From Aztec Pictograms to Digital Media - The Case of the Aztec Temple Square

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Abstract
Virtual archaeology or re-creating ancient worlds digitally is not a new item. While the virtual reconstructions of Cahokia on the Mississippi or the Royal Cemetery at Ur in Iraq have provided us with glimpses of how those ancient sites might have looked, the ‘quality’ of the digital end product has been lacking. This is because virtual archaeology is in its infant stages. This paper makes the point that in order to truly develop the bases of a new cognitive science, virtual archaeology has to incorporate a willingness to achieve higher digital modeling and rendering qualities. In other words, our ability to explore, to interpret and to appropriately use digital tools needs to aspire to greater and more penetrating abilities to reconstruct the past.

This paper presents the case of the digital reconstruction of the Aztec Temple Square. This is a unique project because, unlike other sites in antiquity where there is a substantial amount of archaeological evidence, the Aztec site contains little or almost no evidence. Most of what we know of the case comes from Indian manuscripts and Spanish chronicles.

Keywords
Virtual Archaeology, Reconstruction, History
1 Introduction

On or around November 1, 1519 Hernán Cortés sent ten scouts to look ahead for what was to become the Spanish conqueror’s last fifty miles into Tenochtitlán, the capital of the Aztecs, the largest Pre-Columbian empire in the Americas. Those explorers came back to Cortés with stories of ‘great cities and towers and a sea, and in the middle of it a very great city’. A week later, the Spanish army finally reached Iztapalapa, a town of about 15,000 people just five miles from the center of the city. It is most likely that is was from this point that European eyes first saw the Aztec Temple as well as other remarkable structures in the center of a city ranked as one of the most populated in the world at the time. The military conquest of Tenochtitlán in 1521, was followed by the almost complete destruction of not only the entire Aztec city, but its cultural artifacts as well. Two hundred and sixty nine years went by with almost no concern or interest for the rich cultures that existed before the arrival of Cortés. By chance, in 1790, while updating the layout of the central plaza in Mexico City, several large monoliths of Pre-Columbian origin saw again the light. This single event marked the beginning of a long process of attempting to understand and reconstruct what the Castillian expedition so feverishly destroyed. These efforts culminated with the Templo Mayor Project undertaken by the Mexican National Institute of Anthropology and History. This project brought to light vast amounts of data on the life, customs and achievements of the Aztecs in the sixteenth century.
Despite these efforts, the question of how did the Templo Mayor Square really looked like is still shrouded in mystery. Unlike other great sites of antiquity in Mesopotamia, Greece or Rome where today one can still find remnants and cultural artifacts leading to superb digital theoretical reconstructions of these sites as has been documented by Forte and Siliotti in Virtual Archaeology, the case of the Aztec Temple Square is unique. Cortés and his followers tore down every single structure on sight and scorched every Aztec painting and manuscript they could find.

This paper documents and explains some of the steps taken to reconstruct the area known as the Aztec Temple Square or Precinct, and more specifically, the architecture of the Aztecs in the 1500's. Included in the presentation is the use of a variety of digital tools and techniques that assisted in a) analyzing historic interpretations, b) debunking myths, c) providing accurate visualization of structures and d) highlighting architectural qualities.

2 The Problem
In the search for solutions to the difficult problem of attaining believable visualizations, it quickly became evident that previous attempts at reconstructing Aztec architecture suffered from:

- lack of sufficient evidence
- incorrect interpretation of historic data
- unsound perspective drawing techniques
- cultural bias

