EL-HIBEH: RECONSTRUCTING THE PAST IN VIRTUAL REALITY

by

Kristian D. Howald

Diploma, Classical Animation, Sheridan College, 1992-1995

Graduate Certificate, Computer Animation, Sheridan College, 1995-1996

A Major Research Paper

Presented to Ryerson University

In partial fulfillment of the

requirements for the degree of

Master of Digital Media

In the program of Digital Media

Toronto, Ontario, Canada, 2017

AUTHOR DECLARATION

AUTHOR'S DECLARATION FOR ELECTRONIC SUBMISSION OF A MRP

I hereby declare that I am the sole author of this MRP. This is a true copy of the MRP, including any required final revisions.

I authorize Ryerson University to lend this MRP to other institutions or individuals for the purpose of scholarly research.

I further authorize Ryerson University to reproduce this MRP by photocopying or by other means, in total or in part, at the request of other institutions or individuals for the purpose of scholarly research.

I understand that my MRP may be made electronically available to the public.

Signed,

Kristian Howald

ABSTRACT

There is a desire to push for innovation in the field of archaeology. Technologies like photogrammetry, point cloud scans, and additive printing are being utilized to document historical sites to cataloguing entire museum collections. The breadth of my research focuses on how Virtual Reality can be used as a tool to preserve the past and build new knowledge for our future. During this examination, questions arise around an object's authenticity, as Aura, and whether or not this is a transferable attribute from something with materiality to something with no physicality, such as a digital reconstruction.

Keywords: aura, presence, virtual reality, virtual archaeology, museum, additive printing

ACKNOWLEDMNETS

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

Over the past two decades, I have had a hand in shaping the computer animation industry by training hundreds of future digital artists, as a Professor with Sheridan College's world-renowned computer animation program. I consider myself forward-looking and quick to adapt to new technologies, approaches, and methodologies. Virtual reality (VR) re-surfaced five years ago when Palmer Luckey launched the Oculus campaign on Kickstarter. With it came the promise of VR being a viable tool for conveying ideas, stories, and knowledge from a unique new perspective.

How can an observer's presence in a digital environment be convincing, consuming, and believable to a point where new knowledge is created? The notion of developing this type of hyper-presence has drawn me to the field of digital archaeology. When I was approached to reconstruct the temple found in El-Hibeh, Egypt, I thought this would be an excellent opportunity to explore the immersive capabilities of the new medium from the point of view of a skilled digital craftsman.

LITERATURE

Not having a practical or digital background in archaeology, the majority of my reading focused on developments in these fields. Specifically, my literary review looked at the modernizing path

being taken in the field of archaeology, issues surrounding aura and its transferal to a digital form, and presence.

Virtual Archaeology

Paul Reilly, a research scientist at the IBM UK Scientific Centre, introduced the archaeological community to the phrase Virtual Archaeology in his 1991 paper, *Towards a Virtual Archeology*;

> What does the term virtual archaeology mean here? The key concept is virtual, an allusion to a model, a replica, the notion that something can act as a surrogate or replacement for an original. (Reilly, 1991, p. 133)

He wrote about the potential of three dimensional "terrain models" as a way of crunching large data sets, that field archeologists could use as a way of quickly testing hypothesis (Boismier & Reilly, 1988, p. 222). In his 1988 bulletin, *Three-Dimensional Graphics at Sutton Hoo: A Preliminary investigation*, Reilly began to see the value of using 3D artists to recreate lost information. He noted that it became clear that going through the process of creating a digital model allowed the archeologist to think more critically on how to fill in the gaps of missing information (Reilly, 1988, p. 24).

Adaptation of new technology was initially hampered by the skepticism of the community; this was in a large part due to lack of exposure and access (Reilly, 1996b, p. 39). Before the 1990s there were very few digital artists, software was highly technical (most lacking artist friendly

graphical user interfaces), and hardware was prohibitively expensive. Reilly states; "Until recently, the application and development of data visualization and computerized reconstruction methods in archaeology were restricted to a small group of researchers with access to research systems, often requiring considerable experience and training in programming of such systems" (1996a, p. 38). These issues prevented the less computer literate from seeing these emerging technologies future potential.

By the mid-1990s, around the period I entered the industry these issues had begun to dissipate. Competition in software development brought prices down. Computer Animation software companies like Alias, Softimage, and Side/FX tailored their interfaces and focused their toolsets towards artists. The purchase of Montreal based Softimage by Microsoft Corp. ushered in the use of inexpensive Windows powered personal computers, which went on to replace the costly Silicon Graphics machines. All these factors caused an explosion in production requiring a large number of trained, skilled digital artists. This talent initially gravitated to entertainment related industries, but eventually shifted towards fields, like biomedical, architecture, and archeology. Digital tools that evolved from the 1980's became artistic tools for digital craftsmen.

Aura

Walter Benjamin used the word "Aura" to describe the uniqueness significant objects possess as a response to mechanical mass production at the turn of the19th century (1936, p218.. The idea of having a reproduction of a work of art, or a famous landmark allowed the public to be close to the object without having to travel half way around the world to witness it in person. They were, "bent towards overcoming the uniqueness of every reality by accepting its reproduction."

3

(Benjamin, 1936, p. 219). Benjamin considered an object's base materials, tools used to fashion it, the artist who crafted it, its cultural role, its location and who owned it to be the cumulative notion of aura? That the "uniqueness of a work of art is inseparable from its being imbedded in the fabric of tradition. However, this idea of 'tradition" was malleable; he called it "thoroughly alive and extremely changeable" (Benjamin, 1936, p. 220).

