Reconstructing the West Mebon Vishnu: A Marriage of Traditional Artefactual Analysis with Digital 3D Visualization

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Abstract. The West Mebon Vishnu is one of the most magnificent works of sculpture in South East Asian art history, and a key example of the tradition of large bronzes that plays an important role in the history of the region. Unfortunately, this once powerful and serene sculpture survives only in 19 major fragments that together constitute perhaps 40% of the original statue. Reconstruction of the Vishnu from these fragments is a formidable task that we have approached by combining detailed analysis of the surviving fragments with digitally modeled 3D reconstruction, informed by comparative studies of Vishniavite iconography and the aesthetic and religions traditions of Khmer culture. Beyond its aesthetic value, the reconstruction process may provide insights into the many unknowns surrounding the creation and destruction of this masterpiece.

Keywords: Angkor, West Mebon Vishnu, 3D modelling, Virtual Heritage, Virtual Archaeology.

1 Introduction

The West Mebon Temple ruins are located in the Angkor region of Cambodia on an artificial island built with a series of stepped walls in the West Baray. The West Baray is a massive man-made lake stretching 8km in length and 2.2km in width, the largest such body of water in the Angkor region of Cambodia (Figure 1). In the middle of this ruined sanctuary is a large stone basin, creating a pond approximately 100m square. In 1942, the Ecole Francaise d' Extreme Orient (EFEO) reconstructed part of the wall and outer towers. The outer wall of the West Mebon was pierced by twelve gateways, three on each side. A causeway leads from the Eastern Gateway to a platform at the center of the square pond. The platform itself measures 9.65m from east to west and 8.65m from north to south. (Glaize 1944). The top of the causeway and the surface of the central platform are approximately 1.5m lower than the top of the enclosing embankment. Two masonry built shafts are located in this platform. The more eastern shaft, closest to the causeway, is loosely structured into a square pit on sand foundations lined with stones. Two stone tablets with indentations were discovered

T.G. Wyeld, S. Kenderdine, and M. Docherty (Eds.): VSMM 2007, LNCS 4820, pp. 73–87, 2008.

within this shaft, which may be the remains of a ritual deposit box. The first section of the western shaft is 55cm in diameter and octagonal then circular to a depth of 2.7m and dressed with radiating joints. It was in this shaft that the remaining fragments of the West Mebon Vishnu were discovered in 1936 by archeologist Maurice Glaize. The drawings of the West Mebon by George Groslier from his Researches sur les Cambogiens 1921 were used as a guide to create a computer modeled visualisation of the Mebon (Figure 2).

Fig. 1. West Mebon situated in the West Baray courtesy of Roland Fletcher

Fig. 2. West Mebon Visualization

According to the records of the Ecole Francaise d' Extreme Orient (EFEO), the head conservator, Maurice Glaize, had been informed in 1936 that locals from the West Mebon area were offering ancient jewels for sale to Europeans from Siem Reap. The directors of the Conservation sent a messenger to the local village, reminding the villagers of the ban on pillaging the temples, and requesting that they be informed of any new discoveries. In December of the same year, a local to the area of the West Mebon came forward and told the French team of a dream he had in which Buddha appeared to him, asking the villager to release him from his burial place of earth and stones. He brought with him evidence in the form of a bronze finger, which led the archaeologists to expect a large statue. Fellow archeologists Henri Marchal and Jaques Lagisquet had found a bronze hand in February of the same year, leading them to believe there was a large bronze sculpture buried on the site, but the bronze finger was clearly from a much larger hand. The villager took the archaeologists to a position on the platform of the West Mebon Temple. Here, about one metre below the surface, they found the broken fragments of the West Mebon

Vishnu, buried face down in the western shaft below the platform. At the beginning of the excavation, Glaize thought the statue to have been a giant Buddha but as the four arms and torso were revealed, it became clear that the image was of the Hindu God Vishnu (Figure 3).

Fig. 3. Vishnu as discovered face down in 1936, courtesy of the EFEO

The condition of the large bronze sculpture was very poor due to the bronze having been interred in a damp shaft. Significant oxidation was found covering the entire surface of the sculpture. The head, shoulders and one arm of the four-armed figure remained intact. (Figure 4) There was a gaping hole in the back of the head. An additional 18 pieces of the statue, including bronze ingots and other unidentified debris were recovered from the shaft. The additional pieces included fragments of the back, legs and decorative elements (Figure 5).

