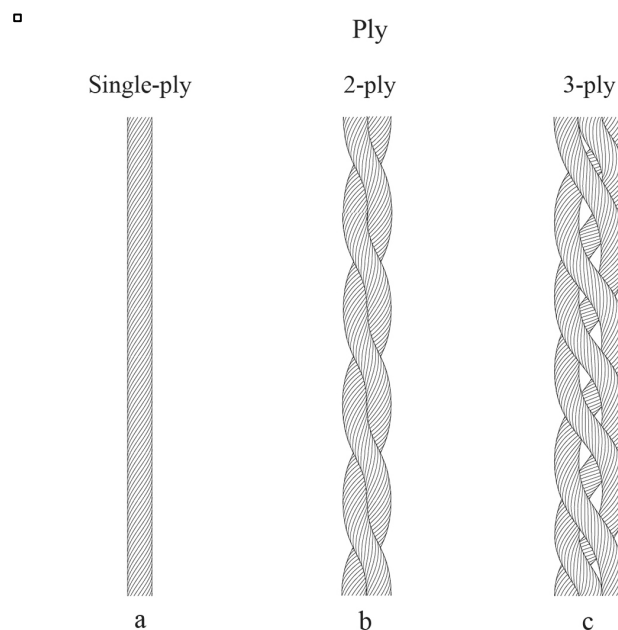


Figure 2. Diagram of Ply

² In some early literature, ply is called “twined” (D. S. King 1949; Sylwan 1941); however, this is a misuse of the term “twine” which “refers to a kind of plied yarn” (Emery 1966:10; italics in original) made from single yarns plied in the direction opposite to the original twist (Osborne and Osborne 1954:1099). In caving, climbing, sailing, fishing, and other disciplines that deal with ropes and cordage, the word “lay” is used for “ply,” though these terms are synonymous (Budworth 1997; Owen 1993). Other terms that refer to the twist direction of rope and cordage include “‘cable laid,’ ‘water laid,’ ‘left hand,’ ‘back hand,’ right hand,’ ‘with the sun’ (same term in both northern and southern hemispheres), etc.” (Osborne and Osborne 1954:1094).

These terms, “singles” and “single yarn,” have problems, too, because they can refer to any solo yarn. For example, in a fabric with paired wefts—meaning two weft yarns running parallel together through the same shed—the author believes that the description “paired single-ply wefts” is clearer than “paired singles wefts” or “paired single-yarn wefts.” For the moment, this paper will use “single-ply,” though later in the text, a substitute term will be introduced.

2-ply describes two yarns twisted together; 3-ply involves twisting three yarns together, and so on (Figure 2). When two or more yarns are plied, they have a natural tendency to twist in the opposite direction to that of the initial spin. Re-plying is the process of twisting together two or more plied yarns, generally in the opposite direction to the twist of the original plying (Emery 1966:10). Textile studies lack terminology for complex yarns, with the possible exception of the vocabulary used for cordage.³

There are problems with cordage terminology, however, that make it inappropriate for textile studies. For example, the definitions for cordage terms, such as rope, twine, hawser, cable, etc., have no standard meanings. They are defined by their size, twist, and/or usage, but not their structures, which alone are unambiguous and comparable.



Figure 3. Diagram of Stage.

This paper presents a concept developed by Keith Dixon (1957:135), called “Stage,” that refers to observable structure, not size, twist, or use, that can describe complex yarn structure (Figure 3). For example, a single-ply yarn is a Stage I yarn, and a 2-ply (or greater) yarn is a Stage II yarn. A Stage III yarn consists of two or more Stage II (plied) yarns twisted together. A Stage IV yarn consists of two or

³ The scope of this paper, however, is limited to cordage produced through spinning and twisting, not braiding, plaiting around a core, etc.

more Stage III (re-plied) yarns twisted together, and so on. It should be noted that the term “Stage I” might serve as a suitable alternative to the dreaded “single ply.”

The concept of stage presented in this paper is a modification of Dixon’s (1957:135) stages of cordage construction (reproduced below):

Stage I (yarn): bundle of fibers spun or twisted in S or Z direction to give continuity.

Stage II (strand): 2 or more Stage I elements (or yarns) twisted together.

Stage III (rope): 2 or more Stage II elements (or strands) twisted together.