Similarly, Jeffery (2015) suggested an object's narrative is what defined its significance. What was its path, its relevance, and its connection to the timeline? He described a connectedness to the past when being near a physical object of historical importance (Jeffery, 2015, p. 145). If objects were continually adapting, could their essence metamorphosize into a digital form? Could digital objects have aura? Because of the digital object's immateriality, Jeffrey (2015) suggested that inherently no. Digital reconstructs had no substance or physicality, no location, no degradation, they were infinitely reproducible, and could never truly be owned "only consumed under license" (Jeffrey, 2015, p. 146).

Jeffrey (2015) outlined a framework that could contribute to the transferal of Aura:

1. An object's aura could be reconstructed through co-production and the democratization of its digital construction, this "would facilitate the migration of, or creation of the aura." (p. 148)

2. Drawing on the craftsmanship of the artistic community (p. 150). Alice Watterson (2015) pondered why she believed this hasn't been the case so far," that the lack of theoretical discussion and absence of any sustained body of critical theory in this area may be attributed to the specialist knowledge required to produce visualizations,

especially in a digital medium where a certain level of technical ability is required." (p. 121)

3. The use of additive printing to make a physical version of a digital model could close the analog-digital-analog loop. If an object was given physicality it would bestow on it location, and allow for direct ownership'(Jeffrey, 2015, p. 149) Reilly (2014) also saw the "spirit" of Virtual Archeology continuing in additive technologies like 3D printing. He went on to state that since 3D printing had existed longer than Virtual Archeology it had already passed through the Gardner Hype Chart (2014, p. 125).

Presence

While at a museum you would be in the presence of artifacts of historical significance. What historical figure might have held them or the craftsmanship and materiality of how and what they were made from all add to the object's authenticity, they had presence. Digitally, if you entered a virtual environment the quality of the immersion directly affects the observer's sense of presence, of being there (Slater & Wilbur, 1997). Traditionally the public had interacted and connected with the past through museums. Tilley and Shanks saw the museum's role as the bridge between archeology as a profession and the general public. The narratives these artifacts possessed are displayed, and communicated to the public giving them a glimpse of the past. They mentioned that the;

Notion of presence is at the heart of the 'romance' of archaeology. It forms the basis of much of archaeology's appeal and popularity […] The objects have presence, human

presence - the features of the burial mask, the thumb-print on the pot. This presence constitutes the object's authority, its authenticity. The presence of the past - the past endures and reaches out to touch us. (Shanks & Tilley, 1987, p. 75).

Jeffrey (2015) described a visceral sense of the exhilaration, when holding a newly discovered object for the first time, "the thrill springs from that sense of proximity to people in the past that the object allows us to experience" (p. 147). Narratives of these objects also had the capability to elicit an emotional response. Dawson, Levy, and Lyons (2011) wrote about the shoes of a little girl that were on display at the Holocaust Memorial Museum in Washington, D.C, and how they embodied "the death of her dreams, those of her family, and the loss of future generations" (p. 390).

The story of the maker, as Andrea Witcomb (2010) wrote, can give a re-creation authenticity. She describes that the emotional story of Mr. Sztajer survival at the Treblinka Concentration Camp gives him the authority to re-create its model, "this model becomes a link to the past by virtue of the fact that someone's memory and lived experience is embodied within it and given material form" (p. 45). Similar to the role of the museum, Virtual Reality would provide a new way of contextualizing and connecting stories in a visual, but much more interactive way. Dawson, Levy, and Lyons (2011) documented two immersive projects: the Thule Whalebone house, and Igluryuaq of the Siglit-Inuvialuit. Regarding presence, they documented that, "these definitions suggest that feeling present in a virtual world or sensing the presence of virtual objects in the real world might also intensify feelings of being connected to an artifact or place" (p.391).

RESEARCH

History of El-Hibeh

El-Hibeh was situated 150 km south of Cairo, along a limestone scarp, on the east bank of the

Nile River. The site of El-Hibeh was first developed under Pinodjem I in the third Intermediate

Period as a secondary residence for the Theban rulers (Arnold, 1999 p. 31). The town was

politically situated on the northern border between Upper and Lower Egypt (Wenke, 1984, p. 7).

Over the years the settlement transitioned from a large town to a fortified temple town (Wenke,

1984, p. 3). The temple (Figure 1) was dedicated to the god Amun Great of Roaring, by

Sheshonq I (945-924) (Wenke, 1984, p. 7). Although smaller than a lot of similarly styled

temples it was architecturally significant, being the first to have a screened *pronaos[1]* (see Figure

2), and freestanding sanctuary (Arnold, 1999, p. 33).

Figure 1. Glass plate photograph of the rear of the temple, Heidelberg Museum (1914)
http://heidicon.ub.uni-
heidelberg.de/BildsucheFrames?easydb=mce06gvl70j32jvsd3cm6eolk5&ls=2&ts=1504127968.

---

[1]The pronaos is a screened porch structure at the entrance of the temple.

Figure 2. The pronaos. Heidelberg Museum (1914) http://heidicon.ub.uni-eidelberg.de/BildsucheFrames?easydb=mce06gvl70j32jvsd3cm6eolk5&ls=2&ts=1504127968

A comprehensive excavation led by German Herman Ranke, occurred in 1913-1914 (Ranke, Abel, & Breith, 1926, p. 58). The collapsed rubble was cleared and sorted as well as glass plate photography being deployed to document the findings ((Ranke, Abel, & Breith, 1926, p. 59)). The photographs depicted the deteriorated state of the temple in great detail, and are currently available to the public through the Heidelberg Museum's website (http://heidicon.ub.uni-heidelberg.de). The temple appears to have gone through various states of repair (see Figure 3) with pillars and columns seem to have been reinforced at some point with a lesser degree of craftsmanship than the original construction (Ranke, Abel, & Breith, 1926, p. 63).

