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The Arizona Openwork (Tonto) Shirt Project

Carol James¹

Abstract

In 1923 a pair of hikers came across a series of objects in a cave near the Salt River in Arizona. Among the objects was an elaborate sprang shirt, later given to the Arizona State Museum where it remains to this date. The cotton yarn in the shirt was subjected to Carbon Dating and assigned a probable origin date of the 12th century. In order to better understand the shirt, a replica was made in early 2015. Diverse technical challenges included hand spinning an appropriate cotton yarn, mapping the pattern, accurately copying the irregularities, and creating the neckline. The project yielded surprising insights.

Keywords: Sprang, Tonto Site, Arizona Openwork Shirt, Anasazi, Ancient Puebloan, Native Cotton

El Proyecto Camisa Entrelazada de Arizona (Tonto)

Resumen

En 1923, dos mochileros encontraron una serie de objetos en una cueva cerca del Rio Salt en Arizona. Entre estos objetos había una camisa elaborada en sprang, mas tarde donada al Museo del Estado de Arizona, donde permanece hasta la actualidad. El hilado de algodón en esta camisa fue fechado por radiocarbono y asignado una fecha de origen probable del siglo XII. Para mejor entender la camisa, se creó una réplica en 2015. Los diversos retos técnicos incluían el hilado manual de un tipo de algodón apropiado, la diagramación de los diseños, copiar con precisión las irregularidades, y crear la apertura del cuello. El proyecto llevó a revelaciones sorprendentes.

Palabras claves: Sprang, Sitio Tonto, Camisa Entrelazada de Arizona, Anasazi, Pueblos Antiguos, Algodón Nativo

Introduction

In 1923 a pair of hikers in Arizona came across a series of objects in a cave along the Salt River. Inside a basket, and associated with the remains of an infant, they found an elaborate openwork shirt (Kent 2957 pg 603). Two years later they donated the shirt to the Arizona State Museum (Teague 1998; personal communication, October 2010). It has been assumed that the shirt was somehow connected with the nearby Tonto Ruins, thus this garment has been called the Tonto Shirt. The word Tonto is rather derogatory in Spanish. Native Americans now prefer that we more respectfully refer to it as the Arizona (Tonto) shirt or the Arizona openwork shirt.

The hikers who found the shirt were later unable to identify the exact location of the cave, nor did they record other information pertinent to archaeology: the find location within the cave or other features of the cave. This means that the exact heritage of the shirt cannot be confidently assigned to any particular tribe, as many different groups inhabited this region (Teague personal communication, October 2010).

The shirt was on exhibit at the Arizona State Museum for some time. Lynne Teague, was the curator at the Arizona State Museum from 1975 to 2002, and coordinated the repatriation program for Native American objects. In a phone conversation she told me that no requests for reburial had been made for this shirt, but it was removed from

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public display, as it has been found in a funerary context. Because exact heritage of the shirt cannot be established and because it has been agreed that the Arizona State Museum has the best facilities, the shirt now rests in special restricted storage conditions at the museum.

Analysis

Lynne Teague reported on this shirt in her book *Textiles of the Southwest*. Yarn in the shirt, Z spun and S plied, proved to be cotton and was subjected to Carbon Dating. The shirt has been assigned a probable date of 1300 CE (Teague, personal communication, October 2010, Kent 1983A, pg 72).

Close examination of the shirt reveals an interlinking structure, and patterns of holes, resulting in designs that can be described as swirls, meanders, and wedges. These motifs, and this combination of motifs, feature in pottery from the time period in the area surrounding the find site. They were contemporary in the culture at the time the shirt was made (Teague 1998, pg 81, Kent 1983B, p 218).

This shirt is one of only three pieces of interlinking sprang which exist from North American pre-Columbian textiles (Kent 1957, pg 603, 714). Far more common are other techniques such as weaving, looping, netting, and plaiting (Kent, 1957, pp. 660-724). According to Mike Jacobs, current curator at the Arizona State Museum, one of the theories about the Arizona Openwork Shirt is that it was made by a visitor to the region. Examples of sprang are known from the Mexican states of Guerrero and Hidalgo (Teague 1998, p. 81). There are clear trade routes for precious metals, coming from Mexico. The theory proposes that a weaver travelled with the metal traders, saw the local designs, and, using local cotton, created this shirt.

