String, and Knot, Theory of Inca Writing

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Of all the major Bronze Age civilizations, only the Inca of South America appeared to lack a written language, an exception embarrassing to anthropologists who habitually include writing as a defining attribute of a vibrant, complex culture deserving to be ranked a civilization.

The Inca left ample evidence of the other attributes: monumental architecture, technology, urbanization and political and social structures to mobilize people and resources. Mesopotamia, Egypt, China and the Maya of Mexico and Central America had all these and writing too.

The only possible Incan example of encoding and recording information could have been cryptic knotted strings known as khipu.

The knots are unlike anything sailors or Eagle Scouts tie. In the conventional view of scholars, most khipu (or quipu, in the Hispanic spelling) were arranged as knotted strings hanging from horizontal cords in such a way as to represent numbers for bookkeeping and census purposes. The khipu were presumably textile abacuses, hardly written documents.

But a more searching analysis of some 450 of the 600 surviving khipu has called into question this interpretation. Although they were probably mainly accounting tools, a growing number of researchers now think that some khipu were nonnumerical and may have been an early form of writing.

A reading of the knotted string devices, if deciphered, could perhaps reveal narratives of the Inca Empire, the most extensive in America in its glory days before the Spanish conquest in 1532.

If khipu is indeed the medium of a writing system, Dr. Gary Urton of Harvard says, this is entirely different from any of the known ancient scripts, beginning with the cuneiform of Mesopotamia more than 5,000 years ago. The khipu did not record information in graphic signs for words, but rather a kind of three-dimensional binary code similar to the language of today's computers.

Dr. Urton, an anthropologist and a MacArthur fellow, suggests that the Inca manipulated strings and knots to convey certain meanings. By an accumulation of binary choices,

khipu makers encoded and stored information in a shared system of record keeping that could be read throughout the Inca domain.

In his book "Signs of the Inka Khipu," being published next month by the University of Texas Press, Dr. Urton said he had for the first time identified the constituent khipu elements. The knots appeared to be arranged in coded sequences analogous, he said, to "the process of writing binary number (1/0) coded programs for computers."

When someone types e-mail messages, they exist inside the computer in the form of eight-digit sequences of 1's and 0's. The binary coded message is sent to another computer, which translates it back into the more familiar script typed by the sender. The Inca information, Dr. Urton said, appeared to be coded in seven-bit sequences.

Each sequence could have been a name, an identity or an activity. With the possible variations afforded by string colors and weaves, Dr. Urton estimated, the khipu makers could have had at their command more than 1,500 separate units of information. By comparison, the Sumerians worked with fewer than 1,500 cuneiform signs, and Egyptian hieroglyphs numbered under 800.

Dr. Urton concedes that his interpretation of a khipu writing system may be hard to prove. No narrative khipu has been deciphered. Spanish conquerors, who suspected the knotted strings might contain accounts of Inca history and religion, destroyed those they came across as idolatrous objects. The few existing descriptions of the khipu by explorers and missionaries lack enough detail for an understanding of the way the Inca made and "read" them.

Other Inca scholars generally agree that the khipu may have served as more than accounting devices or memory aids, and may have been a medium for recording historical information. But they reserved judgment on Dr. Urton's binary code hypothesis.

"Most serious scholars of khipu today believe that they were more than mnemonic devices, and probably much more," said Dr. Galen Brokaw, a specialist in ancient Andean texts at the State University of New York at Buffalo. He was quoted in an article about the khipu in the June 13 issue of the journal Science.

Dr. Patricia J. Lyon of the Institute of Andean Studies in Berkeley, Calif., was unmoved from her position that the khipu were mnemonic devices, personalized visual and tactile cues for the recall of the information retained in the memory of the maker. If that was the case, the khipu would not be a form of writing because they would have been understood only by their makers, or someone familiar with the same memorized accounts or narrative.

"People feel this great need to pump up the Inca by indicating that the khipu were writing," Dr. Lyon said.

Dr. Urton said in an interview that others would soon be able to test his theory and possibly find other patterns and clues in the khipu he studied. A detailed khipu database, financed by the National Science Foundation and prepared with the help of Dr. Carrie Brezine, a Harvard mathematician and weaver, is expected to be ready this fall and will eventually be available online.

Experts in the culture of early Peru think it understandable that textiles would have been the chosen medium for writing. The Sumerians and Babylonians wrote on clay, the Egyptians on stone and papyrus. The Inca may have used cloth, though, to store and communicate knowledge because to them cloth was a widely used marker of status, wealth and political authority.

