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Using Visualization in the Archaeological Excavations of a pre-Inca Temple in Peru

Alan D. Kalvin
IBM Research Division
T.J. Watson Research Center
P.O. Box 704, Yorktown Heights, NY, USA.

Alfredo Remy
IBM del Peru,
Prolog. Av. Javier Prado Este,
540-La Molina, Lima, PERU

Orlando Ardito, Kim Morla, Eduardo Nolasco, Jorge Prado
Pontificia Universidad Catolica del Peru,
Av. Universitaria Cdra. 18, Lima 32 - Aptdo. 1761, PERU

Regulo Franco, Antonio Murga, Guillermo Wiese
Fundación Augusto N. Wiese,
Av. Larco 1101-1123 Miraflores, Lima, PERU

IBM Research Division
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ABSTRACT

We are using computer visualization as an essential tool in the restoration of the disintegrated ceiling of a ritual precinct that was recently discovered during archaeological excavations of a group of temples built by the Moche people who lived in northern Peru between the first and eighth centuries A.D.

This ceiling is unique – it is the only one found that has pictures painted on it, rather than being simply white-washed. The restoration of the ceiling, and the recovery of these iconographic figures will provide an unprecedented opportunity to study the culture of the Moche people who build and used these temples.

We have designed this system to enhance the traditional way that archaeologists restore paintings. Our aim is to put a powerful tool in the hands of restoration experts, rather than to try automate the restoration process.

The system was completed in late December, 1996. We have currently matched and reassembled 61 of the pieces into 16 groupings - this took about 8 hours of work. As we become more proficient at using the system, we anticipate that the matching process will speed up significantly.

1 The Moche civilization and the excavations at El Brujo

At the archaeological site of El Brujo (The Sorcerer) on the coast of northern Peru, a major excavation of a temple building belonging to the Moche people of ancient Peru in currently under way. The Moche, who occupied this region of Northern Peru between the first and eighth centuries A.D. were highly advanced both technologically and artistically. They built sophisticated irrigation canal systems, pyramids, and palaces, are produced artisans highly skilled in ceramics, metallurgy, and weaving. In about A.D. 800, the Moche society suddenly disappeared, for reasons that are still unknown.

Although the Moche civilization existed for a much longer period than that of the Incas (approx. 1450-1600 A.D.), we know far less about them. Firstly, the Moche had no writing system and thus left no written record. Second, because they had already disappeared by the arrival of the Spaniards the 16th century, there are no no first-hand European accounts of the Moche such as those that provide much of our current knowledge about the civilization of the Incas. Therefore the archaeological investigation of the artistic record of their activities, environment, and supernatural realm, plays a crucial role in our understanding of Moche civilization[1].

2 The Huaca Cao Viejo

The temple under excavation, called Huaca Cao Viejo, is one of three stepped pyramids built out of sun-dried bricks at the El Brujo site. It has strong religious connotations within the development of the Moche culture. Depictions of many of the ritual activities that took place in such temples are frequently found in Moche ceramic designs[2].

Within the temple, archaeologists have uncovered the remains of a ritual enclosure (or precinct). Figure 1 shows an artist's rendering of a region inside the original temple, with the man on the left standing inside the ritual precinct. The walls of this precinct are beautifully decorated with small high-relief figures. These designs correspond to figures, actions and themes, with special importance given to scenes of navigation and fishing, human sacrifices, martial conflicts, human figures related to the cosmic world, mythical animals, shamans (medicine men), stellar figures and warriors.

2.1 The precinct ceiling

The ceiling is the focus of great archaeological interest, since it is the only one of its kind know to have figures painted on it. Unfortunately, it has not fared as well over time as the precinct walls. At some point in the past it collapsed and broke apart. The remains that have been recovered consist of about 3,000 pieces. Some pieces are big (10 x 15 cm. - i.e. about 4 x 6 inches), some are as small as thumb-nail, but the majority of pieces are about the size of a fist. Figure 2 shows some relatively well-preserved pieces from the ceiling.

Based on the evidence recovered so far, we hypothesize that this precinct was used as a sacrificial altar, and that the figures on the two walls and ceiling represent part of a belief system, or religious speeches that were transmitted by a priest from the adjoining platform.

We believe that the figures on the walls and ceiling, form a unified iconographic narrative, depicting mythical scenes which represent particular aspects of the cosmogony and cosmology (i.e. the origin and structure) of the religious Mochica universe.