Perhaps one of the best examples of the problems enumerated above is the illustration of the Aztec Temple Square by Cortés himself shown in Figure 3. In this drawing, it is clear that what the Spanish conqueror drew was actually a picture of a European fortified town complete with towers, minarets and draw bridges. Certainly not an accurate representation of what his own eyes saw when he actually climbed the steps of the Aztec temple in the center of the main square. Like Cortés, historians over the last one hundred years have also attempted to illustrate the location and form of major structures in the core of the city. These works have sometimes followed particular idiosyncrasies resulting in formal solutions with a low level of credibility. A case in point are theoretical reconstructions done in the 1960's where a strong French Beaux Arts look was given to Aztec architecture. In other instances, delineations of the Temple Square area have suffered from serious perspective drawing problems. In this particular case the drawings have depicted Aztec architecture with building proportions that could not have been built due to the lack of construction materials and expertise available at the time. Finally, another significant problem over the years has been the cultural bias. For some, Aztec design was of no relevance compared to other Mesoamerican civilizations such as the Maya or Inca. For others, Aztec architecture was not only of huge size and importance, but surpassed all other previous Pre-Columbian civilizations in terms of quality and variety of execution.

3 The Role of Digital Tools
Before any attempt to use digital tools was undertaken, it was deemed of the utmost importance to plan the work in terms of understanding the unique characteristics of Pre-Columbian design. This paramount point of departure was critical because the central idea behind the project was not simply to achieve the reconstruction and produce some ‘cool’ views of Aztec architecture with the aid of modeling and rendering software as has been done by many, but to intensely study the principles of design behind the creation of monumental pyramids and shrines. At this point, it became clear that the Aztec Temple Square was the concrete manifestation of a unique system of be-
lied and view of the universe. The square was the center stage for Aztec drama. It served as the setting for colorful visual displays of highly energized relationships between temples and mountains, between social groups, and between human beings and their gods. Also, the Aztecs understood very well the principles of synesthesia. The Aztec Temple was a perfect example where visual attention was of primary importance to the operation of drives, instincts, emotions, feelings and bodily processes of human beings and thence to the survival and well-being of the Aztec culture. The concept of seeing divine images in dramatic appearances under the auspices of a powerful authority was central in the orchestration of architectural spaces within the precinct.

So, the questions and therefore the goals of the project at this point focused on:

- how to best use digital tools in translating the available historic sources, especially sixteenth century chronicles, into meaningful architectural form
- how to re-interpret and de-code ancient Aztec manuscripts
- how to add special meaning to digital renderings beyond the simple geometric reconstruction

Based on the above, the project was organized in the form of illustrated case studies to create scenes with as much meaning as possible on particular architectural issues. The continuity in the mini case studies was not based on historic chronology, but on related architectural considerations. And, the presentation proceeded from macro scale topics to end with building details, from larger planning and urban design issues, to small scale decorative motifs. The ultimate goal was to link historic data with digital technologies in order to communicate how the Aztecs saw their world.

4 Analyzing historic interpretations - translating historic sources

One of the most common pitfalls of virtual archaeology comes from the fact that the person or team developing computer models and renderings excels in these endeavors but knows very little about the history he or she is trying to visualize. A case in point are the several computer models of the Aztec Temple developed in the 1990's. Figure 4 shows four models of the same pyramid-shrine to illustrate the issue. The top left image is a photograph from an Aztec clay model uncovered by the archaeological record. The top right image is a digital model based on the original Aztec clay model. The center image is a digital model developed in the early 1990's showing a rather exaggerated height of the structure, with a very small shrine at the top. Here, it should be noted that while the digital model is well assembled, it is not conceivable that the Aztecs at the time had the technical know-how to build masonry structures with the proportions shown on this model. The bottom illustration depicts a more authentic shrine, based on both the archaeological record and building proportions and detailing derived from similar shrines in surrounding Aztec communities. The conclusion in this case is clear: in the rush for digitally re-creating the past obvious mistakes were made. The basic geometric configuration was incorrect. Building details and architectural styles were wrong too. Because digital reconstructions give the ‘feeling’ of being real, the general public is unaware of the problems associated with them, especially in relation to their veracity. A superficial inspection of the digital models on the Aztec Temple shown in Virtual Archaeology reveals that the ‘Aztec capital’s ancient splendor’ has been restored by means of...
computer processing, which has recreated the original in all its clarity and color'. However, it is too bad that every single element shown in the publication is incorrect, from the general placement of buildings, to the choice of building details and colors. To make the situation worse, the accompanying text did not even mention the terms ‘theoretical reconstruction’ or ‘probable massing’. It simply put forward a series of images with exaggerated terminology. What this means is that digital reconstructions of the past require high ethical standards. They also necessitate a multidisciplinary approach. Geometry, site analysis, mapping, lighting, environmental conditions, all have to be part of a larger effort that includes the search for all evidence, including both the historic and archaeological record. In the case of the Aztec Temple Square digital project, more than five hundred sources were consulted, ranging from the accounts in Latin of the fifteenth century, to the most recent archaeological excavations by the Mexican Institute of Archaeology and History. In this regard, it should be noted too that one of the most reliable sources for the project was the digital reconstruction of other sites where the archaeological record was more profuse. Applying what was learned from those sites to the Aztec capital proved to be invaluable.