This is consistent with the idea of objects always being in a state of transition that are part of an objects natural trajectory. These trajectories are undertaken so that the object can survive, its

essence can continue (Latour & Lowe, 2011). Elaine Sullivan refers to this as fluidity, "most 'permanent' of structures, often in fact were quite fluid (2016, p.81). They were;

Modified, reconstructed, abandoned, resurrected, or incorporated into new contexts. Ancient people reinterpreted, amended, fabricated, forgot, and reinvented their meanings according to shifting cultural needs […] such fluidities demonstrate that space cannot be separated from time for a nuanced examination of culture meaning. (Sullivan, 2016, p.81)

Figure 3. Photograph of the first pillar hall. Heidelberg Museum (1914) http://heidicon.ub.uni-heidelberg.de/BildsucheFrames?easydb=mce06gvl70j32jvsd3cm6eolk5&ls=2&ts=150412796

Paul Reilly also supports this idea of flux;

> Objects and assemblages gather histories around themselves; they develop cultural
>
> biographies as they accumulate new significance, connections, and meaning […] Their
>
> meaning and significance, however, is contingent on the web of relations and interactions
>
> in which these entities get caught up in. Meanings, therefore, can be renegotiated, even
>
> radically reset. In other words, they are always in progress. (2015, p.12).

The re-creation was to envision what the temple may have looked like earlier in its existence. In addition to the glass plate photography Ranke did do several site illustrations (see Figure 4 & 5). He documented the current state of the temple, as well as illustrating how he imagined what the temple would have looked like originally. According to Karl Breith, this interpretation seemed to have been inspired by aspects from the temples at Karnak and Dendera (1926).
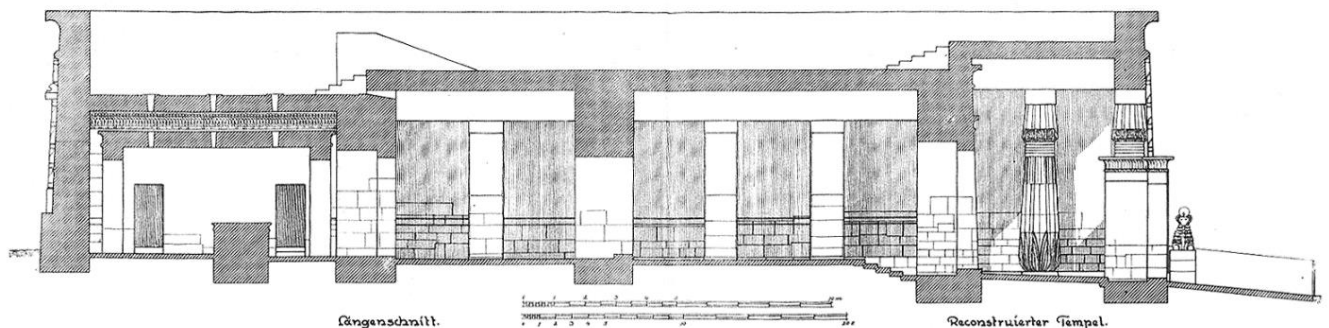

Figure 4. An illustration "Plan 10", by Hermann Ranke, Koptische Friedhofe, 1926.
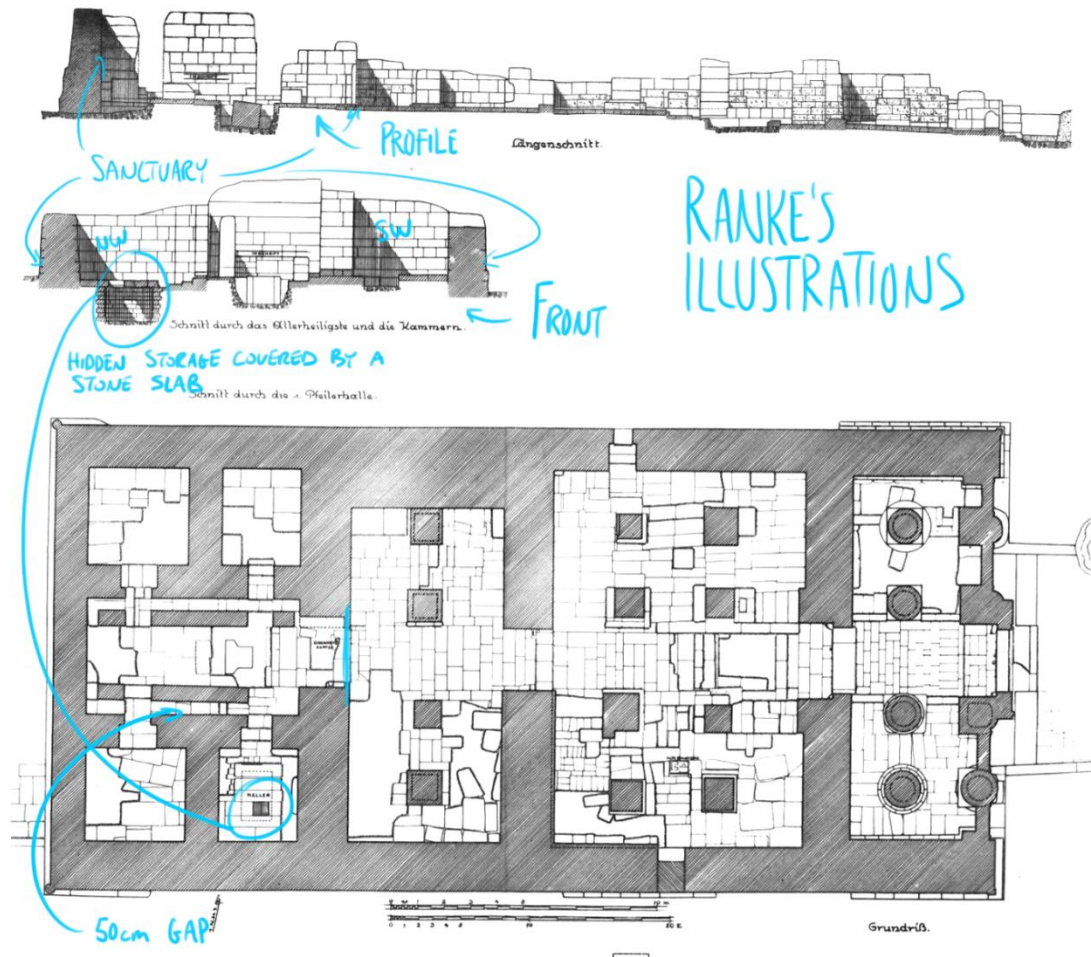
Figure 5. Ranke's illustrations documenting the state of the temple during the 1913 excavation with subsequent markings by Kris Howald to denote areas of interest, Koptische Friedhofe, 1926.