The restoration of the ceiling and its paintings is essential for a complete and a meaningful interpretation of this narrative. Decoding and understanding it will greatly increase current knowledge of the Moche culture.

3 A Visualization-based approach to restoring the ceiling

Our primary motivation for developing a computer-assisted visualization system for restoring the temple ceiling is that a physical restoration is virtually impossible. The large number of pieces, the extensive erosion of their edges, and their fragile condition (they crumble very easily when handled) rule out the idea of laying them out on the ground and putting them together like a giant jig-saw puzzle.

Further, manipulating digitized versions of the pieces on a computer monitor allows us to test potential matchings and arrangements of pieces rapidly and precisely.

We have designed this system to enhance the traditional way that archaeologists restore paintings. Our aim is to put a powerful tool in the hands of restoration experts, rather than to attempt automating the restoration process. Accordingly, we have been working very closely with the restorers from El Brujo.

Initially we began working with a sample of 218 pieces that appear to have come from a common region of the ceiling. Because of the delicate condition of the pieces, they were digitized on-site, using an HP ScanJet 4c document scanner attached to an IBM Aptiva.

The scanned images were shipped to Pontificia Universidad Catolica del Peru (PUCP) in Lima where they were exported to IBM RS/6000 workstation for preprocessing, matching, and manipulation using **ARMADO**, the ceiling reconstruction system that we have built with IBM Visualization Data Explorer visualization toolkit.

The restorers can rapidly experiment with candidate matches between pieces using a "what-if" spreadsheet type of approach. This matching and alignment of the pieces is based on a database of piece features that contains the following information.

- Colors: The Moche used 9 basic colors in their paintings. Each ceiling piece can have any combination of these colors.
- Interpretations: These are the possible interpretations of the fragments of figures on a piece (e.g. fox, crown, king, face, crab, snake).
- Texture: Each piece is classified as rough, smooth or both.
- Repainted: Some pieces were repainted before the ceiling collapsed. This is indicated by multiple layers of paint.
- Cane markings: the back side of each piece contains several parallel grooves made by the cane poles used in the constructioj of the ceiling (see Figure 5).

To select a set of pieces for a candidate match the archaeologist uses a Data Explorer "Feature Selection" control panel (Figure 4) to make a request such as: "Find all pieces that have the colors red, blue and black, have fragmentary details of a fox and a snake, have a rough texture, and were repainted". The user can then rapidly fine-tune the matching results by modifying the selection criteria. Figure 5 shows a Data Explorer Image window with a set of selected pieces. Once a set of pieces has been selected, they are aligned on-screen. The orientation and thickness of the cane markings are used to guide and confirm possible alignments. Figure 6 shows a set of selected pieces about to be aligned - the red lines depict the cane marks.

4 Work in progress

ARMADO was completed in late December, 1996. We have currently matched and reassembled 61 of the pieces into 16 groupings - this took about 8 hours of work. As we become more proficient at using the system, we anticipate that the matching process will speed up significantly.

The paint on the ceiling pieces has faded with time and exposure to the elements. We are working on restoring the painting to their original colors. It is a contentious issue in archaeology whether to restore archaeological artifacts to their original state, or to preserve them as they have been found. By working with electronic pieces we have the liberty of choosing both options.

5 Acknowledgements

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References

[1] Walter Alva and Christopher B. Donnan. *Royal Tombs of Sipán*. Fowler Museum of Cultural History, UCLA, Los Angeles, CA, 2nd edition, 1994.

[2] Guillermo Wiese. Part II - El Brujo. In J.A. Lavalle, editor, *Precolumbian Trujillo*, pages 247–257. Impresora Metrocolor S.A., Lima, Peru, 1985.

Figure 1: An artist's rendering of the region inside the original temple containing the ritual precinct.