Comparing front and back, the designs are mirror images one of the other S & Z. Minute irregularities can be found in the patterns. Where both sides are intact, the identical minute irregularities are present on the both sides. The technique therefore can be confidently described as interlinking sprang.

The top of the shirt, the shoulders and neckline, represent the initial loops in the warp, and the hem represents the cut ends at the meeting line near the middle of the warp. The join at the shoulder was created uniting front and back loops. The sides were sewn together, uniting 'S' and 'Z' stitches.

The Project

The motivations to replicate this shirt, as well as the goals, were numerous.

It was a collaborative effort, mutually advantageous for many. Key players were Arizona State Museum Curator Mike Jacobs, Louie Garcia, Joan Ruane, and the author Carol James.

In writing a book on sprang, author Carol James searched for examples of sprang that would be of interest to a North American readership. It seemed obvious to include the Arizona Openwork (Tonto) shirt. Carol attended a conference of Arizona Handweavers, in Tucson, in April 2014, and the topic of the shirt arose. It had been viewed by many handweavers in Arizona before it was removed and access limited. It was felt that, while respecting the reason for the restricted access, the shirt represents a valuable, but now invisible page of our shared human textile heritage. As interest in the sprang technique re-awakens, a replica would facilitate awareness of this piece of our shared heritage while protecting the original.

Carol James has been exploring low-tech braiding techniques for more than 30 years. Finding few sprang instructors, she has taken to selecting historic pieces as instructors. The Arizona Openwork Shirt presented itself as such an instructor. Carol was interested in examining this ancient example of sprang, as an opportunity to learn more about the sprang technique from an ancient piece. She was looking forward to the challenge of mapping out the patterns and replicating them.

Louie Garcia is a Tiwa and Piro Pueblo weaver and educator from southern New Mexico. He resides in Albuquerque, where he is the president of the New Mexico Pueblo Fiber Arts Guild (Garcia, 2016, pg 66). He works to re-awakening awareness of his people's ancient textile traditions, and was very pleased that sprang, long since abandoned by people of the southwest could be revived.

Joan Ruane, expert in cotton spinning, instructor and practitioner, lives in southern Arizona among cotton fields. Her website, www.cottonspinning.com, is dedicated to information on working with cotton, growing, spinning, dyeing, and weaving. She was interested in the shirt as it represents a handspun cotton garment.

According to retired curator Lynne Teague, she had received a request while working at the museum from a Native American group that she create a replica of the shirt. Not having time for to create a full replica, she made smaller pieces replicating the patterns in the shirt. To her knowledge no full replica existed to date.

The Arizona State Museum was interested in a replica for research and display purposes. Curator Mike Jacobs expressed a willingness to recommend a replica to the acquisitions committee, confident it would be accepted.

Fig. 1. The Arizona Openwork Shirt with the initial comparison sample. (photo Joan Ruane)

Planning

Joan Ruane and Carol James examined the shirt in the Arizona State Museum on April 29, 2014. They brought samples of diverse sizes of cotton for comparison, and determined that commercial 2/8 cotton was closest in size, but the threads in the shirt had a great deal more twist. During the course of this visit, the conversation with the curator Mike Jacobs turned to the possibility of creating a replica of this shirt to be donated back to the museum.

Following this visit to the Arizona State Museum, a sprang sample was made using commercially spun cotton, to verify the yarn size. This sample was cut in two: Joan Ruane took half back to the museum for a comparison photo (Photo 1). Carol James kept the other half as a gauge for comparison in the replica work.

Mapping the Design

Photos taken during the visit provided sufficient information to map out the designs on the shirt. Hole placement was plotted onto graph paper, which would serve as a pattern for

the replica. The manner of pattern writing uses one square per thread. The interlinking stitches are indicated by dashes connecting the threads in each stitch. An example of the pattern is the Meander Pattern (Image 2).

The challenge was to accurately record all details of the pattern. An attempt was made to be as faithful as possible to the original shirt in mapping out the pattern, including all ‘irregularities’. It was felt that these irregularities could be informative. There are places where both front and back are missing. Here a ‘best guess’ was made.

Patterns in the shirt can be divided into three types: meanders, wedges, and swirls.

Each motif appears at least 3 times in the shirt. The motifs are not always repeated identically. There are slight irregularities within the designs.

The central swirl features an open work path that is 2 holes wide. The swirl is formed from two solid lines that do not join at the center of the swirl. Two additional swirls appear in the lower portion of the shirt. They are in better condition on the back of the shirt. These swirls feature an openwork path that is 3 holes wide and the solid lines join at the center.