Digital Tools

I used several digital tools over the duration of the project. Modelling was primarily

accomplished with Autodesk's Maya, which I had been using since its beta release in 1998.

Maya was useful for creating lower resolution objects that I could bring into other software for

detailing. Some of the more organic forms, such as the criosphinx and king statues were

completed in Zbrush. The tools I used for texturing ran the gamut, from graphic tools like

Adobe Photoshop and Autodesk Sketchbook, to Autodesk Mudbox, Allegorithmic's Substance

11

Painter and B2M. Substance Painter became the primary tool for creating the final look of all the textures used in the project. I grew to appreciate the way it packed roughness, metallic, and occlusion into one file, allowing for easier file management and organization.

Temple Version 1

I began preliminary construction during the months of March and April. During this period, I blocked in the main shapes of the temple using Ranke's illustrations as a guide (see Figure 6). I imported the front, top, and side illustrations depicting how Ranke envisioned the temple as image planes into Maya and scaled them to the proper size using the legend on the illustrations as a guide. The temple itself measures at 15.9m x 35m x approximately 8.6m. Dr. Jean Li, the current el-Hibeh site co-Director, completed a recent measurement of temple in July of 2017. Her values were very close to the ones recorded by Ranke. My lack of knowledge concerning Egyptian architecture was evident during the first version. The ceilings weren't properly positioned, cavetto cornice was misplaced throughout, the screen structures of the *pronaos* were too high, and I had built it as one seamless polygonal structure, which would end up making it difficult to texture. This original temple had to be completely rebuilt.
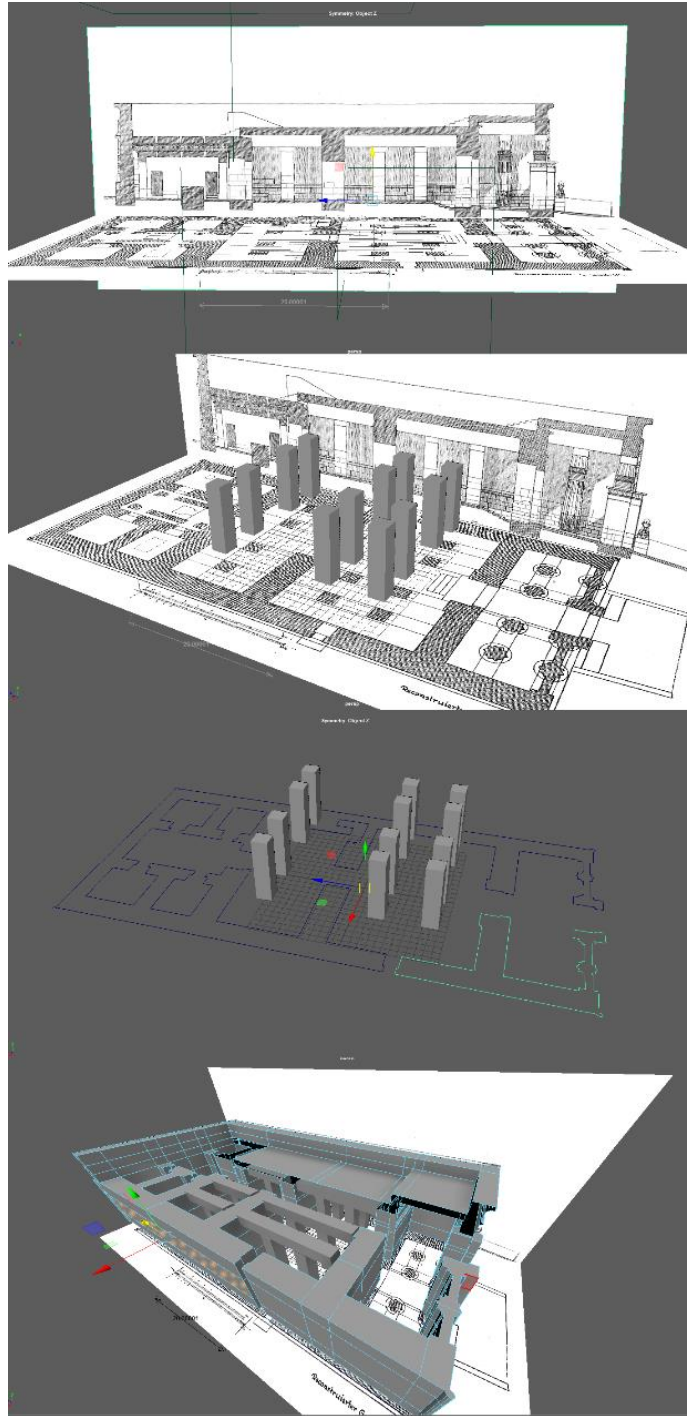
Figure 6. The early stages of the temple (Howald, 2017).