Tcheou Ta-Kouan, a Chinese official who visited Angkor between 1296 and 1297 AD, recorded in his Customs of Cambodia his observation of f a "bronze Buddha, from whose navel flows a steady stream of water". He locates this object to the Eastern Baray of Angkor`in his writings. At this stage, no evidence has been found to indicate the presence of a large reclining Buddha in the Eastern Baray, nor any other large sculpture or pediment. It has always been assumed that the Chinese visitor must

Fig. 4. West Mebon Vishnu courtesy of the National Museum of Phnom Penh

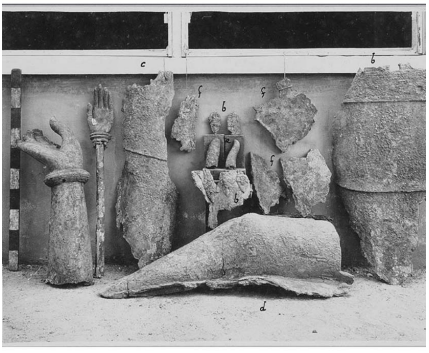

Fig. 5. Fragments of the sculpture at the time of excavation, courtesy of the EFEO

have been referring to the West Mebon Vishnu, but was mistaken in identifying it as a Buddha and locating it in the Eastern Baray. If this was the case, the Vishnu was still in place at the end of the 13th century, and was interred after this time.

Consistent with this line of reasoning, Jacques Dumarçay suggested in his paper La cité hydrolique that the western shaft under the platform of the West Mebon formed part of a hydrometer indicating the level of water in the Western Baray (Dumarçay, 2003). Unfortunately, none of the surviving pieces of the West Mebon Vishnu include the area of the navel, making it impossible to determine directly whether water could have issued from it, but the fact that the central platform of the West Mebon is 1.5 m lower than the surrounding embankment makes such an observation hydraulically feasible.

Until 2005, when one of the authors (MF) visited the National Museum of Cambodia in Phnom Penh to do so, the surviving fragments of the West Mebon Vishnu had not been documented. Digital images were made of each piece, along with measurements and weights. This provided the basic data for the ongoing research. On the same field trip, MF located in the EFEO Conservation Depot in Siem Reap an important stelé depicting Vishnu Anantasayin (Vishnu reclining), which was found at the West Mebon site in 1944. This stelé may hold some vital clues to the overall structure of the West Mebon Vishnu (Figure 6).

Fig. 6. Stelé found at the West Mebon site

Since returning from Cambodia in 2005, MF has made a quantitative and qualitative analysis of the surviving fragments of the Vishnu. In a quantitative analysis, the mass of data has to be organized and somehow meaningfully reduced or reconfigured (Miles and Huberman: 1994). In order to organise the data and analyse its significance, a digital reconstruction of the West Mebon Vishnu was made. To provide a basic form on which to manipulate these data, a wire frame model was created by NG and BA under the general supervision of TC. MF then made a comparative study of the iconography of Vishnu, particularly in a reclining pose. Informed by these representations and through digital manipulation of the fragments from the National Museum of Cambodia, a comprehensive visualisation of the Vishnu has been developed (Figure 7).

The digital visualisation for the West Mebon Vishnu came about through the need to look at the surviving pieces of the Vishnu in the context of the overall structure. The questions asked were: How much of the Vishnu is missing? What clues do the remaining fragments hold for the format of the statue when it was whole? What patterns and common themes emerge when looking at the decoration of the Vishnu? If the statue is indeed a Vishnu Anantasayin, what other figures may have been present in the representation? What evidence is there to date the statue, or determine under the reign of which Khmer king it was commissioned?

Fig. 7. Visualisation of Vishnu Anatasayin murti

2 Analysis of the Surviving Fragments of the West Mebon Vishnu

Prior to the commencement of work on the computer generated visualization, a detailed study was made of the surviving pieces. Besides the head and shoulders, much of the statue is missing and the rest is very fractured. Extrapolating from measurements of the surviving fragments, it seems the statue would have been over five meters in length. It also became apparent when looking at the remaining pieces that around 60% of the sculpture was missing. The structure of some of the fragments indicated that the components of the statue were cast by the lost wax technique, and then assembled later. The external patina of the sculpture is rough and green with oxidation. Small square and rectangular indentations pattern the surface in an irregular way. These indentations are a result of mending casting errors. (Woodward 1997: 37) The surface shows there are many of these mending patches indicating the sculpture to have been cast with an inferior mix of metals.