5 From Aztec manuscripts to digital media

Because Cortés pulverized most of the physical evidence, only two reliable historic sources were left to decipher the Aztec Temple Square architectural puzzle: chronicles written in the sixteenth century and several codices dating before and immediately after the Spanish conquest. In the last category only very few extant manuscripts were considered authentic and suitable for serving the theoretical reconstruction efforts. While it is possible that codex drawings were only intended to be seen as pictograms with no architectural significance, there were enough elements in the pictograms to begin to derive and sketch possible architectural delineation. A significant problem was, obviously, that Aztecs did not use the same architectural notation we use today. So, using what appeared to be a combination facade and section representation in the codices shown in Figure 6 (Codex Cospi in particular), the exploration began by digitally removing all the elements that were not considered architectural. Then the section part of the codex drawing was converted to an elevation as shown in Figure 7 (typical Aztecs).
In other words, a mirror elevation was then created and placed side by side. The final result was still a composite drawing in that it showed elements apparently drawn in section — like white coatings and what appeared to be structural reinforcing rods — and elements that were clearly drawn as a facade or elevation. This particular reconstruction revealed three volumetric elements: a base, the structure itself, and a decorative building termination sitting on a flat roof. Structurally, it showed a post-and-beam construction system. The outside of the building was probably a lime-based stucco applied on a frame. It is very interesting to note that the interior seemed to be covered with a straw-mat type of finish placed diagonally. As the post-and-beam structure did not show any type of cross-bracing, the diagonally placed mats may have added a reinforcing quality to the whole, preventing potential collapses. It was also evident that it was not possible to arrive at conclusions on dimensions and proportions. However it is very likely that the platform was raised about 1.5 meters from the ground as was done in other historic sites. In sum, this process was used throughout the project, enlisting a variety of historic sources in order to arrive not only at the most correct geometric representation of buildings, but to their full characterization with colors, textures and special details. A different approach was pursued in regards to the placement of major structures as shown in Figure 8 illustrating the area around the main pyramid.

Figure 6. Section of the Cospi Codex used as the basis for reconstructing prototypical elevations.

Figure 7. Composite elevation drawing derived from the Aztec pictogram in the Cospi Codex.