Stage IV (cable): 2 or more Stage III elements (or ropes) twisted together.

Methods for recording twist direction

When describing yarn structure, it is common practice (but not always strictly followed) to note the direction of twist. Twist can take one of two forms:

“Twisted in one direction, the fibers will show a spiral that trends upward and to the left (\). Twisted in the opposite direction they will show the opposite trend; that is, a spiral moving upward and to the right (/). The spiral produced by spinning or twisting is visible in any spun thread (frequently without magnification), and it must trend one way or the other no matter what manner of spinning process produced it” (Emery 1952:252).

Twist direction has been recorded in numerous ways: clockwise/counter-clockwise, left/right, ordinary/reverse, crossband/openband, opposite/regular, etc. (Osborne and Osborne 1954:1094). The most prevalent method, and the one employed in this paper, is the use of the letters S and Z to represent left and right spirals, respectively (Figure 1a and 1b). To illuminate some of the challenges involved with describing yarn structure, a brief history of the development of yarn notational systems follows.⁴

Perhaps the first attempt to introduce a clear terminology for describing yarn twist was made by Charles Amsden, a researcher of Navajo textiles and former curator of the Southwest Museum, Los Angeles. Amsden noted that terms “right” and “left,” “clockwise” and “counter-” or “anti-clockwise,” are ambiguous and can mean either: (1) the act of spinning, which is a technique or procedure, or (2) the resultant spiral, which is an attribute of the yarn (Amsden 1930:579). Amsden suggested that writers describe the spiral, because it alone is unambiguous and observable, and describing the action of spinning can sometimes be problematic. For example, when using a drop spindle, if the top of the spindle is twisted right (clockwise), the resultant yarn will be Z-spun, but if the bottom of the spindle is twisted with the same wrist movement, the yarn will be S-spun: same word, different meanings, when describing an action.

Louisa Bellinger, a researcher of Middle Eastern textiles, developed a system to record yarn twist using slashes (\ and /) (Pfister and Bellinger 1945), which are symbols that closely approximate the slant of

⁴ I would like to thank Ann P. Rowe for clarifying this history and bringing many of the references to my attention, especially Irene Emery’s 1952 article, “Naming the Direction of the Twist in Yarn and Cordage.”

fibers when the yarn is held vertically. In Bellinger's system, hereon referred to as the slash system, S-spinning is represented with a backslash, \, and Z-spinning is represented with a forward slash, /.⁵

The use of letters to describe yarn twist appears to have been first suggested by Zelma Bendure and Gladys Pfeiffer (Bendure and Pfeiffer 1946).⁶ They used the letters S and Z because, like the slash system, the slants of the central portions of those letters resemble the angles of twisted fibers when held in a vertical position. Their nomenclature, hereon referred to as the letter system, was adopted early on by Lila O'Neale, an anthropologist and researcher of Peruvian fabrics (O'Neale 1946, 1948; O'Neale, et al. 1949; O'Neale and Clark 1948), Irene Emery (1952), former curator of technical studies at The Textile Museum, Washington, D.C., and others (e.g., King 1949). The letter system is now in standard use.

Both the slash and letter systems for describing yarn twist have advantages over other systems (e.g., left/right, opposite/regular, etc.). For example, the slash and letter systems are concise and can be typed. Both systems can be used to describe any angled attribute, such as the twist of twining, the slants of stitching, the crosses of looping, and the directions of knots.

The slash system has at least one advantage over the letter system, however, in that it avoids the potential confusion that can happen when letters are also used as abbreviations. For example, the letter S is sometimes used as an abbreviation for silk (Kühnel and Bellinger 1952:4). In addition, slashes more clearly represent twist direction. In spite of its advantages, however, slashes are symbols and have no verbal expression, making the slash system clumsy in discourse. For example, it would be awkward to describe a yarn as "forward-slash spun." On the other hand, "the letters S and Z combine the merits of both term and symbol. The slanting line serves only as a symbol" (Emery 1952:260).

