

Wool Yarns in Late Classic Navajo Blankets

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By the second half of the nineteenth century, Navajo weavers had established a sophisticated yet simple weaving system that made use of many different types of yarn (Figs. 1, 2). Their handwoven blankets and other functional fabrics ranged from thin and fine, to soft and fluffy, to thick and tough. The yarns that provided such a versatile array of qualities were themselves quite varied.

These yarns were one focus of an extended research project begun in 1972 by Joe Ben Wheat, late curator emeritus of the University of Colorado Museum in Boulder. His forthcoming book, *Blanket Weaving in the Southwest* (2003), documents the history and use of handmade and commercial yarns, as well as many other aspects of nineteenth-century weaving by Pueblo, Navajo and Spanish-American people.¹

Wheat noted that the widest variety of yarns appears in textiles made during the Late Classic period of Navajo weaving. He described the differences in the yarns' fibers, textures, structures, colors and dyes. Together, these characteristics may indicate the source of and period during which the yarns, and therefore the textiles, were produced.²

This article focuses specifically on the descriptions of wool yarns found in Late Classic blankets and their utility as diagnostic features.³ A group of serape-style blankets from the Textile Museum in Washington, D.C. contains most of the known yarn types and serves as an excellent illustration of them.⁴

The Classic period of Navajo weaving extended from roughly 1800 to 1865, followed by the Late Classic period from about 1865 to 1880. Handwoven blankets and garments from these times may be divided into two categories: textiles woven wider than long in the original Pueblo fashion and those woven longer than wide in the Mexican serape style. Wider-than-long textiles during both the Classic and Late Classic periods include chief's-style and woman's-style blankets, with bold stripes of natural white or gray and dark brown, accented with blue and red (Fig. 5), and women's mantas in several styles. Longer-than-wide textiles were woven on the same type of vertical loom with the same techniques as the wider-than-long blankets. These include many simple striped blankets, serapes with more elaborate terracing patterning, ponchos with central, woven-in neck slits (Fig. 3), and women's two-piece dress panels.

Most extant Classic serapes and ponchos date from 1840 to 1860.⁵ The color palette of Classic serapes consists almost exclusively of bold reds, contrasting with natural white and deep indigo blue (Figs. 3, 3A).



1. Late Classic serape, 1865–1875. 50" x 32" (127 cm x 81.25). This tapestry woven blanket includes four handspun and four raveled (three z and one s) weft yarns. Courtesy of the Textile Museum, Washington, D.C. Gift of General Mike Sheridan. Cat. No. 86.5.



1A. Micrograph left and right: raveled red (2-5s) yarn, lightly twisted together; center: thicker, raveled speckled red (1-2z) yarn; both cochineal-lac dyed (thirty-six to forty-eight wefts per inch).

Note that all micrograph details are shown rotated ninety degrees from the textile's orientation to illustrate the direction in which the yarn was spun (see footnote 9). Because of lighting and magnification, the colors of the micrographs appear brighter and more intense than in the weavings.



2. Late Classic serape, 1865–1875. 45" x 31" (114.3 cm x 79 cm). This tapestry woven blanket contains eleven weft yarns, including six raveled (five z and one s), three commercial (3zS) and two handspun yarns. Courtesy of the Textile Museum, Washington, D.C. Gift of G. Pabst. Cat. No. 86.15.

Designs are tightly organized, with finely terraced (also called stepped) motifs derived in part from earlier Navajo and Pueblo basketry patterns. In contrast, Late Classic serapes exhibit a wider array of colors, shading and design; paneled or banded layouts; terracing in varied proportions and even serrations; and more individual, floating motifs.

The Late Classic period was an intense time of culture contact and change for the Navajos. The Santa Fe Trail had been a lifeline for Western commerce since 1821, and it became more so. United States military forces made repeated incursions into the Southwest, and army posts were established. Kit Carson's roundup of Navajo families and their forced march to Bosque Redondo (Fort Sumner, New Mexico) and back to Navajo country were perhaps the most cataclysmic events of this period. Hispanic and Anglo settlers began claiming homesteads and established small Western communities. By 1881 the railroad extended across the country, linking the East and Midwest with the Southwest.

Stylistic Periods of Navajo Weaving

Pre-Classic (before 1800)

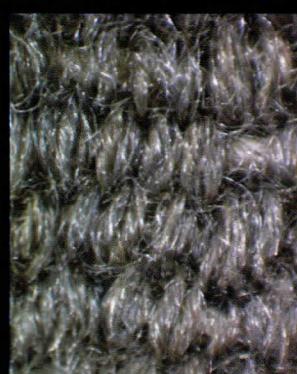
Classic (1800–1865)

Late Classic (1865–1880)

Transitional (1880–1895)

Rug (1895–1950)

Modern (1950–present)



2A. Micrograph of raveled gray-green (2s) woolen yarn, vegetal dyed.