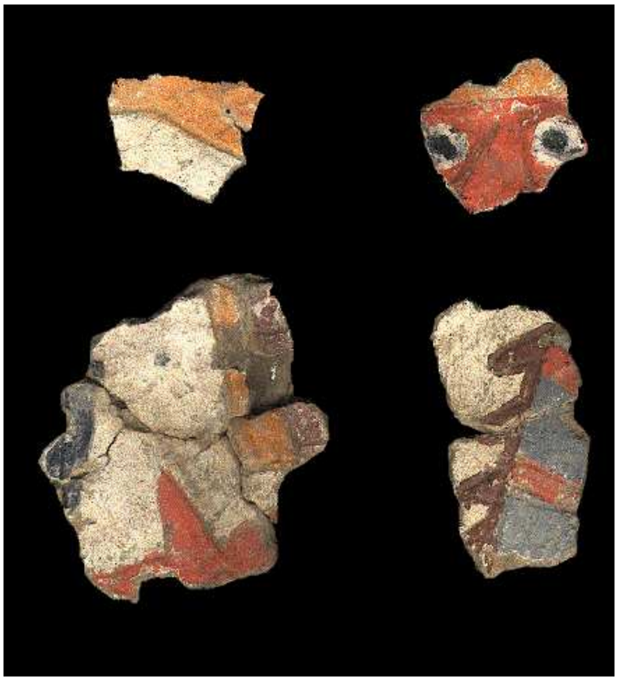

Figure 2: Some of the relatively well-preserved pieces from the ceiling.

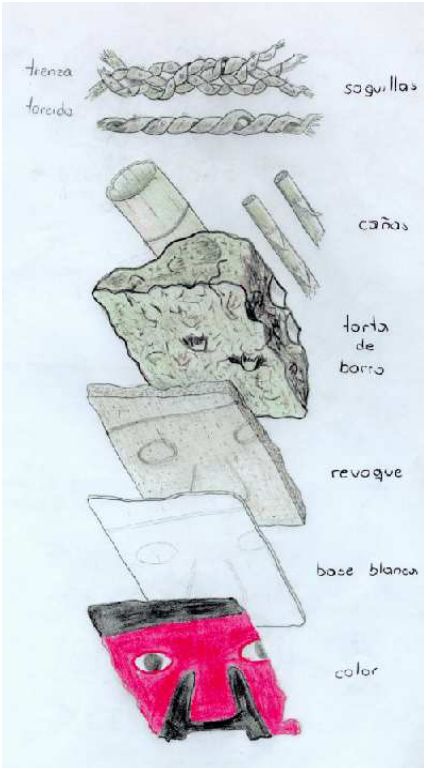

Figure 3: Exploded view of the layers making up the ceiling.

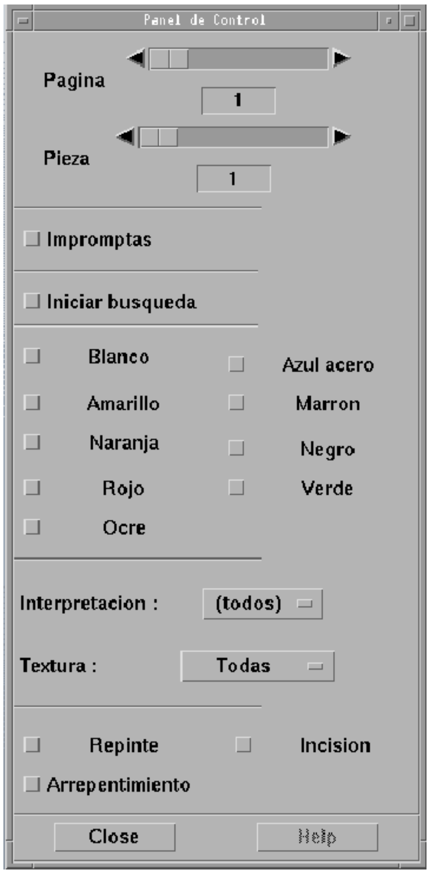

Figure 4: Data Explorer "Feature Selection" control panel.