In particular, five pieces of the statue were critical in formulating a view as to the format for the sculpture as a whole. Each piece contained valuable information which when analysed added to the information available on the sculpture. There were multiple rounds of revisiting the data as additional questions emerged, new connections were determined, and more complex formulations developed. As our understanding of the material deepened, the pieces were moved on the virtual model. Several positions were tried, tested, and reviewed in 3D before the final decision was reached. These iterations in the analysis of the data made in virtual space assisted in advancing the interpretation of the sculpture.

The main intact fragment includes the head and shoulders of the Vishnu (Catalogue number A5387). What is clear from this large fragment is that it is a figure of Vishnu reclining. In order to interpose the remaining fragments on a reclining model, it was necessary to evaluate the options available for the murti of the reclining Vishnu, or Vishnu Anantasayin.

Fig. 8. Vishnu Anatasayin located at Kbal Spean courtesy of V. Roveda

The lack of any precedent of a three-dimensional representation of Vishnu Anantasayin in Khmer Art, made the next step difficult. It was necessary to turn to the rich tradition of bas-relief works found in Khmer temples to put the sculpture into some context. By creating a catalogue of the different representations of Vishnu Anantasayin, it became apparent that some features within the Khmer iconographic tradition remained constant. It must be noted here that these depictions of the Anantasayin murti do vary in India and Thailand. Within the Khmer depiction of Vishnu Anantasayin from the 9th century onwards, the consort of Vishnu, Lakshmi, is always in attendance, holding or massaging the legs of the reclining god. Also constant and in constant position, with only one or two exceptions, are the four attributes of Vishnu: the wheel or disc in left rear hand, the orb in the left front hand, the staff in the right front hand and the conch shell in the right rear hand. The Vishnu Anantasayin (literally translated as ‘resting on a serpent’) reclines on a Naga (a seven-headed serpent), which in Khmer iconography was replaced at times by a Reachesay, or dragon, reflecting the influence of Chinese culture during the 12th century. (Vickery 2002) Sometimes, both icons appear, with the Naga resting upon the

Reachesay. Vishnu floats above the primordial ocean on this bed. From Vishnu's navel, a lotus appears on which a small Brahma sits in the act of creating the world (Figure 8)

Examination of the main fragment of the head and shoulders revealed other important information. There is a large gap between the palm of the upturned right hand and the side of the head, that the hand clearly supports. This gap allows room for the missing headdress (Jutamukuta) and also for the attribute of the right hand (the orb). The large round hole in the back of the head and the round hole on the left side of the forehead are also consistent with a missing headdress or diadem (Figure 9).

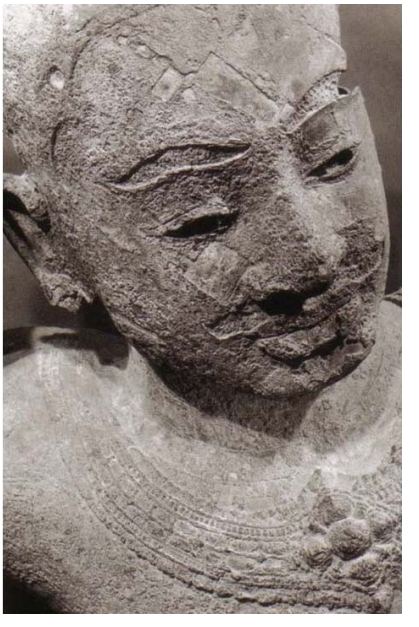

Fig. 9. West Mebon Vishnu showing hole in forehead courtesy of the National Museum of Phnom Penh

The Vishnu has a large sweeping pectoral collar of pendants, featuring a Chan flower motif at the back and the front. The design also includes the chakachan design wherein a square is drawn around the flower in a diamond shape. This design is also known as the pich or diamond composition. The royal insignia of Cambodia is set into a Chakachan shaped frame when displayed. Thick ornate armbands encircle both sets of arms, and are positioned artfully to cover a join in the cast pieces. Similar bands may have been located also on the ankles, as indicated by examples such as the frieze located on the western part of the South Gallery of Angkor Wat of a procession of Suryavarman II in which the King is dressed with very similar pendants and arm bands (Figure 10).

The second key fragment of the Vishnu is a large segment of the right leg (Catalogue number A2084). It includes the thigh, knee and shin. From the inside of this piece, it can be seen that these three sections have been caste in separate pieces

and joined together. Most importantly, there is a return lip along the length of the upper edge of the right leg fragment, indicating the line of attachment of the missing left leg (Figure 11). Due to the shape and orientation this joining lip, it was possible to ascertain that the ankles were crossed. This piece also yielded up important information about the pose of the sculpture because the angle of the lower leg to the thigh showed a very prominent bend in the knee. This information would be consistent with the Vishnu lying on his right side with both legs bent and raised with the ankles crossed. This pose is very typical of depictions of Vishnu Anantasayin in Bas Reliefs, such as the Vishnu Anantasayin of Phnom Rung (Figure 12).