Irene Emery, whose book, *The Primary Structure of Fabrics*, is currently the most commonly used source for textile terminology (Emery 1966), preferred the letter system for several reasons: (1) S and Z picture the direction of twist rather than describe it; (2) the use of the letters S and Z to denote twist was widespread; and (3) the letters S and Z are both visually and verbally understood. She noted, "while *left* (or *right*) may mean one twist to one person and just the opposite to another, *S* (or *Z*) seems always to indicate the same actual twist whether it is described as right or left since it pictures the direction rather than describing it" (italics in original) (Emery 1966:258). Thus, by using S and Z, the writer no longer needs to state whether s/he is describing a technique or an attribute; S and Z approximate the slant of a yarn's spiral, an attribute which, as previously noted, alone is constant, observable, and unambiguous.

Existing methods for notating yarn structure

There are three methods for notating yarn structure: narrative, depictive, and formulaic.

⁵ The name for the forward slash is the solidus. Other terms include the oblique dash, virgule, stroke, and slash (<http://www.askoxford.com/asktheexperts/faq/aboutsymbols/backslash>).

⁶ Other writers used the letters S and Z before Bendure and Pfeiffer (e.g., Broholm and Hald 1940); however, they were referring to the process of twisting and not the direction of the resultant spiral.

Narrative Methods

Narrative methods are written descriptions of yarn structure. For example, the yarn in Figure 2b may be written in narrative form as, “2-ply, Z-spun, S-twist”. There are no standardized narrative methods, however, so the same yarn in Figure 2b has also been described in narrative form as: “2-ply, spun Z, plied S” (Dwyer 1979), “2-ply left-spun, right twined” (King 1949), “spun Z and 2 plied S” (Rowe 1986), “2-ply Z spun” (Conklin 1975a, 1979), “2-ply S” (Dwyer 1979; Gayton 1967), “Z-spun, S-plied” (Conklin 1975b), “2-ply S-doubled” (Bird 1952), “Z-spun, S-doubled” (Skinner 1986), “S-strand, 2 Z-yarns” (Dixon 1957), and “2-ply, s-twined” (Sylwan 1941). Other narrative wordings for this yarn, if not actually employed, can be imagined.

The narrative method has several disadvantages, the most conspicuous being that it is often wordy and confusing and is language specific (a person must know the language in which the description is written). Despite these drawbacks, a cursory review of the literature reveals the narrative method as the most commonly used of the three, perhaps because it is the most natural, least technical approach, and it can be used without explanation as to which letter is the spin and which is the ply.

Depictive Methods

Depictive methods are illustrative representations of yarn structure which is easy to comprehend, because it maps the process of making a yarn like a decision tree. For example, the yarn in Figure 2b could be depicted in a number of ways as shown in Figure 4.

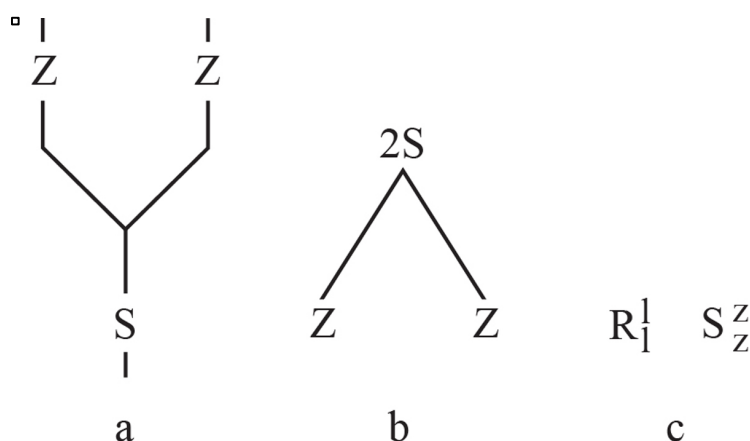


Figure 4. Depictive Methods for a 2-ply (Z-spun, S-plied) Yarn.

- a. System developed by Oscarre Guidici (1943) method.
- b. Mary Frame's method (Diagram courtesy of Mary Frame).
- c. Method developed by William Hurley (1979) that records both twist direction (right/left) and the resulting spiral (S/Z) for studying fabric impressions on Wisconsin Woodland ceramics.