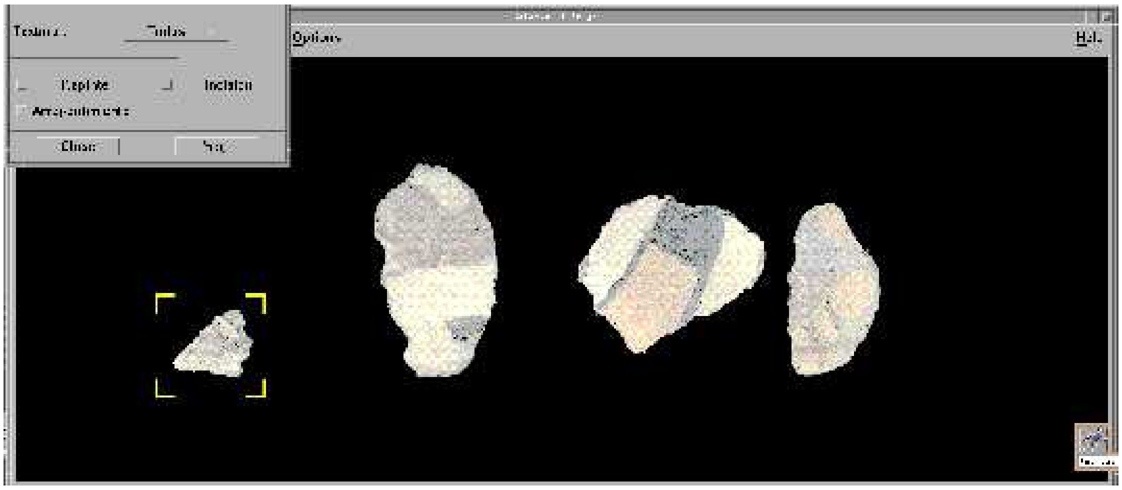

Figure 5: A set of pieces satisfying the selection criteria.

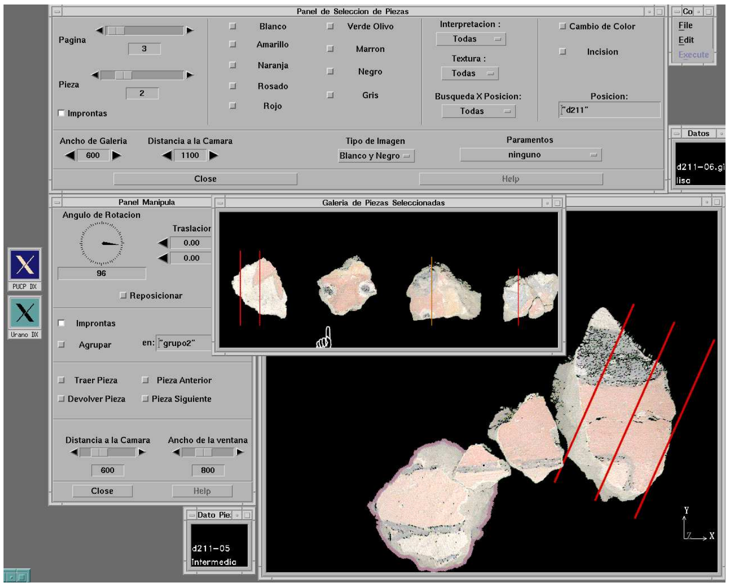

Figure 6: Aligning a set of selected pieces (the red lines indicate the cane markings on the back.

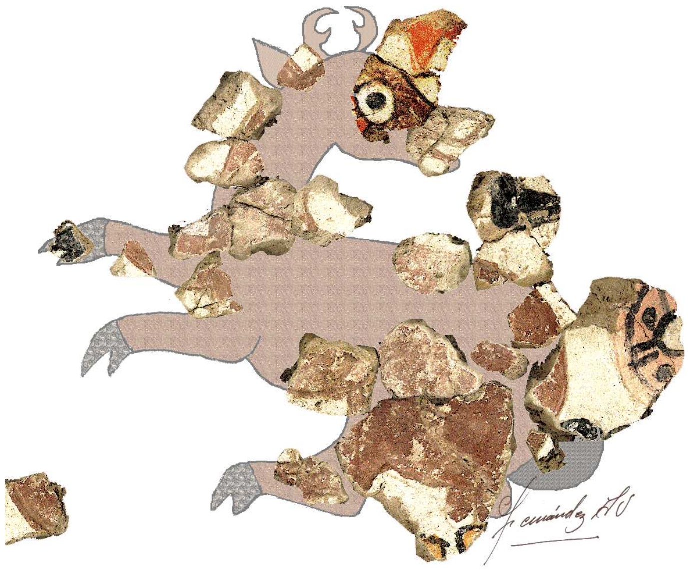

Figure 7: Late-breaking results: Reconstructed deer (March 1997).