2B. Micrograph of raveled yellow-gold (3-4z) worsted yarn, vegetal dyed.



2C. Micrograph of raveled red (2z) worsted yarn, cochineal dyed.



2D. Micrograph of raveled purple (2-4z) worsted yarn, cochineal dyed; raveled red (2z) worsted yarn; handspun indigo blue (z) yarn.

As a consequence of the forced removal of Navajo families from their homeland, from 1863 to 1879 the United States government supplied myriad household goods to relocated Navajos, including skeins of brightly colored yarns, bolts of fabric, piles of blankets and cartons of hand tools, such as sheep shears and wool carders. By the 1880s the first independent trading posts were introducing new products and different ways of life. During this period, many new woven styles and colors appeared; more textiles in smaller sizes, with highly attractive designs and with strong trade value were produced.

Churro Sheep's Fleece

Juan de Oñate brought the earliest wool sheep — belonging to the long-haired Andalusian breed called Churro — to the American Southwest in 1598 (Wheat 1977:421). Records of the Navajo acquisition of sheep from Spanish flocks in the Rio Grande Valley date as early as 1640 (Hackett 1923–1937). By 1706 many sheep and goats were in Navajo possession (Hill 1940:400–413), and between 1846 and 1850 Navajos and Apaches commandeered more than 450,000 sheep from neighboring flocks (Van Valkenburgh 1938:11 in Vogt 1961:296).

Since the 1700s homegrown Navajo sheep's wool has been a mainstay in Navajo weaving. Every piece illustrated here — and the majority of blankets created by Navajo weavers before 1880 — contains some hand-carded, handspun sheep's wool in addition to other materials. The smooth-textured, glossy fibers derived from the Churro sheep's fleece are evident in the yarns. These fibers, which appear like parallel glass strands under low magnification, are barely twisted to form a fine but sturdy and straight yarn (Figs. 3A, 3B).

During the second half of the nineteenth century, other sheep breeds were introduced to the Southwest, beginning in 1859 with Merino sheep (Wentworth 1948:237). Rambouillet, Romney, Corriedale, Cotswold, Shropshire, Karakul and other breeds followed. In Navajo blankets, a change in texture from smooth, shiny Churro fleece to curlier, crimpier varieties occurred at the end of the Late Classic period.

Two of the three principal colors in handspun yarns during the Classic and Late Classic periods are evident in the blankets illustrated here. Creamy white is typical of undyed wool. Dark blue represents an imported dye — indigo — brought north to the American Southwest from Central America since prehistoric times (Kent 1983:42–43). Dark brown or black is conspicuously absent in most fancy serapes, but prominent in chief's-style, woman's-style and many striped blankets of the same period (Fig. 5). When present, it is either a natural undyed color or a natural brown wool



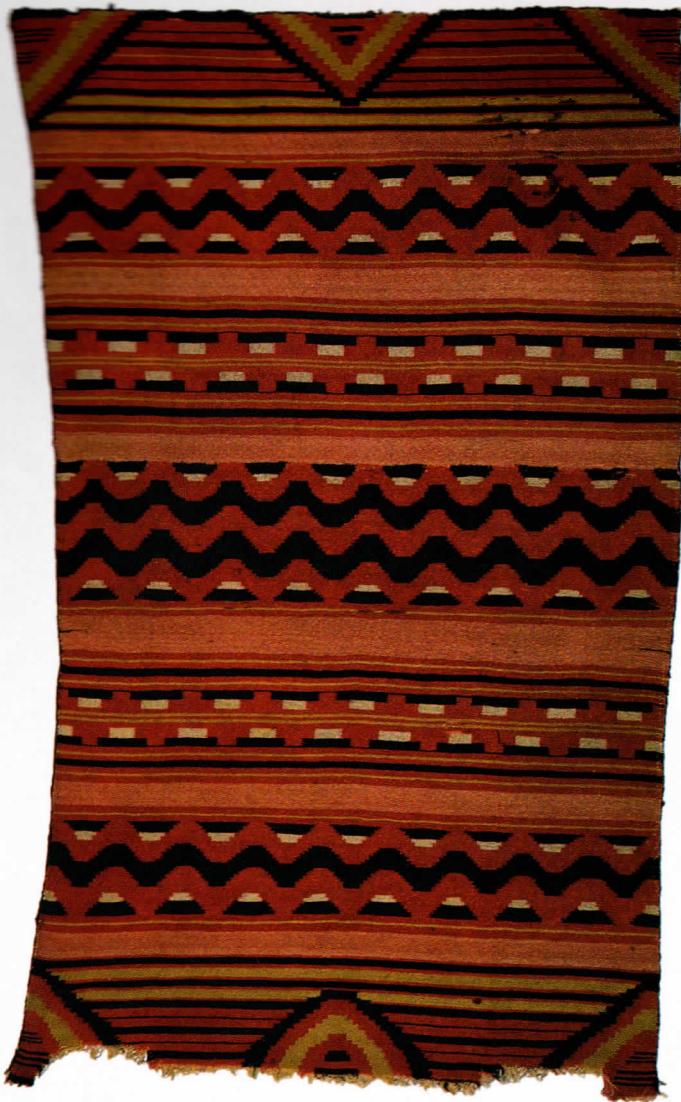
3. Classic poncho, 1840–1860. 82" x 54½" (208.25 cm x 138.5 cm). Two handspun and one raveled (s) weft yarns constitute this tapestry woven blanket. Courtesy of the Textile Museum, Washington, D.C. Gift of G. Pabst. Cat. No. 86.14.