Depictive methods are probably the most accurate way to record yarn structure; however, they cannot be typeset and must be treated as figures, taking up page space (e.g., Johnson 1977). While it might appear that a system developed by William Hurley (1979)⁷ (Figure 4c) is an exception and could be reproduced with a standard keyboard, it is clear that Hurley's system would require graphics (Figure 5c) to depict a

⁷ I wish to thank Ann Pollard Rowe for alerting me to this reference.

complex yarn, like the one in Figure 5 from Cerrillos, an Early Horizon (ca. 850-200 BCE) Paracas site on the south coast of Peru.

Despite their inherent bulkiness in print, depictive methods are easier to understand than narrative methods for notating complex yarns. For example, a narrative-method equivalent of the depictive-method example in Figure 5 might read: a yarn consisting of twelve Z-spun, Stage I yarns Z-twisted with six, Z-spun-S-plied, Stage II yarns, and two of these Stage III yarns are S-twisted to create the final, Stage IV yarn or cord. Obviously wordy and confusing compared to the depictive method (e.g., Figure 5c), depictive methods are tedious to transcribe and difficult to publish. Thus, in spite of their superior accuracy and readability over narrative methods, they are rarely used.

Formulaic Methods

Formulaic methods use a linear series of letters or slashes and numbers, often separated with dashes or slashes, to describe yarn structure. For example, the yarn in Figure 2b may be notated as Z-2S (Bruce 1986; Feldman 1986; Lothrop 1992; Rowe 1986). Like the narrative and depictive methods, there is no agreed-upon standard formulaic method, and the same Figure 2b yarn has been described as: Z2S (Dransart 1992; Mallett 1998), z-S (Emery 1966:14), Z-S (Wallace 1979), Z/S (Matthews 1947), Z:s,s (Petersen, et al. 1984), zzS (Vellanoweth, et al. 2003), and 1Z, 2S (Gayton 1967). These examples draw from the literature known to me; however, given human inventiveness, other systems undoubtedly exist.

One of the more sophisticated formulaic methods was developed by Dixon and is based on numbered stages (described earlier). Using Dixon's system, the yarn in Figure 2b would be notated as "II:S/I:2Z" (Dixon 1957:135). Although Dixon's system is quite versatile, it is cryptic and cannot notate the structure of complex yarns, such as the yarn in Figure 5, where Stage I yarns are twisted with Stage II yarns.

Yet another formulaic method was developed by Bellinger based on her slash system. Using this system, the yarn in Figure 2b would be described as / \. Outside her own work (Bellinger 1950; Bird and Bellinger 1954; Kühnel and Bellinger 1952, 1953),⁸ however, Bellinger's system was never widely used and remains cryptic to most readers. Most importantly, the slash system cannot describe complex yarns like the one in Figure 5.

There are several problems common to all applications of the formulaic method so far described. For one, they are dependent on "reading" order. Except for Dixon's, they must always begin with the initial spin, problematic because, for reasons discussed later, it is not always possible to determine the initial spin.

Another problem common to formulaic methods involves numerical coefficients. In some formulaic notational systems the coefficient refers to ply and the number of yarns twisted together (e.g., Z2S); in others it refers to both spin and ply (e.g., 1Z, 2S); and sometimes it is omitted altogether (e.g., Z-S). Thus, for any specific yarn, unless the writer is consistently careful to describe his/her method (and frequently writers are not), the reader is sometimes unable to mentally reconstruct that yarn's structure solely from its formulaic notation. In short, formulaic systems are easy to write but the resulting codes are sometimes puzzling.

⁸ Ann Pollard Rowe (personal communication, 2006) notes that the slash system was also used in catalog records at The Textile Museum and in the museum's Workshop Notes (e.g., Hunter 1953; M. E. King 1958).

Perhaps the most important problem with most formulaic methods is that none presented so far can describe complex yarns in a systematic way. Neither Dixon's stage nor Bellinger's slash systems, which are perhaps the most sophisticated of the published formulaic methods, can notate the yarn in Figure 5. As a result, when confronted with a complex yarn, most writers must resort to lengthy (and often confusing) narrative methods. Because of the myriad kinks and tangles in the previously described methodologies, anyone working with fibers, yarn, or cordage would clearly benefit from an easier, yet more sophisticated, notational system for recording yarn structure.