Fig. 2. Diagram of the Meander Pattern. (photo Carol James)

The meanders feature a solid path on an openwork background. The uppermost meander features a narrower path, only 3 stitches wide. The other meanders feature a solid path that is 5 stitches wide. The length of the turn-around varies from 4 holes to 6. There are occasional extra holes, or missing holes. There is only one place where the solid path is discontinuous, near the middle of the meander along the left side of the shirt.

The wedges show the most variation in design, and also the most irregularities. They vary in height from six holes tall to nine holes tall. There are also holes that are extra small, representing a missed row.

Evidence of the greatest difficulty with these wedges can be seen where one wedge meets up with the next wedge. The uppermost series of wedges avoids this problem by working the base line of holes first. In subsequent series of wedges the worker begins by creating the tip of the wedge first. In later rows the wedges need to join up properly. Of 55 wedges in the shirt, 19 of them, 28% have this problem joining. The problem is made manifest by irregular spacing between holes, irregularities in the number of threads

between individual holes where wedges meet. The frequency with which this occurs, and that it occurs more frequently as the work progresses, leads us to speculate that perhaps the original artisan was not interested in the holes neatly lining up. It occurs to us that perhaps the artisan was intending to create irregularly shaped solid wedges. The irregularities in the hole spacing was less important.

For the graph paper grid, we selected paper that was 11 x 17 inches, 10 squares to the inch. This provided squares that were a reasonable size that could be comfortably read by the weaver seated at the weaving loom. Six sheets of this graph paper taped together were required to contain the entire pattern. The graph paper grid yielded the number of threads required to create the patterns on the garment: 456.

Calculating the Warp

To calculate length of warp required, the general rule of thumb is that a sprang warp can shrink as much as 30% during the braiding process (James 2011, pg 10). Official measurements of the shirt are 65cm x 65cm. Adding 30%

to this means starting with a 90 cm warp for each side, so 1.8 m total warp length. Such a length was not sufficient for all the patterns in the shirt.

Indeed, there are two kinds of 'shrink' involved in sprang. One is 'uptake' as each stitch is made. Bends made in the straight line, as stitches are made, shorten the total length. The second type of 'shrink' happens after the cloth is complete. When the garment is spread to open the holes and reveal the pattern, the total width increases and the length decreases.

Calculations were made, tested, adjusted, and tested again. The replica shirt on the frame began as a warp that was 2.4 meters long and measured 41 cm across. Upon completion of the braiding the width was still 41 cm, and the length of each side of the shirt was 1.01 meters. The 2.4 meters had shrunk to 2.02 meters. After blocking, the shirt measured 68 cm wide x 70 cm long.

The Yarn

In all, 3 shirts were produced. The first shirt used a commercially spun thread. This first shirt was used to correct the pattern. This first warp, 90 cm long, proved to be too short, lacking sufficient space for the full pattern. The 2nd shirt used a longer warp of cotton handspun. Joan Ruane had set to work to spin cotton for the project. She was unhappy with the results of her spinning, as she was unable to impart the required amount of twist in the yarn. She thus solicited the participation of Louie Garcia. Joan nevertheless provided her insufficiently twisted yarn to the weaver Carol James. Joan's skein was used to check calculations for length of warp. It also provided comparison for work with handspun.

Joan had spoken with Louie Garcia, inviting him to participate in the project. Before accepting, Louie went to visit the shirt at the Arizona State Museum, to ask permission from the shirt.

Sensing the shirt was agreeable, Louie signed on to the project.

After visiting the shirt, Louie Garcia sent two varieties of his handspun cotton, Acala and Hopi cotton to weaver Carol James. She worked these two types of cotton into a single piece of sprang, and returned the sample to Louie Garcia. Handling the sprang piece, Louie Garcia was able to judge that the Hopi Cotton was more appropriate to what he had seen at the Arizona State Museum.

Louie Garcia agreed to provide Hopi cotton grown in his own yard, ginned by hand, which he would spin to required specs. Usually he uses a drop spindle. Because of the length of yarn required as well as time constraints, he used a charkha. In January 2015, he sent a 1500 yd ball, one continuous thread, to Carol James.