3A. Micrograph of raveled red (2s) worsted yarn, cochineal dyed; handspun white (z) and handspun indigo blue (z) yarns (seventy-two to eighty-four wefts per inch); interlocked tapestry joins.



3B. Micrograph of handspun (z) white Churro sheep's wool yarn (seventy-two wefts per inch).



4. Late Classic serape, 1865-1875. 54" x 33" (137 cm x 84 cm). Two handspun yarns, two raveled yarns (one z and one s) and one raveled, recarded yarn appear in this tapestry woven blanket. Courtesy of the Textile Museum, Washington, D.C. Gift of General Mike Sheridan. Cat. No. 86.6.



4A. Micrograph left: raveled red wool, carded with white wool and respun into pink (z) yarn, dye not tested; right: raveled red (2s) worsted yarn, cochineal and lac dyed (fifty-six to sixty-four wefts per inch).



4B. Micrograph of handspun indigo blue (z) yarn, raveled red (2s) worsted yarn and raveled olive green (2z) yarns (fifty-six to eighty wefts per inch).

that has been overdyed to black with a native mix of plants and minerals.⁶

In some Late Classic blankets, small quantities of handspun yarn also appear with yellow or green vegetal dyes (Figs. 1, 6), but these native-dyed yarns are rare in comparison with the white, brown-black and blue handspun yarns. Green is usually a combination of imported vegetal blue (indigo) and native vegetal yellow dyes. Very often, upon close inspection, the small amounts of yellow or green yarns in Late Classic blankets turn out to be commercial raveled yarns rather than handspun (Figs. 2A, 4B).

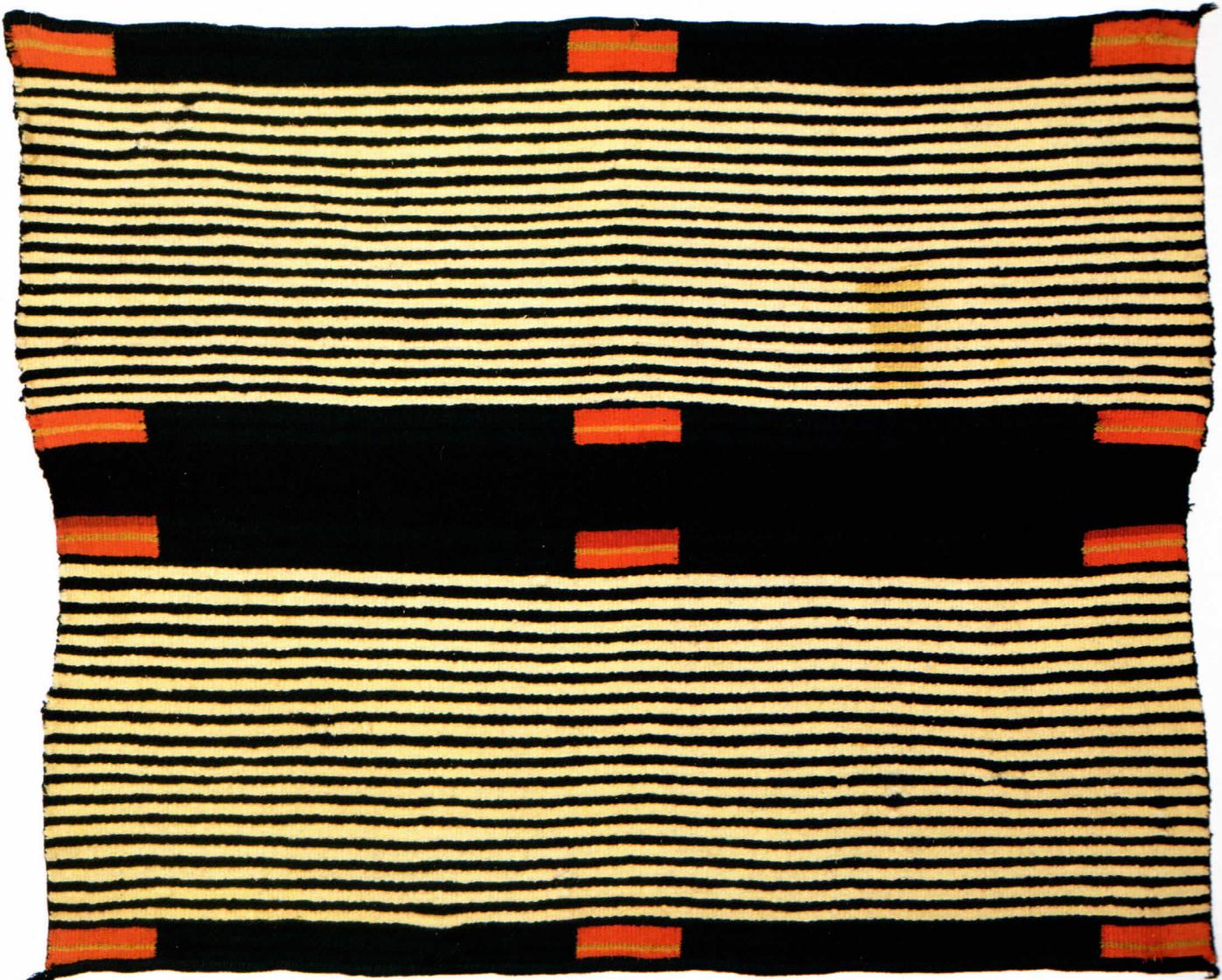
Carded gray wool, in which natural white and black or brown fibers were combined, was used predominantly in simple striped blankets and rarely in serapes until the 1880s. Also after 1880, packaged synthetic dyes obtained through trade or purchase were used to create brightly colored handspun yarns; prior to this, synthetic dyes appeared only in commercial and raveled yarns (Fig. 7B).