Parentetical notation

No formulaic method presented so far, including Dixon's stage and Bellinger's slash systems, can describe complex yarns in an unambiguous way, forcing researchers to resort to lengthy (and often confusing) narrative descriptions. Parentetical Notation, however, provides a method for systematic and precise descriptions of all yarns (simple, complex, and irregular), in which each notation refers to one, and only one, yarn structure. This is possible, because Parentetical Notation is a formulaic method that uses parentheses to group stages of yarns that are twisted together. It is modeled after mathematical expressions, in which nested parentheses dictate a consistent order of operations and are dealt with from the inside out. Like in most formulaic methods, the S, Z, and I denote twist direction (where "I" refers to no twist) that is modified by a coefficient signifying the number of yarns that are twisted together. Using the proposed method, the yarn in Figure 2b would be notated as S(2z); the yarn in Figure 2c is S(3z); and the yarn in Figure 5 is S(2z(12z+s(6s(2z))))). A yarn made by S-twisting two groups of unspun filaments would be notated S(2i).



Figure 5. Complex Yarn: S(2z(12z+s(6s(2z))))).
a, left. Cerrillos specimen 2001-L185-B1654-S001.
b, center. Detail of Cerrillos specimen 2001-L185-B1654-S001.
c, right. Diagram of Cerrillos specimen 2001-L185-B1654-S001 using Hurley's (1979) method.

□

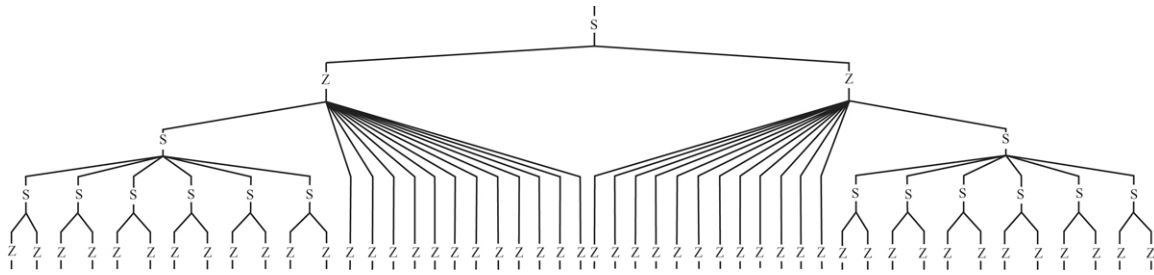


Figure 5. Complex Yarn: $S(2z(12Z+6S(2z)))$.

d. Line diagram (depictive method) of Cerrillos specimen 2001-L185-B1654-S001.

Sometimes it is impossible to determine initial spin, especially yarns in extremely dirty or fragile textiles, like many archaeological textiles, or in tightly-twisted and complex yarns. In these cases, a question mark “?” should be used in place of “S”, “Z”, or “I”. Final twist, on the other hand, is always discernable. For this reason, final twist is always capitalized and is the only capitalized letter in the sequence.

Reading order is dictated by parentheses. As in scientific notation, the rule is to read from the innermost set of parentheses out. Therefore, reading order can be in either direction, and it is not necessary to suggest a standard (e.g., left to right). I notate from right to left: the innermost set of parentheses is on the right, and the final twist is on the left. I would write the yarn in Figure 2b as $S(2z)$; however, without sacrificing accuracy or readability, the same yarn could be notated as $(2z)S$, or $(z2)S$,⁹ in which case the reading order is left to right.

There are tradeoffs, however, to consider when choosing one reading order over the other. Studies that focus on process or technique might prefer a left-to-right reading order with the initial spin first for a couple of reasons: (1) it follows normal practice, because spinning always precedes plying, and (2) it makes it easier to group and sort on spin when spin is the first letter. Therefore, studies that focus on spin direction and/or the technique of spinning would want the first letter of a notation to be the spin, especially if the data set includes first- and Stage II yarns that need to be grouped by spin, e.g., Z ,¹⁰ $(2z)S$.

Studies that focus on structure or final twist will probably find it more accommodating to record the final twist first. There is another advantage to rendering the final twist first (as opposed to initial spin): it avoids the potential problem of having to sort on unknown data (i.e., question marks).