Temple Version 2

I decided to break the model into individual components that were grouped based on their location within the temple. All geometry and materials were given three letter prefixes based on which of these groups they were associated with. This gave me the ability to quickly find, select, or isolate elements across all the software I used. Photoshop was used to create comparative studies between Ranke's photographs and his site illustrations, to ensure block placement would be correct (see figure 7). Although the photographs were extremely high resolution, there was a lot of occluded information due to the angles from where they were taken. I found the illustrations to be fairly accurate, particularly when it came to the floor block placement.
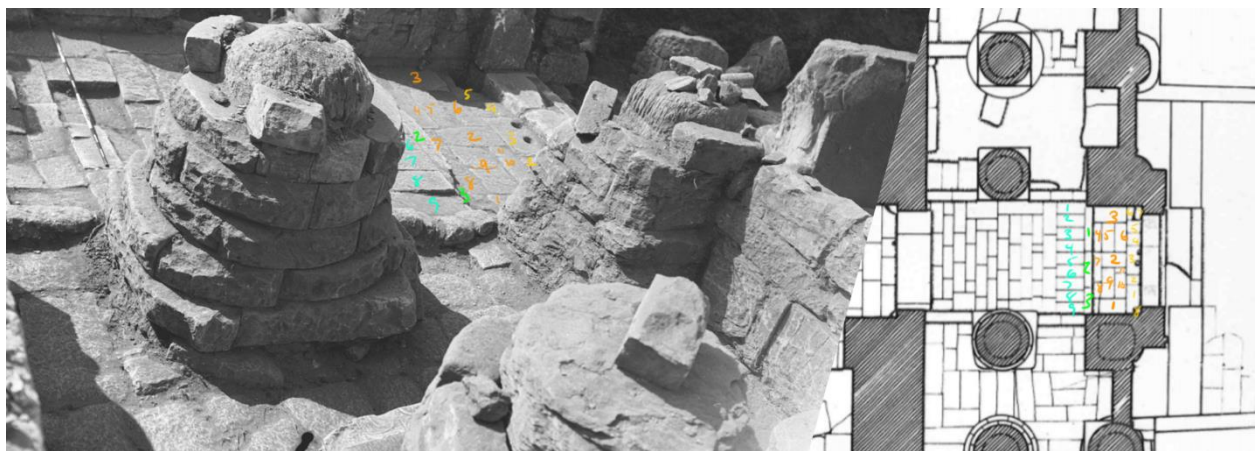

Figure 7. Comparing the block placement between Ranke's illustrations and the photography (1914)
http://heidicon.ub.uni-heidelberg.de/BildsucheFrames?easydb=422dhc4t1f0oktaqrbehph80b4&ls=2&ts=1504139081.

I began by dividing the floors into four areas: the ramp, column hall, first pillar hall, second pillar hall, and sanctuary (see Figure 8). I planned on using one normal map for each section, but quickly realized that the bump detail would fall apart when viewed from shear angles. To create a more authentic feeling I decided to place each floor block by hand. This approach offered a

better realization of the subtleties of this element. Some blocks might be slightly raised, lowered, or angled depending on location in the temple (see Figure 9). They might be affected by how the foundation may have shifted, or the effects of local traffic walking on them over time. There was some evidence of this in the Heidelberg photographs. The central blocks entering the first pillar hall were slightly concave. These subtleties are a necessity to inject the feeling of use.

Figure 8. The floor groupings (Howald, 2017).

Figure 9. The image on the left is the floor of the pronaus, and the image to the right are the stairs leading to the first column hall (Howald, 2017).

Figure 10. A textured view of the Sanctuary after using Substance Painter (Howald, 2017).

Although, it did cross my mind to build the temple walls in a similar fashion, I realized my schedule would not accommodate such a lengthy process. Instead, I decided to use a more

practical approach through the implementation of textures. I avoided using tiled textures throughout the temple. Tiled textures are convenient, because of their speed to quickly populate a surface. However, from my experience they act more as compositional filler, a time saver that could lessen the overall sense of craftsmanship. Sketchbook provided a robust set of draftsman tools that were perfect for creating the wall details, that I then brought into substance painter as bump base for generating the material (see Figure 10). The material itself underwent several iterations. My first attempt at a limestone ended being a looking too pink with odd ridging when scrutinized up close. Once I developed a material that worked I was able to apply it to every object with similar properties. Since the material is procedural[2], it generated a unique texture for each piece of geometry it was applied to while maintaining a consistent look.

Found Artifacts of the Temple

A variety of artifacts were found during Ranke's dig (http://heidicon.ub.uni-heidelberg.de/BildsucheFrames?easydb=k8ijjs43h13v9a3f2alni5osp7&ls=2&ts=1504206706). It was important to include as many of these items as I could within the timeframe available, however I freely chose which items to represent. The objects modeled included: two offering tables, a pot, a vessel, a censer, two king statues, and the *barque*[3] - an object that wasn't found but may have been present in the sanctuary. Due to time constraints, I enlisted other digital artists to help with some of the models (See figure 10).

---

[2] A procedural material is adaptive to the type of object it is applied to.
[3] The barque is a ceremonial boat that was used as a sacred form of transportation for the gods.

Figure 11. Censer modeled by Pooya Armaghan, (Howald, 2017).

Two statues were found in the first pillar hall (see Figure 12). Both statues were largely

damaged. Statue one consisted of the hips, torso, and head. The right hand looks like it is

holding an *Ankh*[4], the left arm and legs are missing. The majority of the face was missing.

There may have been an indication of a false beard but it was too difficult to tell. Statue two

comprised of the hips and right leg. The belt and wrap are similar to statue one which led me to

speculate that these statues were a pair. The overall height was a little difficult to judge;

however, statue two was photographed angled near an archaeological yard-stick, surrounded by

boot prints. Given this information, it seems that these would have been close to life five feet

high.