Processed Wool and Commercial Single Yarns

We do not have evidence or documentation for any wool being commercially cleaned, carded and supplied to the Navajos until the very late nineteenth or early twentieth century, when traders John Lorenzo Hubbell at Ganado, Arizona and J. B. Moore at Crystal, New Mexico began working with Eastern mills to scour and card native wool for local weavers. Likewise, commercial yarns of a single spun strand (as opposed to multiple plies, discussed below) appeared around 1900 and disappeared shortly thereafter, only to reappear in modern form in the 1970s.⁷

Raveled Red Yarns

Red yarns raveled from various commercial fabrics, sometimes called *bayeta* after a particular type of Spanish flannel-like cloth, represent the most significant and diagnostic yarns in nineteenth-century Navajo blankets. Wheat documents the origins, range of qualities and diagnostic characteristics of these yarns, and charts their occurrences in his extensive study sample.⁸ Because of the myriad sources for raveled yarns and because these origins did not appear to matter to the Navajos who used them, Wheat proposed "that for Navajo textiles the term *bayeta* should be used for any cloth that was raveled to provide colored threads for the Navajos' own weaving" (2003:85). This article will describe the most common of these *bayeta* yarns and their configurations, according to direction of spin; worsted and woolen spinning; the yarns' relative quality or size; their use singly or in multiples; the quality of the color; and the dyestuffs that produced the color.



5. Second Phase woman's-style blanket, 1875–1885. 41" x 52" (104 cm x 132 cm). Four handspun and two raveled (both s) woolen weft yarns, one with cochineal-lac and one synthetic red, are represented in this tapestry woven blanket. Collected by Captain Harry G. Trout, Second Cavalry, stationed at Fort Wingate, New Mexico, from the mid-1880s to 1892. Courtesy of the Textile Museum, Washington, D.C. Cat. No. 1962.11.3.

Direction of Spin

Fibers may be twisted into yarn in a clockwise direction (right to left from the bottom of the strand), producing an s-spin — the middle bar of an S reflecting the same direction as the fibers' twist when the yarn is held vertically. Or, they may be twisted in the opposite direction, producing a z-spin — the middle bar of a Z likewise reflecting the fibers' twist direction (Fig. 8).⁹

All native handspun yarns are z-spun, even if only a very slight twist is present. Multiple-ply yarns, such as those used in selvage cords in Southwestern blankets and rugs, are almost all z-spun and s-twist. Raveled yarns vary through time, however, with s-spun worsted yarns generally appearing earlier than z-spun worsted or s- or z-spun woolen yarns.¹⁰

In general, s-spun yarns tend to date from before the mid-1860s, and often correlate with the red insect dyes (cochineal and lac), while z-spun yarns may have

appeared later and often contain red cochineal or synthetic dyes (Table 1). However, both s- and z-spun yarns often appear in the same blanket during the Late Classic period, confounding the absolute use of this principle. The date when materials became available to weavers does not account for a lag in receiving the yarns in many rural areas or for the weavers saving certain materials for a later project.