To demonstrate the versatility of the proposed method, let’s record the structure of a hypothetical, 2-ply yarn, in which one strand is Z-spun and the other is S-spun. The yarn would be notated as: $S(z+s)$.¹¹

⁹ When notating yarn structure, it makes no difference if the numerical coefficient denoting the number of yarns twisted together comes before or after the direction of twist (e.g., $2S$ or $2Z$); however, it is consistent with mathematical formulas to write the numerical coefficient first.

¹⁰ Note that the letter Z , as the notation for a Z-spun, Stage I yarn, is capitalized. All single-ply yarns in the proposed method are capitalized, because final twist is always capitalized, and in the case of single-ply yarns, initial spin and final twist are one and the same.

¹¹ This yarn could also be notated as $S(s+z)$, $S(1z+1s)$, or $S(1s+1z)$.

While I have never seen such a yarn, Ann Pollard Rowe notes that they exist (personal communication, 2006).

Now let's record the spin and ply of another complex yarn from Cerrillos. The specimen, a Stage V all-cotton yarn (see Figure 6a), is too complex to clearly describe using narrative methods but is described using a depictive method in figure 6b. Using the method proposed here, the yarn is easily notated as: $S(2z(2z(3s(2z))))$. If, hypothetically, the initial spin was not determinable, the yarn's notation would be $S(2z(2z(3s(2?))))$.



Figure 6. Complex Yarn, $S(2z(2z(3s(2z))))$.

a. Cerrillos specimen 2002-L126-B879A-S001 (Photograph by Mercedes Delgado A.).

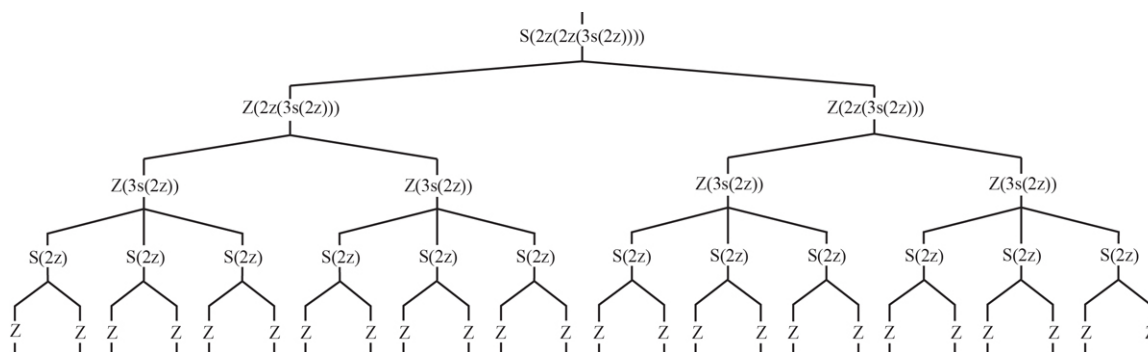


Figure 6. Complex Yarn, $S(2z(2z(3s(2z))))$.

b. Diagram of Cerrillos specimen 2002-L126-B879A-S001.

A question mark is used for all indeterminate data. For instance, it is often impossible to determine the number of yarns twisted together, especially when analyzing extremely dirty or fragile yarns. Using the same example, if both the initial spin and the number of yarns plied were indeterminate, the yarn would be notated as: $S(2z(2z(3s(2?))))$.

While on its face “ $S(2z(2z(3s(2z))))$ ” may seem no less cumbersome than other notational representation systems, it must be remembered that this method is applicable to *all* yarns (unlike the previously stated methods, which, owing to their shortcomings, must be used piecemeal and in combination to describe

the entire universe of yarn types). The proposed method will allow researchers to exchange yarn structure notations with the same degree of precision that recorded sheet music allows different musicians to exchange melodies, because each notation is essentially a formula representing one, and only one, yarn structure. Thus, the proposed method not only becomes a practical and standardized method for recording yarn structures, but it serves as a vehicle to further research by providing scholars with a standardized formula by which they can recreate, discuss, and compare all yarn structures no matter how complex. The existing hodgepodge of methods has heretofore precluded such possibilities.¹²

Recording color and fiber type using the proposed method

A slight expansion of the proposed method makes it possible to record yarn attributes such as fiber material, color, angle of twist, fiber/yarn diameter, yarn length, etc. These attributes can be incorporated into the notation through superscripts and/or subscripts; however, due to time and space limitations, only methods to record color and material type will be presented.