---

[4] The ankh is the Egyptian symbol of life.
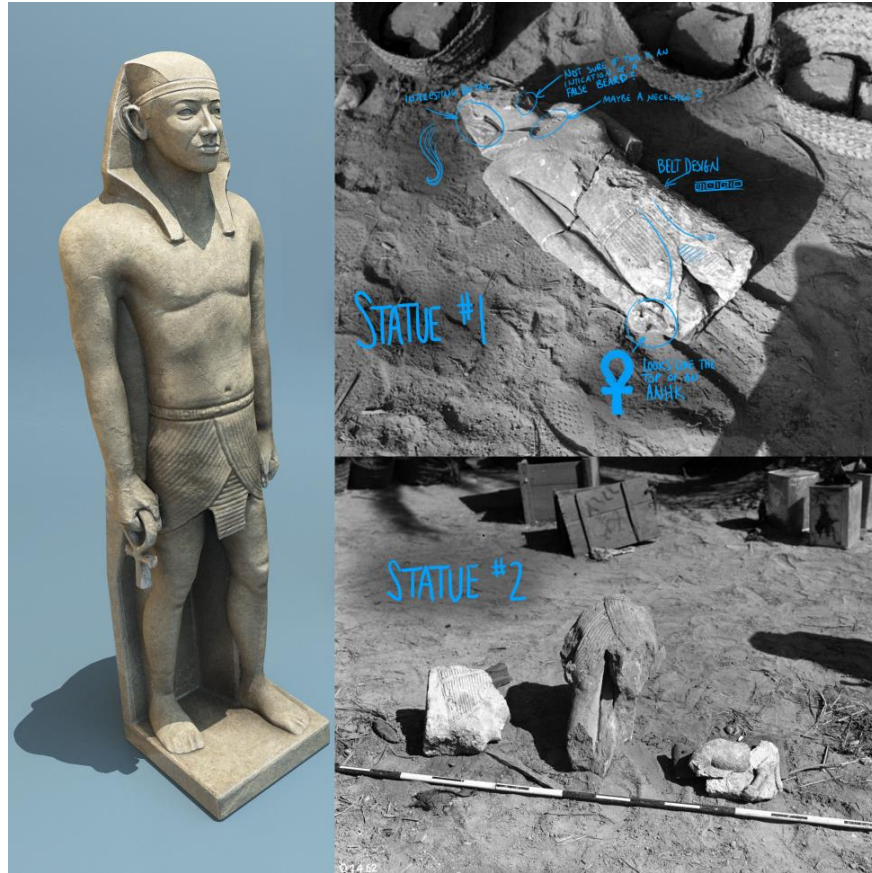
Figure 12. On the left is the final modeled king statue (Howald, 2017). The statue was constructed from the found fragments during Ranke's 2014 excavation (top right) http://heidicon.ub.uni-heidelberg.de/BildsucheFrames?easydb=422dhc4t1f0oktaqrbehph80b4&ls=2&ts=1

Dawson, Levy, and Lyons used placed artifacts in their Thule whalebone house as a way to create a narrative allowing a larger connection to be formed between the viewer and the environment (2011, p. 391). They utilized "nested" objects to evoke "phenomenological experiences" (Dawson et al., 2011, p.391). The whalebone house used static objects placed throughout the dwelling, but the *Igluryuaq* incorporated disembodied movements that depicted how the object would work within a "kinetic context." (Dawson et al., 2011, p. 393) This created an interesting disconnect, creating an effect where the artifacts seemed to be used by ghosts.

19

Digital Avatars

The addition of inhabitants into the temple added a sense of spatial awareness. The ancient

Egyptians were approximately five feet to five feet six inches in height (Ewen, 2015). Viewers

would see these avatars and instantly grasp the scale of the environment. Aesthetically, I

originally intended to treat the human element in a stylized and representational manner so that

the focus would be on the clothing and surrounding environment. I found the anthropomorphic

quality to be somewhat off-putting. This lead me to treat the priests in a slightly more realistic

fashion. They were to resemble plastic store mannequins wearing realistic clothing. Not to be

confused with real humans their skin would be fifty percent grey. This would also allow the

viewer to focus more on the surroundings.

Sterling Castle in Scotland had employed a similar style to great success (see Figure 13). I

created the initial sketches of the UAB priests from which a professional 3D artist used Zbrush to

sculpt the humans, and Marvelous to generate the clothing. The characters were then brought

into Maya where I rigged, posed, and prepped them for to the Unreal Engine (see Figures 14 and

15).

Figure 13. The posed characters from Sterling Castle. Photograph by Michael Carter (2017).

I looked to Sheridan College's SIRT facility at Pinewood Studios in Toronto to create some motion capture for the avatars. Regrettably, the scope of a detailed examination into "the other" including input from the Egyptian people was not achievable within the existing timeframe. However, there needed to be some thread of narrative. Mel Slater and Sylvia Wilbur stated that the "more the "plot" line potentially removes a person from everyday reality and presents an alternate self-contained world, the greater the chance for presence" (1997, p. 606). How can we build on the experiences demonstrated by Dawson, Levy, and Lyons? In addition to an environment that is meticulously crafted, a bridging narrative that ties all the elements together, additional senses beyond sight should also be addressed: sound, touch, and taste. Also, I believe that the world should feel lived in, and populated.

The Museum of Natural History, in New York, effectively uses dioramas to depict humans and animals in their habitat. Spitzer Hall of Human Origins has several displays that illustrate the evolution of humans (see figure 13). I decided to have two priests posed carrying out an aspect of their daily rituals. The specifics of these actions need to be planned out further with the possible introduction of a few more avatars.