Dr. Heather Lechtman, an archaeologist at the Massachusetts Institute of Technology who specializes in early Andean technology, said that "fibers were the heart of Andean technologies of all kinds, even long before the Inca, and so it doesn't surprise me that people would have thought of using khipu perhaps for some sort of writing system."

Early Spanish colonists gave conflicting accounts of the practice. A drawing of a khipu maker in an Inca storehouse seemed to reflect the view that the knotted strings involved record keeping. A Jesuit chronicler said the khipu were like ledgers or notebooks that overseers and accountants used "to remember what had been received and consumed."

Another account tells of Spanish travelers who came upon an old Indian man who tried to hide the khipu he was carrying. Under questioning, the Indian claimed the khipu recorded the activities of the conquerors, "both the good and the evil." The Spanish burned the khipu and punished the Indian.

Not until the 1920's did scholars seem to reach a consensus on what the khipu were. From studies of a collection of knotted strings at the American Museum of Natural History in New York City, L. Leland Locke, a science historian, concluded that they did not represent a conventional scheme of writing but signs recording columns of numbers. Khipu makers must have been bookkeeping bureaucrats.

This remained the prevailing opinion until the last two decades. Husband and wife researchers, Dr. Robert Ascher, a retired Cornell archaeologist, and Dr. Marcia Ascher, a mathematician at Ithaca College, reopened debate by pointing out that khipu seemed to use numbers as both numbers and labels. They estimated that about 20 percent of existing khipu were "clearly nonnumerical" and could have been examples of an early form of writing.

Dr. Urton has carried the idea further. A creator of khipu, he posits, made a series of choices involving the type and color of string and each knot. Each choice contributed to creating a binary signature. A certain string configuration could represent signs that stood for a value, object or event, much as graphic signs do in familiar forms of writing.

Emboldened by this insight, Dr. Urton said in his book that the Inca "may well have been recording full subject-object-verb notations in the khipu."

Dr. Urton based his research primarily on khipu specimens at museums in the United States, Germany and Peru. A discovery in 1997 in northern Peru, at a burial site of the Chachapoya culture, yielded 32 khipu with exceptionally elaborate and varied types of string patterns. Strands hanging from the horizontal cord had their own secondary and tertiary pendants.

These complex pendant attachments, he wrote, "must have been an important mode of binary coding in the khipu."

A close examination of Dr. Urton's new database of khipu elements by other scholars, including linguists and pattern-recognition experts, may win wider support for the writing hypothesis.

"It's much too early to say anything about how this will all come out," said Dr. Lechtman of M.I.T.

More definitive would be the discovery of an Inca "Rosetta stone." It was such a trilingual inscription that finally enabled scholars to decipher Egyptian hieroglyphics.

A colonial governor had khipu makers "read" some strings and scribes record the accounts in Spanish. This could have been a start toward decipherment, if only the khipu had been preserved.

A prospective Rosetta stone was announced in 1996 by an Italian amateur historian, who claimed to have found a translation into Spanish of a song encoded in a khipu. But other researchers have not been allowed to examine the material, and Dr. Urton said that many questions had been raised about its authenticity.

Dr. Urton holds out more hope of making a breakthrough discovery in the Chachapoya material. Most of the khipu there appear to be from the early colonial period. For that reason their encoded messages are more likely to have been transcribed in Spanish documents as the sought-after Rosetta stone of Inca writing. If, that is, the Inca wrote with strings and knots.

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a string theory, i.e. a theory of maps from Riemann surfaces to a certain "target" space. This idea has had some applications in mathematics: the Kontsevich matrix. Â in [LM1, LMV]. String theory and knot invariants 3. 2.2. Chern-Simons theory. In 1988, E. Witten introduced a completely dif-. ferent point of view on quantum group invariants of knots and links. He considered. a topological gauge theory for a gauge connection A on a three-manifold M, with.Â In 1993, Joan Birman wrote [B]: Thus we can compute the simplest of the invariants by hand and quickly ïll pages. with the coeïƒcients and exponents of W. Enhancing Memory Using Knots. Other perhaps less known artifacts include the talking knots or khi-pus, a textile object used by the Incas for bureaucratic recording and as a communication device to send messages throughout their em-pire. Their origin dates back to 3,000 B.C. and to this day, khipus have puzzled scholars; no one has been able to decipher completely their content 13. Khipus are textile devices made from cotton cords, arranged in such a way that there is one main cord, from which many pendant ropes with knots hang. There has been speculation.Â 14 Wilford, J. N. (2003). String, and Knot, Theory of Inca Writing. The New York Times. 15 Murray, D. E. (2000).