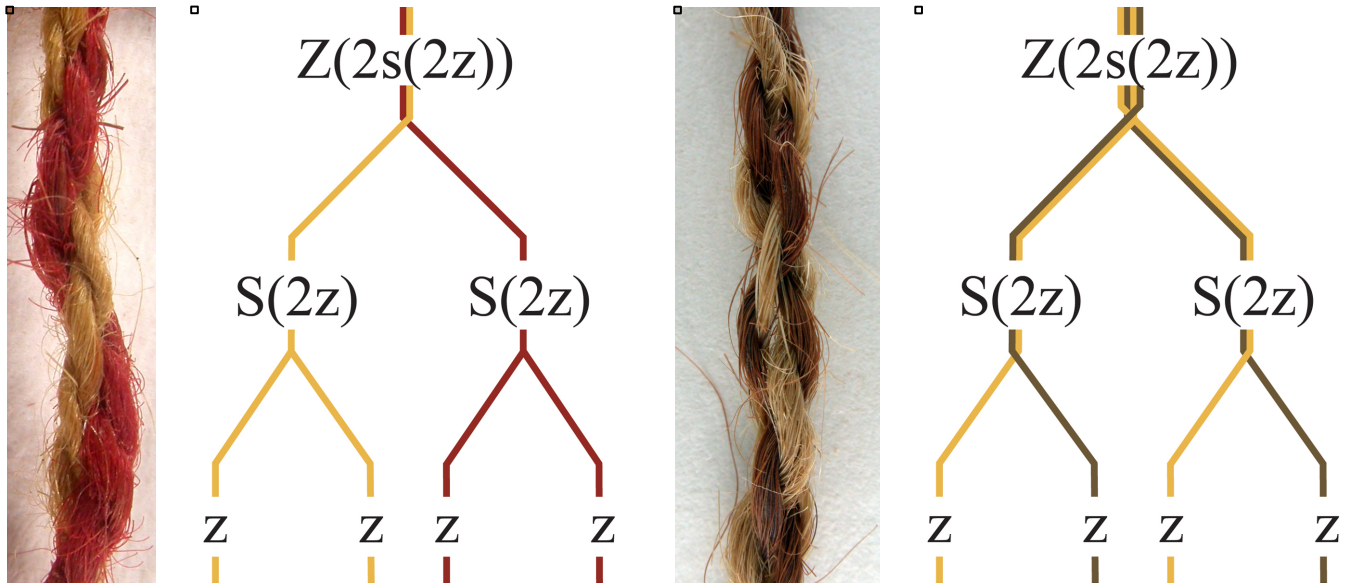


Figure 7. Multicolored, Camelid-Hair Yarns with $Z(2s(2z))$ Structure.

a, left. Cerrillos specimen 1999-L038A-S008.

b, left center. Cerrillos specimen 1999-L038A-S008 diagrammed using depictive method.

c, right center. Cerrillos specimen 2000-L430-B430-S003.

d, right. Cerrillos specimen 2000-L430-B430-S003 diagrammed using depictive method.

For example, two yarns from Cerrillos, shown in Figures 7a and 7c, are both made of camelid hair with identical $Z(2s(2z))$ yarn structures. The yarn in Figure 7a is red and gold in color. A depictive diagram of this yarn is shown in Figure 7b and can be described using parenthetical notation as $Z(1s(2z^{\text{red}})+1s(2z^{\text{gold}}))$ or $Z(1s(2z^{\text{red}})+1s(2z^{\text{gold}}))$. The yarn in Figure 7c is brown and gold. It is depicted in Figure 7d and can be described using parenthetical notation as $Z(2s(1z^{\text{brown}}+1z^{\text{gold}}))$ or $Z(2s(1z^{\text{brown}}+1z^{\text{gold}}))$.

¹² As an added potential, the yarn structure codes generated by the proposed method could be used with computer programs that reproduce fabric structures. The yarn-structure code would allow these programs to recreate actual yarns and thereby produce more realistic renderings of textiles.