Figure 8. Site plan of the Aztec Temple
Archaeological and two-dimensional data from the Templo Mayor research and related projects was first scanned with the highest level of precision possible. The scans were then embossed digitally using a variety of contrast levels and lighting angle effects. The idea was to arrive at the optimal geometric description upon which a foundation plan could be correctly traced as shown in figure 8. Upon completion of the optimized map, the process continued by outlining the major axes and intersecting volumes at ground level with the outline of the foundation shown in darker lines. Because archaeological data only contained traces at the foundation level, with no information on height, it was necessary to complete the geometric construction using the accounts of chroniclers of the time. This process proved to be extremely complicated because unlike the Gizeh pyramids, the Aztec Temple was built following a layer process. Aztec architects did not have an established definitive plan when construction began as evidenced in the numerous transformations of the structure. The historical record revealed that over time, the only constants were the orientation, access, the double staircases and the twin shrines at the top of the temple. Based on this argument, several study digital models were developed in order to test if what they showed matched the accounts of the sixteenth century Spanish chroniclers. One by one these models were discarded because their general configuration did not correspond to the accounts. At the end only two propositions became viable. These were modeled and mapped accordingly for full rendering and visualization. What came up from this process is a vision of the Aztec Temple that greatly differed from previous visualization efforts. Not only the testing of the models produced a more accurate architectural representation, but the drawings were devoid of perspective errors that had plagued previous visualization efforts. In the end, the visualization resulted in the debunking of several myths including the idea that the Aztec Temple square was surrounded by a crenellated fortified wall and corresponding moat. In sum, what was learned about this particular phase of the project, is that digital modeling of historic sites cannot be taken lightly. Very serious mistakes can be made resulting in depictions that are actually more problematic than the ones they were supposed to improve.

6 Virtual archaeology and quality of representation

The third major component of this paper is the question of quality of representation. At the most basic level, virtual archaeology requires researchers to make decisions on geometric construction. In most cases many gaps have to be filled with assumptions and interpolations between known data. Then, at a higher level, the researcher has to make decisions on original colors and textures in order to correctly map the geometry. In this instance, more suppositions have to be formulated in an environment where the degree of speculation is much higher because for the most part this information has long vanished. At a third level, there is the question of experiential quality. In other words, how would special lighting and other environmental factors affect the quality of visualization. And finally, there is the issue of correctly representing the more subtle cultural qualities that conformed historic sites. In other words, while one can today produce accurate geometric representations of the Bakenrenef tomb in Saqqara Egypt or the tomb of Pakal in Palenque Mexico it is more likely that these two sites had a clearly different ‘tone’ and ‘feeling’. Or, how to illustrate the unbelievable drama that occurred at the top of the Main temple, where tenths of thousands were believed to have had their hearts ripped out of their chests.

In order to solve these issues and the extremely difficult challenge of making the visualizations
believable, which is what virtual archaeology is all about, the process involved the breaking of the task into several components that were considered essential in defining the architectural qualities of Aztec architecture. Briefly, these components were: a) site planning principles, b) use of open spaces, c) architectural delineation of special structures, d) architectural devices, e) building materials and, f) the temples at night. For each category a number of modeling and rendering studies were conducted attempting to visualize with the highest fidelity possible the embedded qualities. Because the length of this paper does not allow for the full presentation of each one these aspects, only two items will be presented in an abbreviated form: delineation of special buildings, the Skull Rack, and the shrines at night.

7 Skull Rack or Tzompantli Area
In the ruins at Persepolis, the visitor can see in the reliefs numerous accounts of human sacrifice. The royal tombs at Thebes do not leave doubt that sacrifices actually took place. In India, human skulls adorn many deities such as Bhavani. Tenochtitlán also saw human sacrifice. However, what made human sacrifice somewhat different from those other civilizations, is that the Aztecs connected human sacrifices with religious practices by a ruling class desirous to claim its hegemony and power through fear.

From a computer modeling and rendering point of view, the challenge consisted of illustrating a most dramatic event within the context of a unique building type - a structure with thousands of bloody skulls strung along horizontal poles. Rather than literally illustrating such an overpowering edifice, it was decided to express the concept architecturally as a building that acted as counterbalance or gateway to the main temple. In other words, if processions toward the temple took place, which is very likely, they must have had to pass either through or along the sides of the skull rack and its bloodstained content. Before worshipping at the temple, individuals were thus forced to experience the view of thousands of skulls as proof of the tremendous power of their rulers and accompanying system of belief. According to the ideas admitted by the Aztecs, they were not committing any injustice. Actually, Aztecs believed that once individuals were sacrificed, they became consecrated, that is, they belonged to the gods. Individuals were thus transformed into a mystic substance. Therefore, Tzompanlitís were not just skull depositories, they were sacred shrines or temples. For the final execution of the modeling and rendering of this section of the Temple site, photographs were taken from human skulls found during recent archaeological excavations in Mexico City. These images were then placed within a series of models that showed in the background several shrines west of the main temple all with a most stunning visual result.