Sprang work, constantly pushing the cross to the mirror image side, places different stresses on the yarn than does knitting or weaving. Thread must have high amounts of twist to maintain integrity during the process. We were pleasantly surprised to find the handspun cotton to be particularly well-adapted to sprang work. Joan Ruane is quick to tell anyone that commercial processing of the cotton fiber, to adapt it to requirements of factory production, changes the fiber completely. The handspun worked differently from commercially prepared cotton and proved ideal for sprang. Stitches, once made had a certain amount of 'grab'. They stayed packed in place along the just-completed row. At the same time the fiber surface was smooth enough for ease of movement of rows to the mirror image side.

The Frame

Requirements for this type of work include a frame on which the warp is stretched (Image 3). The full length of the warp must be available to the worker, in this case more than 2 meters. There has been some speculation on the type of loom used to create the original shirt. According to Lynne Teague, there are images of horizontal looms

Fig. 3. The sprang technique. (photo Richard Sparling)

Fig. 4. The mirror image created adjacent to the end loops. (photo Carol James)

on pottery dating to the appropriate period. Theoretically a horizontal loom would work well for this project. In this model, threads are stretched out on a frame that lies on the ground. Requirements are a space on the ground of sufficient length and width to allow work on a 2.4 m x 41 cm warp. The worker sits at one end, working each row, and then moving the row to the other end. Weaver Carol James cannot work crouched down, so does not work horizontally.

We used a false-circular warp method as described in Peter Collingwood's *Techniques of Sprang* on page 256. The

circular warp method has loops from both ends of the warp around a single common stick or thread. This method requires a frame that is only half the total length of the warp. It permits worker to sit upright at the frame. The warp can be moved around the frame and adjusted to a comfortable position for work.

A frame made from 2x4s and 2cm diameter dowels was used to measure and hold the warp. Smaller dowels were used to create the first cross. The end loops were originally wrapped around a knitting needle. The knitting needle was later replaced with a string.

Creating the Cloth

Work began at the first cross. Each row, upon completion was moved down and around the 2 meters of warp, also creating a mirror image braid at the other set of loops (Image 4).

The basic interlinking stitch in sprang represents threads that link around the neighbor to the right, and then the neighbor to the left. Holes are created by virtue of ‘missed’ linkings (Image 5). One can also think of this as pairs of ‘edge stitches’ that occur mid-row. For more on the method to create these patterns see the book *Sprang Unsprung*, or view YouTube videos:

<https://www.youtube.com/watch?v=JY3jyy2rGEs>

<https://www.youtube.com/watch?v=CKIqIoMegig>

The grid pattern created on the graph paper indicated the exact placement of holes. The weaver counted the number of squares (indicating stitches) for each row, writing the numbers in on the pattern and then worked each row accordingly, from right to left across the warp. Each row was then pushed to the mirror-image side. Frequent checks assured the work to be as accurate as possible, as close as possible to the original. As a measure to prevent errors, a cardboard tube and knitting needle were used as a cloth-spreader during construction. (Image 6) This helped the weaver to accurately select the correct thread, avoiding irregularities. The small sample made immediately following the visit to the museum, served as a gauge. It was checked frequently to be certain of the correct number of rows per cm.

The hem of the garment features tabs. Slits were formed when the cloth was made. The ends of the tabs are where the two pieces, front and back were cut apart. Each tab ends with a knot. Examination of the garment reveals varying numbers of threads in these tabs, from 10 to 14.

Fig. 5. Close-up of the openwork patterns. (photo Carol James)

Fig. 6. The sprang frame with the project. (photo Carol James)

When the weaving of the shirt was almost complete, slits were made to form the tabs (Image 7). Depending on the pattern above, it was difficult to maintain a constant ten threads per tab. Perhaps this helps to explain the variation

Fig. 7. Fringe slits. (photo Carol James)

Fig. 8. Cutting, wetting and tying the fringe. (photo Carol James)

in number of threads per tab. The tabs were cut apart, and each end knotted to secure the work, prevent un-raveling (Image 8). Ends were dipped in water to make them easier to deal with. A crochet hook was used to help tie the over-hand knots.

Finishing

Interlinking sprang adds twist on one side, removes twist on the other. The result is a cloth that has the distinct need to curl when removed from the frame. Blocking allowed the cloth to lie flat. The cloth was placed in water until thoroughly wet. It was then pinned to a blocking board and allowed to dry. When the pins were removed the cloth no longer curled. (image 9)

The shoulder seam and finishing around the neck were described by Kate Peck Kent (Kent 1957, pg 604). A single thread holds the initial loops, alternating loops from front and back forming the shoulder seam. This is exactly the feature of the false circular warp. Initially we thought that this could indicate that the original worker had used the false-circular method. Upon further examination this cannot be the case. The swirl at the center of both front and back features a counter-clockwise direction. One side was intentionally turned over before assembly.