The serape in Figure 6, like many others of this period, contains raveled s-spun lac-dyed yarn (Fig. 6A) and z-spun cochineal-dyed yarn (Fig. 6B left), as well as a commercial three-ply cochineal-dyed yarn (Fig. 6B right). In slight contrast, the blanket in Figure 1 has both s-spun raveled and z-spun raveled red yarns (Fig. 1A), all dyed with a cochineal-lac combination. These combinations suggest that both blankets date to around 1865–1875, which is corroborated by each blanket's Late Classic design elements. The blanket on the front cover has s-spun cochineal-lac dyed yarn (Fig. 7A) and z-spun



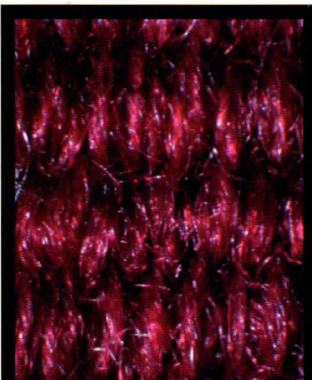
6. Late Classic serape, Navajo, 1865–1875. 52" x 31" (132 cm x 79 cm). Eleven weft yarns are present in this tapestry woven blanket, including four raveled (three z and one s), two commercial and five handspun yarns. Courtesy of the Textile Museum, Washington, D.C. Gift of General Mike Sheridan. Cat. No. 86.4.

synthetic-dyed yarn (Fig. 7B), plus a three-ply yarn discussed later. In addition, the blanket in Figure 5 contains two coarse s-spun raveled red yarns. The maroon red was dyed with cochineal and lac (about fifty percent of each), and the tomato red with a synthetic colorant; its handspun yarns are equally fuzzy and coarse. These materials, plus the designs, contribute to attributed dates of 1870–1880 and 1875–1885, respectively, for these two blankets.

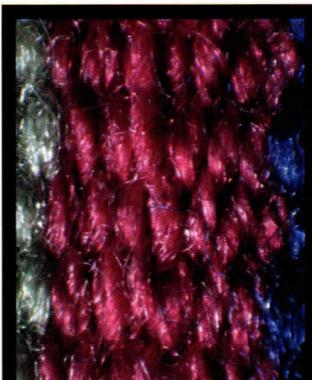
Worsted and Woolen Spinning

When wool is prepared for the spinning process, whether by hand or machine, the fibers may be combed into parallel strands or may be carded into a spiral configuration. When combed parallel strands are spun, the action produces a firm yarn with a smooth texture, known as worsted. When the fibers are spun from a spiral alignment, the resulting yarn, termed woolen, has a softer, fluffier appearance with a more angular twist. Most early Pueblo and Navajo handspun yarn was made with straight Churro wool using the worsted technique. Later, as finer-textured, curlier wool from other breeds such as Rambouillet and Merino was used, native-spun yarn took on a fuzzier, woolen character.

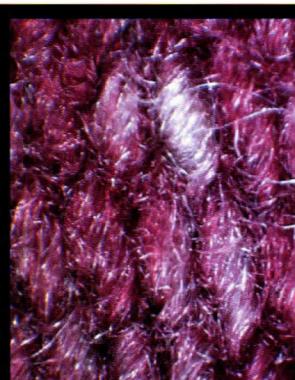
Commercial yarns that Navajos raveled from trade cloth are also characterized as either worsted or woolen by the way they were spun (Table 2). Worsted raveled yarns tend to be used as two to four strands together and may be either s- or z-spun. Woolen raveled yarns are more likely to be larger and used singly. Nearly two-thirds of the woolen yarns in Wheat's sample were s-spun rather than z-spun. Worsted raveled yarns are generally earlier, predominating until the mid-1860s when woolen yarns began to predominate (Wheat 1996:72–73).



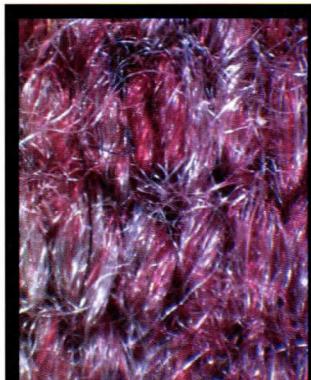
6A. Micrograph of raveled red (2s) worsted yarn, lac dyed (sixty wefts per inch).



6B. Micrograph left: raveled red worsted (2z) yarn; right: commercial red three-ply (3z) Saxony yarn; both cochineal dyed (forty-two to forty-eight wefts per inch).



6C. Micrograph of raveled speckled red (z) woolen yarn, cochineal dyed (forty-two wefts per inch).



6D. Micrograph of red raveled wool, carded with white wool, and respun into pink (z) yarn, with one remnant of original solid red raveled yarn visible; lac dyed (forty-four wefts per inch).