This pose of the sculpture is also consistent with the presence of Lakshmi to support the raised, crossed ankles in her lap, and to stabilize the sculpture. In order for the sculpture to be stable and not to have been out of proportion it requires a Lakshmi to be under the leg supporting both the feet. This too is characteristic of the Bas - Relief carvings of Vishnu Anantasayin in Khmer Art the 10th and 11th Centuries. It is important to note here the images of Vishnu in sleep without Lakshmi in attendance to support the feet, which are found rarely in early Khmer Art of the 8th and 9th century, always show both feet together and the legs straight. In Indian and Nepalese traditions, this Anatasayin murti has been shown lying flat on its back with legs together. In contrast, the surviving fragment of the bent right leg and the bend of the right arm supporting the upper torso of the West Mebon Vishnu indicate clearly that this cannot be a depiction of Vishnu lying flat, or with the legs straight. It was at this point in the investigation that it was possible to choose a model for the Vishnu which included the figure of Lakshmi supporting the crossed legs of the Vishnu lying on his right side with the upper torso and head supported by the flexed right arm.

With the critical decision made regarding the pose of the Vishnu, it was possible to construct a preliminary 3D wire frame computer model, as outlined below, and to begin to 'float' the digital images of the Vishnu pieces onto the model to empirically test the 'best fit' of the remaining pieces in an iterative process (figure 13). Several important pieces gave a clue as to their correct position due to texture, form and curvature, and indications of ornament. Allowance had to be made at times for damage or deformation of some pieces during the destruction and interment of the statue. Once the larger pieces were placed, it became possible to find the positions of the smaller pieces of the sculpture, and to estimate how much of the sculpture was missing. Reassembling the fragmented pieces of the sculpture in a virtual space provided us with advantages that would have been difficult to execute through traditional methods. The ability to edit, rotate, angle and experiment with subtle alterations in the placements in three dimensions was instrumental in the painstaking process of bringing the sculpture back to a semblance of its original form.

Having positioned the head and torso fragment and the right leg fragment on the 3D model, we next 'floated' on the very large piece of the back of the Vishnu (Catalogue number 2084/E1230) (figure 14). It became apparent immediately that the correct orientation of this piece was the opposite of our initial expectations. This large fragment included the belt of a Sampot that, once correctly orientated, clearly sat very low over the hips, consistent with the Baphuon style. Further investigation into this piece showed a square indentation in the middle of the belt, which was consistent with a butterfly clip ornament being placed there, again in the Baphuon style (cf the large bronze sculpture of a deified king, possibly Jayavarman VI in the collection of

the Metropolitan Museum of Art, New York, Bulletin Vol 47, No 2, p92, 1988-99). The butterfly tie bow at the back of the Sampot was associated with the upper boarder the Sampot being turned down at the front. This style innovation accompanied the reappearance of the diadem. (Boisellier:1966:p252-258), evidence for which on the Vishnu has been noted above.

The correct orientation of the large fragment of the back also indicated that the upper border of the Sampot followed a line high up over the flanks, typical of the elegant late Baphoun style, sweeping steeply from a high line over the loins down to below the navel, as defined by scholars such as Philippe Stern and Gilberte de Coral - Remuzat in 1936 in and illustrated by Jean Boisselier in the Manuel d'Archeologie D'Extreme-Orient, 1966. We used the line drawings of Boisselier to experiment with the sampot style and position (Figure 15).

On the front of the sculpture, we had a lot of difficulty with a piece that was most definitely part of the curve of the lower thigh (Catalogue number 2988.6). When placed on the model, we found the Sampot line on this piece was oriented in the wrong direction, and it was necessary to move a few pieces in order to place it correctly on the thigh.

An important piece of the belt (CatalogueA2988.1/ E1230D) was located to the middle of the leg join, and this gave us confirmation of the correct overall position of the belt on the figure. This important piece also shed light on the finish of the sculpture as it showed evidence of gold leaf in places. This would be consistent with other sculptures of similar style which were amalgam gilded.(for example: see guardian of Kamphang Yai figure 17) (figure 16)

The belt of the West Mebon Vishnu is also Baphuon in style. Another large section of the back with lines of the Sampot and belt indicates a line of lozenge-shaped ovals, which may have represented metal plates or a belt set with jewels. These decorations can also be seen on other examples of late Baphoun style sculpture.