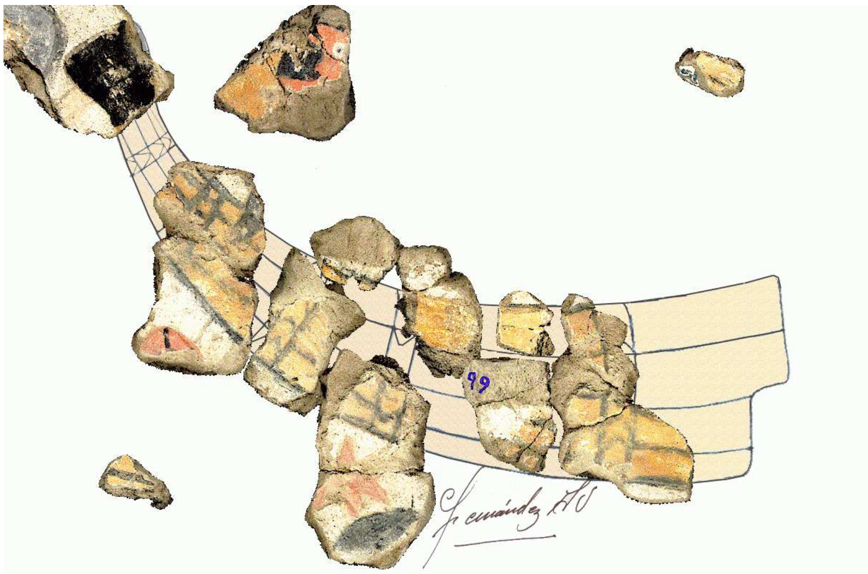

Figure 8: Late-breaking results: Reconstructed reed boat (March 1997).

Figure 9: Late-breaking results: Reconstructed face with crown (March 1997).

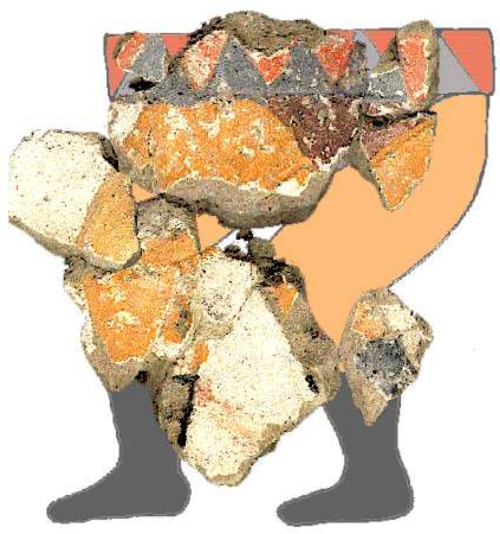

Figure 10: Late-breaking results: Reconstructed legs with skirt (April 1997).

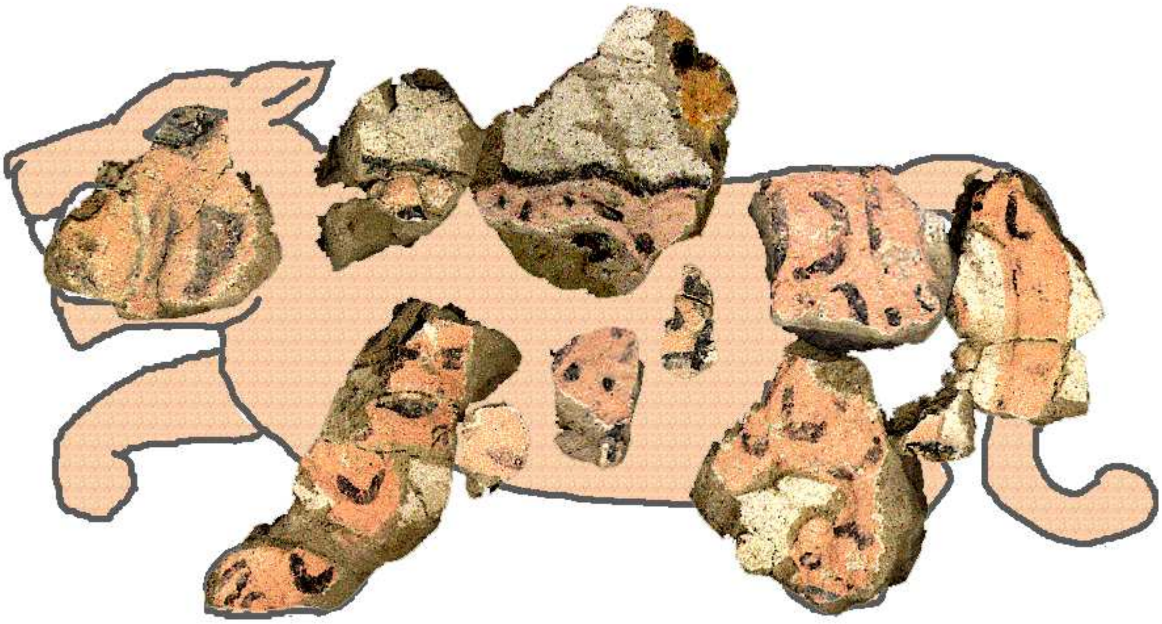

Figure 11: Late-breaking results: Reconstructed puma (April 1997).