Figure 14. The Homo Ergaster Diorama is a dynamic example of the effective use of this form of display. Contributor: Tomas Abad / Alamy Stock Photo

Figure 15. The Avatar for the head priest of the temple (Howald 2017).
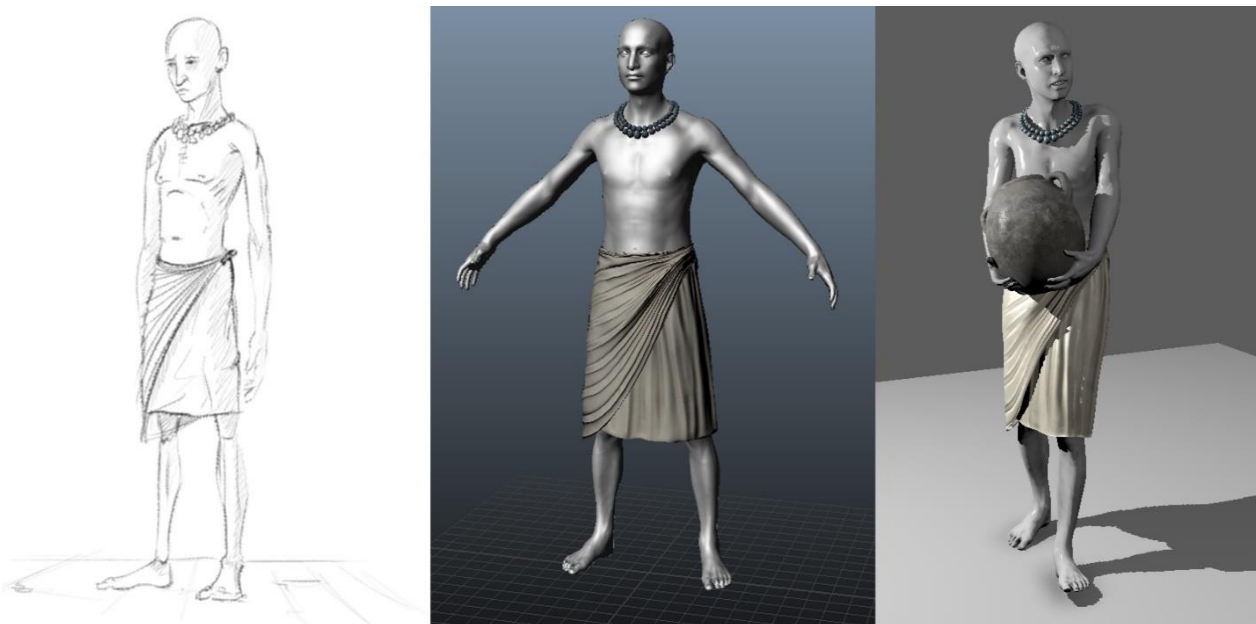
Figure 16. The digital avatar of the second priest. (Howald, 2017)

One issue developed once the priests were placed within the unreal engine. It was mentioned that they were looking too Caucasian. Even though the skin material is 50% grey, the bounce light within the temple can be quite warm. This was giving the skin a warmer than intended appearance, and will require further investigation to insure the avatars are neutral in a natural way.

Figure 17. Lighting in the second pillar hall seems to have altered the perception of skin colour. (Howald, 2017)

The Surrounding Environment

A basic environment was needed to ground the temple. Fortunately, the surrounding area had natural barriers on all four sides: the wall being the boundary to the north, east, and south, and the Nile river acting as the western boundary. This created a stage that appeared to be nested in a much larger world. At first, I considered having the environment become deconstructed further from the temple. Transitioning from detailed textures and modelling near the temple to grey