Fine, Medium and Coarse Raveled Yarns

Raveled yarns range from extremely thin threads to relatively thick yarns. In very simple terms, thinner yarns tend to be earlier and thicker ones later. Using a micrometer, Wheat measured the diameter of more than 250 raveled yarns and found that standard sizes generally ranged from fine (.01–.04 mm), to medium (.05–.07 mm), to coarse (.08–.15 mm). Of these, seventy-eight were tested for dyes (Table 3).

When rewoven into Navajo blankets, the finest raveled yarns can result in sixty to ninety weft threads per inch; the range moves to forty to sixty threads per inch for medium-weight yarns and twenty to forty for coarse yarns. Weft counts for raveled yarns in the serapes illustrated here range from thirty-six to eighty-four wefts per inch.

Singles and Multiples

Raveled yarns may be used singly or may be grouped into bundles of two or more strands. Often, as groups of yarn are used, they become twisted together unintentionally by the weaver's motion of passing the yarn back and forth. In handwoven blankets, this sometimes appears as a plied yarn of multiple strands, rather than the simple raveled yarn (Fig. 1A). Likewise, the use of multiple-ply yarns and a systematic untwisting of the strands through the movements of weaving may also occur, making commercial yarns appear on the surface somewhat loose like raveled yarns (Fig. 7B right).

Solid-Colored or Speckled Yarns

When yarns in commercial fabrics are thoroughly dyed before the weaving process, the colors of the yarns and cloth appear as solid colors. However, when commercial fabrics are dyed after weaving, as many are, their yarns may have speckles where the dye did not adequately penetrate the woven fabric. Raveled yarns in Late Classic blankets often show these telltale speckles from their former use in an earlier commercial cloth (Figs. 1A, 6A, 7A), but this trait does not assist in identifying the dye.

Dyes

Several strong shades of red predominate in Late Classic raveled yarns. Through the 1860s and into the 1870s, these were commercially dyed with one of two imported insect dyes — lac from Asia and cochineal from Central America — or varying combinations of the two. At least by the 1870s, synthetic red dyes were also obtained in trade cloth and yarns. As shown in Table 1, s-spun yarns tend to contain some lac, and z-spun yarns are more likely to have cochineal or synthetic dyes.

Spectrophotometric and other diagnostic tests have been used to determine the red dyes used in Late Clas-

sic blankets. In those illustrated here, a full range occurs, from pure lac, through various mixtures of lac and cochineal, to pure cochineal, plus several synthetics.¹¹

Raveled and Recarded Pink Yarns

Wool from raveled yarns — either the raveled strands themselves or perhaps the short ends that were left over from raveling longer strands — were sometimes recarded and respun (Figs. 4A, 6D). Recarded pink yarn, in which raveled red wool is mixed with virgin white sheep's fleece, was popular, especially in the 1870s (Wheat 1996:79). Sometimes whole strands of yarn were incompletely carded and remain visible in the recarded yarn (Fig. 6C top center).

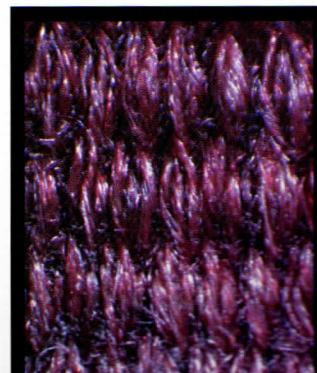
It is uncertain how often a solid red yarn was produced by raveling, recarding and respinning without adding native white wool. Rarely detected, this was likely a late practice, toward the end of the century, involving coarse, synthetic-dyed red flannel.

Novelty Yarns

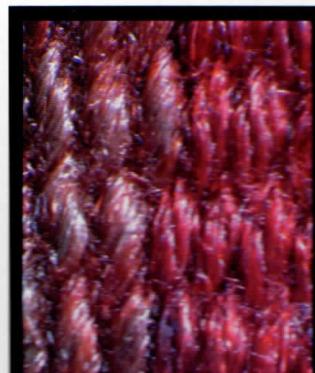
Weavers occasionally cut strips of trade cloth and, instead of raveling them, used the strips much as rags are used in rag rugs today. Sometimes these appear like simple bundles of raveled yarns, but at other times, the original fabric structure emerges fuzzily in the woven blanket, just as chenille yarns do in Euro-American weaving.