In the final examples, yarns made of different fibers are analyzed. The first is a Cerrillos yarn with a basic structure of $Z(2s(2s(2z)))$ is made of tan cotton and red camelid hair (Figure 8a and 8b).¹³ When including both color and fiber type, it is probably best to use colored font to indicate color and subscripts to indicate fiber type: $Z(2s(1s(2z_{ch}) + 1s(2z_{co})))$, where “ch” refers to camelid hair, and “co” refers to cotton. In the second example, a yarn from Huaca Prieta specimen 2008.16.1.A is made of S-spun cotton and unspun milkweed twisted Z and is notated as $Z(1s_{co}+1i_{mw})$, where co=cotton and mw=milkweed (Figure 8c).

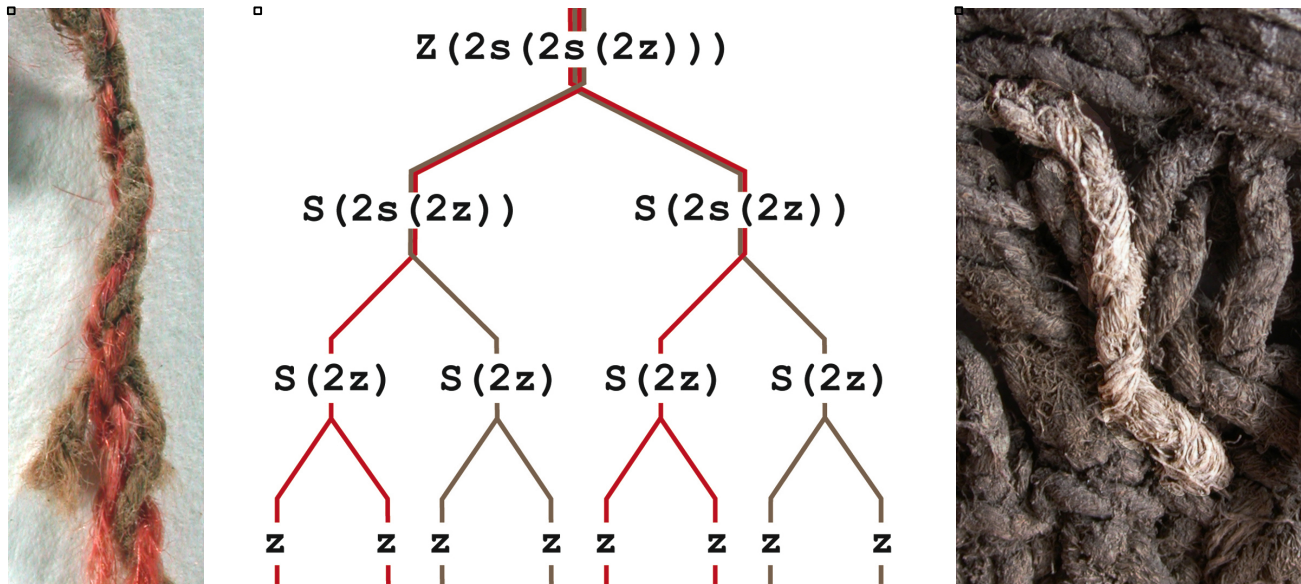


Figure 8. Multi-Fiber Yarns.

a, left. Cerrillos specimen 2002-L139-B0967-S004-E; yarn-structure notation becomes $Z(2s(1s(2z_{ch})+1s(2z_{co})))$, or $Z(2s(1s(2z_{ch})+1s(2z_{co})))$, when materials and colors are recorded, where co=cotton and ch=camelid hair.

b, center. Cerrillos specimen 2002-L139-B0967-S004-E diagrammed using depictive method.

c, right. Huaca Prieta 2008.16.1.A; $Z(1s_{co}+1i_{mw})$, where co=cotton and mw=milkweed.

General Note

Sometimes it is difficult to determine the number of yarns that are twisted together without taking the yarn apart. In cases where the yarn could be gently unraveled without damaging it, this was done to provide accurate counts. In cases where such treatment would damage the yarn, the count was either estimated with a range (e.g., 6-8) or a question mark. A range of numbers was provided in cases where there was a range along the length of the yarn, but there was no apparent breakage or disruption in the yarn structure indicating such a change. In those cases, it was presumed that a “sub-yarn” ended somewhere along the length of the main yarn.

¹³ Note that this yarn’s stages II and III (ply and re-ply) are twisted in the same direction.

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