Important comparative works are the figure of Kamphang Yai and the Siva head from Por Loboeuk, both of which are stylistically very closely related to the West Mebon Vishnu. (Figure 17)

The West Mebon Vishnu shows other important hallmarks of the Baphuon style of Khmer sculpture, including full curved lips, arched eyebrows, curled moustache, round wide skull, full cheeks and broad shoulders.. Beginning in the reign of Udayadityavarman II (1050 – 1066) this style was named after the Baphuon temple. Although the Baphuon style was predominant throughout the latter half of the 11th century, some features of the late Baphuon style continued to be seen in a modified way in the style of Angkor Wat, which marks the reign of Suryavarman II (1113 – 1150).

One striking and surprising feature of the West Mebon Vishnu is the complete absence of lines indicating the tiny pleats in the Sampot that are one of the hallmarks of the Baphuon style. This is most important because there are no major examples of bronze Baphoun style sculptures without a typical lined Sampot. In contrast, the depictions of Suryavarman II and the major images of Vishnu in the Bas -Relief carvings of the temple of Angkor Wat all show unlined sampots. This may indicate a later construction date for the West Mebon Vishnu. The king Udayadityavarman II and the minor kings who followed his reign implemented the official state religion of

Siva. This changed only in 1113 AD with the reign of Suryavarman II, a powerful king and worshiper of Vishnu, to whom Angkor Wat is dedicated. One possibility is that Suryavarman II commissioned the sculpture of Vishnu at the beginning of his rule, as he waited for his main temple Angkor Wat to be built. (figure 18)

Fig. 10. Bas relief of Suryavarman II from Angkor Wat

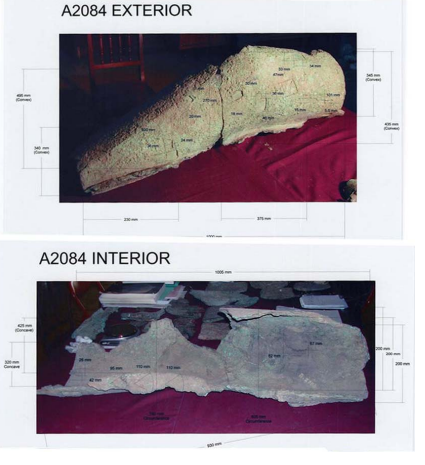

Fig. 11. Catalogue A2084 piece with join for legs

Fig. 12. Vishnu Anatasayin located at Phnom Rung

Fig. 13. Fragments of the Vishnu floated on the computer model

Fig. 14. Catalogue 2084/E1230 piece of the back with sampot and belt

Fig. 15. Vishnu with Sampot both Baphuon and late Baphuon drawings by Boisselier

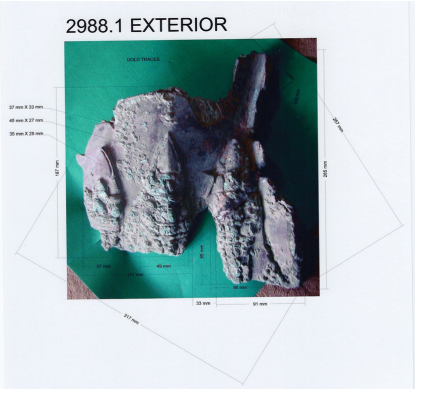

Fig. 16. Catalogue 2988.1 piece of belt

Fig. 17. The guardian figure of Kamphang Yai

Fig. 18. Vishnu Anatasayin murti placed in the West Mebon

3 The Visualisation Process

The marriage of archaeological reconstruction with 3D visualisation that this project entailed presented several problems and attendant solutions.The primary problem from a 3D modeling perspective was the inherently iterative nature of the reconstruction process, which differed markedly from the common practice in the 3D modeling industry. Typical 3D modeling projects are largely linear in progression in that the outcomes are pre-planned before digital construction commences, and only

minimal changes are made during construction. In contrast, when dealing with the vagaries of a fragmented and incomplete historical artifact, such as the West Mebon Vishnu, the process of modeling needed to be kept flexible, as insights and discoveries made along the way all affected the unrealized end product. From the outset, it became apparent that the ongoing research into the visual appearance of the statue required frequent changes to the pose, materials, and the environment throughout its creation.