Multiple-Ply Yarns

Compound yarns made up of more than one strand of wool twisted together are technically termed plied, and are often described according to how many strands are

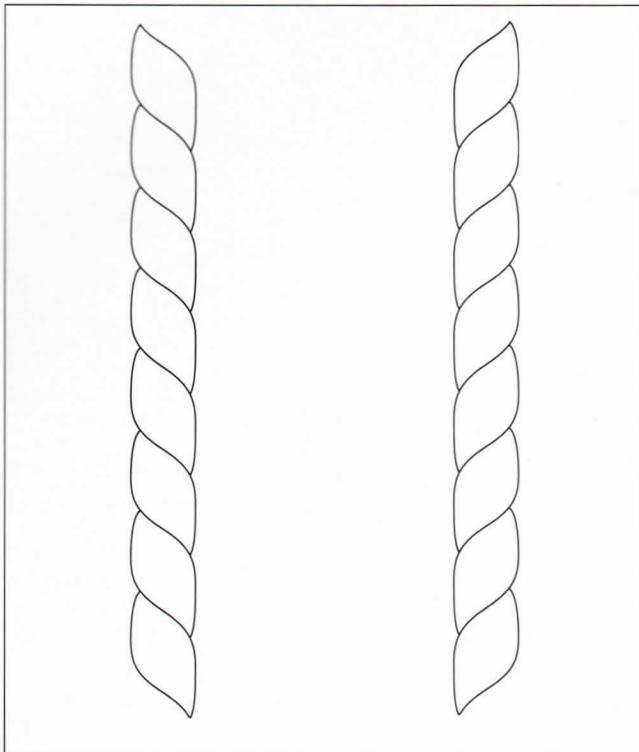


7A. Micrograph from the textile illustrated on the front cover showing raveled red (2-4s) worsted yarn, cochineal and lac dyed (fifty-two to sixty wefts per inch).



7B. Micrograph from the textile illustrated on the front cover. Left: raveled speckled red (z) woolen yarn with synthetic dye; right: commercial red (3zS) yarn with synthetic dye (forty-eight wefts per inch).

Wool Yarns continued on page 92



8. Yarn: a group of fibers twisted together to form a continuous length. Direction of twist in spun and plied yarns: S (left) and Z (right).

combined (Emery 1966:10). For example, three-ply yarns are composed of three separately spun strands that have been twisted together for added strength, weight or texture. Navajo spinners produce handspun, hand-plied yarns exclusively for the heavy cords that are twined along the ends and sides of a textile. All other Navajo-produced handspun yarns used in Navajo blankets and rugs are single yarns (that is, not plied at all).

During the Late Classic period, several types of three-ply yarns became popular. During the 1860s and early 1870s these included fine European yarns with the names Saxony and Zephyr (the latter was quite rare and may have included silk fibers). The blanket in Figure 6 contains a three-ply, cochineal-dyed Saxony yarn (Fig. 6B). Slightly coarser American yarns from mills in Germantown, Pennsylvania began appearing in the late 1860s, roughly coinciding with the Navajos' departure from Bosque Redondo around 1868.¹² The blanket on the front cover has a three-ply synthetic-dyed yarn, probably early Germantown (Fig. 7B right). Despite the serrated design elements that appear later than terraced or stepped motifs, and often date to the 1880s; the three-ply yarn suggests a date up to 1873–1875. Taking all its features into account, the piece is assigned a date of 1870–1880.

Although most Navajo blankets and rugs from all periods employ handspun wool warps, occasionally a plied yarn will form the warp. For the blanket in Figure 4,

the weaver took three-ply white wool yarn and respun it with a tighter twist for strength and then used it for the blanket's warp, well covered by weft yarns. Like others of the period, another small serape in the collection of the Textile Museum (not illustrated here) contains medium blue three-ply commercial warps treated in a similar manner.

By the mid-1870s weavers no longer obtained Saxony and Zephyr yarns, and by 1875 the Germantown variety had changed from three plies to a slightly heavier four-ply yarn, colored with synthetic dyes. As this occurred toward the end of the Late Classic period, four-ply yarns are not illustrated here.¹³

Conclusions

Within a matter of several decades, Navajo weavers acquired and employed a range of materials that analysts now use to describe and identify the Late Classic weaving tradition. The combination of specific fibers, yarns and dyes, and their overlapping use through time, allows previously unidentified textiles to be dated and identified.

This mixture of commercial and handmade materials in part defines the identity and legacy of historic Navajo weaving. The appearance of varied yarns in blankets of the Late Classic period, from 1865 to the 1880s indicates an eclectic resourcefulness that continues to characterize Navajo weavers to this day. It reflects the advent of the serious outward changes in store for Navajo culture beginning in the late nineteenth century, and signals the Navajos' abilities to absorb and yet remain resilient, both culturally and aesthetically.

Footnotes

¹ Wheat's research also suggests directions for future research. Because his work was incomplete at his death, some questions among the data remain unanswered. The three tables presented here are derived from Wheat's analyses of more than fifteen hundred Southwestern textiles, but such summaries were only recently possible, given the computerization of his extensive database. Further research is now possible because of this major resource, which will eventually be available to other researchers.