8 At Night
Did all activity die at dusk? The Aztecs did not have candles - these were brought to the Americas by the Spanish. However, this does not imply that the capital of the Aztec empire was a quiet place at night. Religious leaders wandered throughout the night lighting torches, chanting and whispering prayers. Aztec youth were sent by their preceptors to bathe in the city’s waterways. Privileged classes probably entertained guests throughout the night, while merchants brought goods from surrounding communities on their swift canoes. The city at night probably was not a grim or gloomy place; it was punctuated by the brightness of numerous wood resin torches. Also, it was at night that the most sacred rituals took place as the Spanish chronicled... “In such way flutes were played: when it was late at night, when it was close to midnight, then flutes were played, then the temple ritual of bloodletting was performed... when it was midnight, the flutes...”
Figure 11. The Aztec Temple Square at dusk.

Figure 12. The Aztec Temple Precinct as seen from the West Gate.
played again. With this, the priesthood awakened and thus began what was called the Guard of Those Who Play the Big Drum.

Finally, it is probable that when the various designs and reconstructions of the Aztec temple precinct were contemplated, its architects saw an opportunity to express and make tangible the dialectic that set in motion the Aztec universe. In reality, the Aztec Temple square was like a large temple where pyramids, dance platforms, schools, areas for the priests, and shrines were only pieces of a larger vision of the cosmos. Its form and presence matched the complexity of a system of belief dependent on gods who were symbols of mystery. The basic difference between the Acropolis in Athens and the Aztec Templo Mayor precinct is that in the former, Greek deities imposed upon their following a permanent, static cult while in the latter the religious experience was more dynamic and ritualistic. Huitzilopochtli, Tláloc, Tláhuizcalpantehcutli and many other Aztec deities only became ‘alive’ through the giving of oneself to them. In other words, Aztecs lived and died for their gods. In the Aztec temple project, understanding these extremely complex parameters was the key that opened the door to higher quality virtual archaeology visualization. It was only after the realization such profound debt to the gods demanded, that the final ingredient of high quality visualization became a reality. These components were tied to architectural spaces that a) were ample enough to permit the elaborate rituals and festivals, b) integrated sacred physical elements to the design, c) facilitated magical practices and rituals and d) followed religious and philosophical constructs.

9 Conclusions
First, the field of virtual archaeology has entered a new phase. With current modeling and rendering tools we are now able to generate reasonable visualizations of ancient sites such as the Aztec Temple in Mexico. Because these visualizations are relatively easy to produce and contain a much higher level of information compared to older representational aids, the risk of producing imagery that is not historically correct and therefore misleading is much higher than ever. Therefore it is essential that we re-invent the discourse on

cultural projects like virtual archaeology. We need to be as knowledgeable as possible not only in the use of digital tools but in the historic and cultural context of the sites that are being investigated.

Second, poor quality virtual archaeology visualization is now commonplace. We must strive not only for more historically accurate representations, but for higher rendering quality, especially in the area of cultural interpretation. We must realize that the most difficult thing to do in computer modeling and rendering is to visualize what cannot be seen, but we know exists.

Notes
2) The Codex Cospi is at the Biblioteca Universitaria, Bologna. It is a skin screenfold type of manuscript consisting of 20 leaves (24 painted pages, 13 on obverse, 11 on reverse). It was first published in Kingsborough, Antigüedades de Mexico, Volume II.

Additional Sources