All models, materials, and the lighting needed to be prepared, to accommodate these requirements, resulting in a much higher amount of work than is usually associated with a project of this scope.

Although the resulting visualisations of the Vishnu depict an immovable bronze statue, the modeling of the Vishnu involved character and 3D human figure modeling techniques common to animation studies in order to ensure the correct positioning of the limbs and arms. The Vishnu model was built to incorporate a system of simulated bones inside the arms and torso that enabled joint movements so the limb's poses could be manipulated in a manner similar to a puppet.

Once the statue had been modeled, textures were applied to simulate its compositing materials, or surfaces. In a similar manner to the skeletal system used for posing the statue, these textures needed to display diverse possibilities rather than singular and preemptory outcomes, and several different textures were applied to suggest varying graphical representations. While some of these representations depicted photographs of the surviving fragments being projected ('floated') onto the completed statue model to show their original context and position, other materials such as gold leaf and bronze were applied variously to create visualisations of possible appearances. (figure 19)

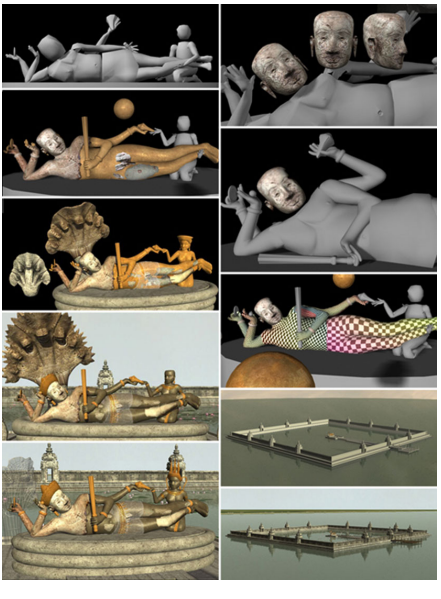

Fig. 19. Visualization development

Throughout all phases of the statue's construction, the modeling, posing and texturing, progressive pictures were subject to successive rounds of review and re-evaluation. Being a cross-disciplinary collaboration, this project entailed on the one hand that archaeologists gained an understanding of the production processes involved in 3D graphics in evaluating work-in-progress material, and on the other that the 3D artists became familiar with archaeological research in being able to interpret the supplied reference material and produce 3D imagery understandable to the archaeological discipline. Frequent correspondence was essential to build an understanding of each other's worlds.

4 Virtual Heritage and Angkor: The Road Ahead

Angkor is a UNESCO World Heritage Site and Cambodia's rich architectural and archaeological heritage is world-renowned. Although conservators are now overseeing many of these monuments, many structures have been in ruin for centuries and the wooden buildings of centuries ago have long since disappeared. The ruins of the temples at Angkor, like most archaeological sites, are incomplete. In line with the growing emphasis on Virtual Heritage, comprehensive 3D visualisations can significantly advance the awareness of historical sites that might be inaccessible due to their remote location or fragile condition.

To visualise Angkor's historic landscape is to see an entirely different world from the serene and reconstituted tourist park that Angkor is today. A virtual world that visually conveys not only architectural and sculptural edifices accurately but also the subtle hues of the water and soil is one that communicates the fundamentally chthonic nature of the civilization.

However, as we have demonstrated, the creation of such virtual visions is dependent on a great deal of research, testing, and reviews by a wide range of experts. The images presented here visually portray the many steps that are necessary to reconstruct not only the statue but also one possibility of the original context of its immediate environment at the centre of the lotus filled pond in the interior of the West Mebon shrine. In this respect, simulated colours, reflections, shadows, the wafting of incense smoke and the environmental ambience of the West Mebon are integral additions to the final rendering of any reconstructed geometry of its centerpiece - in this case the sculpture of Vishnu Anatasayin. Given that they move from the precise

Fig. 20. Vishnu Anatasayin visualisation as viewed from behind

to the general, these later scenes are necessarily broad in scope, but their inherent value lies in their potential to convey the wider context and significance of this sculpture at Angkor. (Figure 20)

It should not be forgotten that Angkor was a living city, and it is through the lens of digital animation that reconstructed life can be viewed (and heard) again. To this end, digital animations that depict the entirety of the West Mebon temple and its surroundings, complete with murmuring devotees disembarking from boats and walking along the temple causeway, are currently being tested and researched. These animations will constitute the next stage of the marriage of traditional artefactual analysis with digital 3D visualization that is presented here, and it is hoped that they will be presented in upcoming paper.

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