² Scholars of nineteenth-century Navajo weaving vary somewhat concerning the specific dates for weaving periods and materials' time spans, as well as style names and technical terminology. Attribution is art as well as science. Nevertheless, there is general consensus on basic temporal trends, stylistic attributes and their relative significance (cf. Blomberg 1988; Bonar 1996; Hedlund 1990; Kent 1985; Wheat 1977, 1996; and Whitaker 1998, 2002).

³ The organization of this article follows that of an earlier article (Hedlund 2003), which includes more discussion about many of the basic materials and processes mentioned here. Wheat's forthcoming book will address the detailed historical and technological context of pre-1900 materials (2003).

⁴ One Classic poncho from the Textile Museum, Washington, D.C. was included in Wheat's study (Fig. 3) and in *Blanket Weaving in the Southwest* (Wheat 2003). Only two other Textile Museum textiles were included by Wheat in his original study, in part because his research project was predicated on finding as many well-documented Southwestern textiles as possible. Without recorded collection histories, most of the Textile Museum pieces did not contribute new data. Now, however, they demonstrate admirably the utility of Wheat's research, as dates may be accurately attributed to them and to other undocumented textiles, because of their material composition and regardless of the lack of recorded histories.

⁵The Spanish terms *sarape* (Anglicized in this article as *serape*) and *poncho* are frequently used in the literature about Navajo weaving for blankets that were woven longer than wide, that is, shaped like a vertical rectangle on the loom. Serapes may be solid-woven fabrics or they may include a central, woven-in neck slit, indicating their function as a poncho.

⁶This native black dye was derived from piñon pitch, juniper-bark ashes and yellow ochre, forming a natural ink that darkly coated the surface of each fiber, as Wheat was fond of saying, "like shiny black shoe polish."

⁷Hedlund (2003) outlines the trends since the 1970s. Regrettably, that article omits the significant role of Connie and Sam Taylor's Cerro Mojino Woolworks, near Tres Piedras, New Mexico, in providing Navajo weavers with Churro wool as custom spun yarn and raw fleeces during the past two decades.

⁸Among the documented textiles that Wheat studied, he detected — in addition to reds — a single early case of raveled brown (1800–1850) and another of pale yellow, plus several instances of dark blue and olive green (1860–1870).

⁹Note that the detail photographs in this article are oriented in the direction in which the yarn was spun — that is, with weft yarns presented vertically and warps horizontally.

¹⁰Without specific research on equipment and customs that would affect spin direction, we must presume that something shifted in the industrial practices or the patterns of commerce that brought different yarns to the Navajos during different time periods.

¹¹We are very grateful to David Wenger of the Jefferson Medical College, Philadelphia, Pennsylvania, who performed hundreds of dye tests for Wheat's research project. In 2002 Wenger generously tested forty-two samples for the Textile Museum, and some of his results are reported here.

¹²Research by Kathleen Whitaker reveals that three-ply Germantown yarns may have been available as early as 1864, if acquisition dates on one particular collection are taken into account. She also notes that according to a Philadelphia mill sample card, a four-ply Germantown yarn existed as early as 1868–1869, but has not been definitively identified in Navajo weaving of that time. Such discrepancies highlight the need for more research and useful collaboration by scholars studying different collections (2003).

¹³A small number of four-ply yarns have been described in earlier blankets, but these are not common and may be raveled yarns that were re-plied or other aberrant variations.

Table 1. Direction of Spin and Dyes

	Lac	Lac & Cochineal	Cochineal	Synthetic	Totals
S-spun	39	28	13	4	84
Z-spun	6	10	42	14	72
Not id'd.	0	1	3	3	7
Totals	45	39	58	21	163

N = 163 raveled yarns included in Wheat's sample of dye tests.

Table 2. Direction of Spin and Types of Raveled Yarn

	Raveled Worsted	Raveled Woolen	Totals
S-spun	20	62	82
Z-spun	15	37	52
Totals	35	99	134

N = 134 raveled yarns included in Wheat's sample, with types specifically designated.

Table 3. Quality of Raveled Yarns and Dyes

(in mm)	Lac	Lac & Cochineal	Cochineal	Synthetic	Totals
Fine (.01-.04)	16	11	16	4	47
Medium (.05-.07)	3	1	9	1	14
Coarse (.08+)	4	1	6	6	17
Totals	23	13	31	11	78

N = 78 raveled yarns included in Wheat's tested sample, with types specifically designated.

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Cover: Late Classic serape, 1870–1880. 45" x 32" (114.5 cm x 81.25 cm). This tapestry woven blanket contains two handspun yarns, two raveled (one z and one s) yarns and one commercial (3zS) yarn. (See details, Figs. 7A, 7B.) Courtesy of the Textile Museum, Washington, D.C. Gift of General Mike Sheridan. Cat. No. 86.3. (See article pages 78–85, 92–93.)