The common thread holding the end loops, was removed carefully (Image 10). Loops were placed onto two knitting needles, one for front loops, and one for back loop. The front and back pieces were now separate. One side was turned over, and the shirt was ready for the shoulder seam.

Fig. 9. The completed cloth with fringe, before creating the neck opening. (photo Carol James)

Fig. 10. Separating the looped join for the neck opening.. (photo Carol James)

Fig. 11. The neck opening, centered, before twining. (photo Carol James)

Two shoulder seams were created. Each seam features a thread holding alternating loops from the front and from the back pieces (Image 11). .

According to Lynne Teague the neck opening was secured with twining. The initial attempt to twine around the neck resulted in an opening too small to pass over an adult human head. A looser twining at the front of the neck allowed sufficient space for the head, and also created the sag along the front neckline seen on the original garment.

Sprang can have an invisible seam. The 3-thread edge

stitch can be used to sew up in a manner that imitates the interlinking stitch, creating an invisible seam. The original shirt was not sewn up in this careful manner. Side seams are sewn using a similar thread, not particularly neatly done.

Sprang work on the replica shirt was carried out during the month of February, 2015, during a lecture and teaching tour of the state of Arizona. Members of the public and those interested in sprang classes viewed the progress of the shirt. In all it required 42 hours of work to complete the shirt.

Fig. 12. Presentation of the replica shirt to the Arizona State Museum. From left to right, Mike Jacobs, Carol James (with shirt), Louie Garcia and Joan Ruane. (photo Paula Garcia)

The Results

In all 3 shirts were created. The first was made using commercially produced thread, and has been kept by the weaver Carol James. She uses it in teaching and promoting the sprang technique.

The second shirt, made from Joan Ruane's handspun cotton, is kept by Louie Garcia, who uses it for teaching purposes.

The 3rd, the real replica, was donated to the Arizona State Museum on Sunday, March 4, 2015.

Interested members of the public were invited to come to the lobby of the museum to view the completed shirt just prior to donation. Louie Garcia came from New Mexico with his family. Louie Garcia and his daughters said a blessing and sprinkled the shirt with corn meal before it was handed over to Mike Jacobs. The shirt was placed on the plastic torso that had been created for the original shirt and was, in due process, entered into the museum collection. (Image 12)

Conclusions

Work to create this replica helped us to appreciate the skill of the original worker, who assembled these motifs and so expertly executed them. We marveled at someone who would have worked without the aid of graph paper. It was suggested that Navaho rug weavers do not always work across the full width on every row. They frequently work on pattern sections. This led us to look again at the motifs, to see if they could be created in sections. Indeed we marked off motif zones, and numbered them in the order that they could be created. (Image 13) A problem occurred around the central swirl, zone 13 which must be completed before zones 11 and 12. Interestingly the 'irregularity' in the meander pattern is located in this exact spot in zone 12, and likewise an 'irregularity' in the wedge pattern in zone 11.

This could be interpreted as evidence that the worker paused at this point in order to work on another section, presumably the swirl. When returning to the meander the artisan had lost track of the position in the motif and the error occurred.

Looking at the shirt again, we note that the first meander pattern to be created (zone 3) uses only 3 stitches for the meander path. The other meanders use 5. This could represent the development of the pattern as the worker created the shirt. After creating Zone 3, the artist decided to use 5 threads in subsequent meanders.

Fig. 13. One half of the shirt with diagram of the pattern zones identified. (photo Carol James)

The first wedges appear pointy-side up. All the other wedges appear blunt-side up, making it easier to create the irregular appearance of flame. The large swirl at the center features a path that is two holes wide. The two swirls near the hemline feature a path that is three holes wide.

These irregularities could be seen to corroborate the theory that the shirt was made by a visitor. The original artisan clearly was highly skilled in the technique, but the patterns developed as the shirt was made.

By July 2015, four months after completion and donation, all three shirts had been on display, available to members of the public. Already the goal has been met. The original shirt is respectfully preserved and at the same time the public has access to this important piece of our common human textile heritage (Image 14).

Fig. 14. The sprang shirt as worn. (photo Richard Sparling)

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