scale low polygon geometry closer to the wall would allow the focus to be the temple. However, much like the anthropomorphic avatars, this style could actually become a distraction. A colleague used a technique called blocking within in the 3D environment using recent El-Hibeh topological maps as a guide (see figure 17). The ground model was rebuilt two additional times. In the first attempt, I used Zbrush to add more detail closer to the temple, this ended up being too dense and could cause some issues with the game engine (see Figure 18). For the final version, I used Unreal Engine's landscape tools to build, texture, and add foliage (see Figure 19). There had been some discussion of the placement for the Nile river in relation to the temple. Today, according to Dr. Jean Li, the Nile is quite far the temple. Breith indicates in his writings that the river could have been much closer when he suggested that during flooding, the land around the temple and town would have appeared to have been an island ((Ranke, Abel, & Breith, 1926, p. 58)). Breith also points out that flooding could have led to the deterioration of the temples limestone cladding (Ranke, Abel, & Breith, 1926, p. 58). Regardless, I moved the river further away.
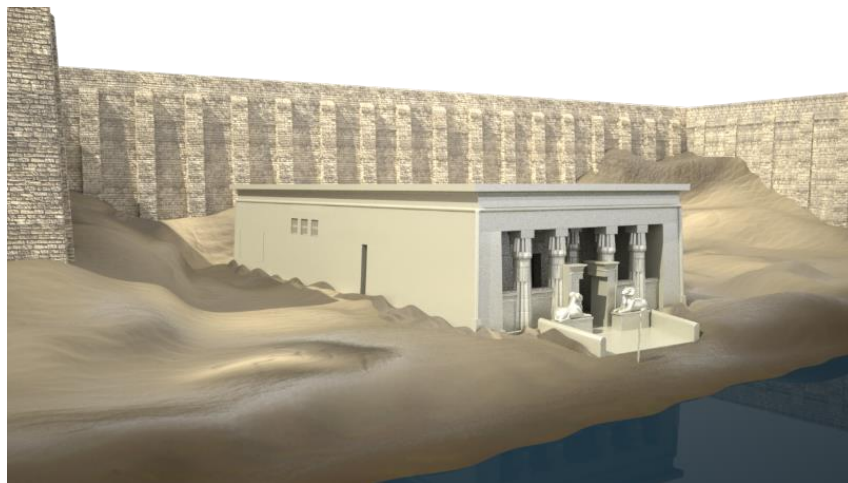
Figure 18. *The original model by Carlos Santos (Santos, 2017)*
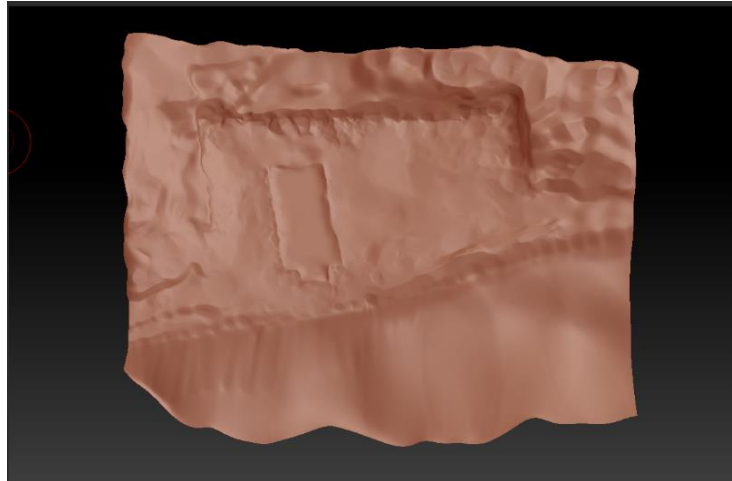
Figure 19. The rebuilt and re-topologized version of the landscape completed in Zbrush (Howald, 2017)
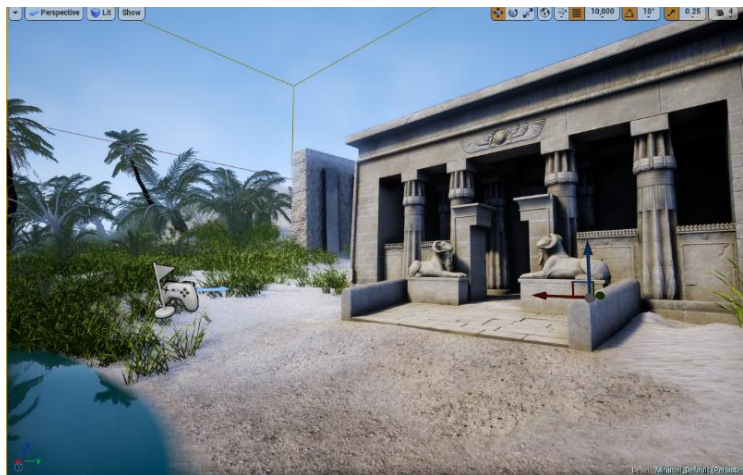
Figure 20. The final version of the landscape finished in the Unreal Engine (Howald, 2017).

Sound and Touch

Dr. Jean Li recorded some audio during their July expedition to El-Hibeh. It offered a good indication of the types of sounds that exist around the site today. I layered a few additional sounds as placeholders until higher quality 3D sound could be produced. This included the wind

blowing across the temple roof, and the sounds of the distant river flowing. Unreal has experimental audio tools for 3D sound that would allow for dynamic audio simulations. This could provide for a more immersive re-creation of the inner temple acoustics in a future version.

Over the last few days of the project I attempted to address touch. Unreal offers basic haptic feedback capabilities. If the viewer's motion controller comes in contact with a collision surface, the controller would rumble. I had implemented this in a separate file; however, time ran out before I could properly test this with the temple.

Virtual Reality and Unreal

The majority of my personal work over the past twenty years has been building and animating characters, or crafting small-scale environments for short form television shows and advertising. Television content employs a lot of tricks or smoke and mirrors in an effort to focus on what the audience will see within any given frame. If a computer-generated element is off camera, out of the view of the individual watching, then it didn't need to exist. The level of detail an environment could have was less of a concern, because final images would typically go off to a render farm. A single frame would take anywhere from a few minutes to a day, or longer. Disney developed Hyperion, a 55,000-processor render farm to deal with these types of large scale renders (Seymour, 2014). Unlike a directed commercial, an individual in the virtual world can look and move anywhere within the environment. Render times are replaced with real time, virtual reality must run smoothly at 90 frames per second (Digital Trends Staff, 2016). To allow for this, a series of compromises and optimizations should be considered: how many polygons

are visible at any given moment, size and number of textures, the number and type of lights, the use of particle effects, and the amount of post processing.

I had been exposed to virtual reality earlier in the year as part of a small team building a virtual test environment to study hoarding.[5] This experience gave me a fundamental grasp of what the potential for the medium could be, and a basic understanding of what was involved when it came to producing for it. The Unity game engine and the Oculus Rift were the main tools for this project. Even though I found the process rewarding, I wasn't particularly impressed with Unity's lighting capabilities and overall quality of the image. This lead me to search for other options.   I decided to use the Unreal Engine for the software and the HTC Vive for the hardware. Epic, the developers of Unreal, had been actively pushing into VR which led me to believe there would be a greater degree of support.

Hardware consistency could become an issue. The specifications of the computer system could make the difference between a smooth immersive viewing to one that could induce VR sickness. Game engines use the power of the graphics card and rely very little on a computers CPU. The final week of testing the temple walkthrough took place at Ryerson's Collabrotory, a Library faculty research facility. Michael Carter took part in the first day of testing, and pointed out some significant frame drops, drops I didn't notice when working from my office.   After doing some investigation, I realized that the graphics card in the Collaboratory's machine was the

---

[5] Hannah McCabe-Bennett directed a study into memory and hording. I developed the VR Memory Test where participants had to remember which of a number of elements where organized within another aspect of the study.

Nvidia GTX 970, a mid-range card from the previous generation, which was older than the GTX 1080ti I used for the majority of the testing. This revelation led to additional optimizations, which succeeded in removing the dropped frame issue (see Figure 20).
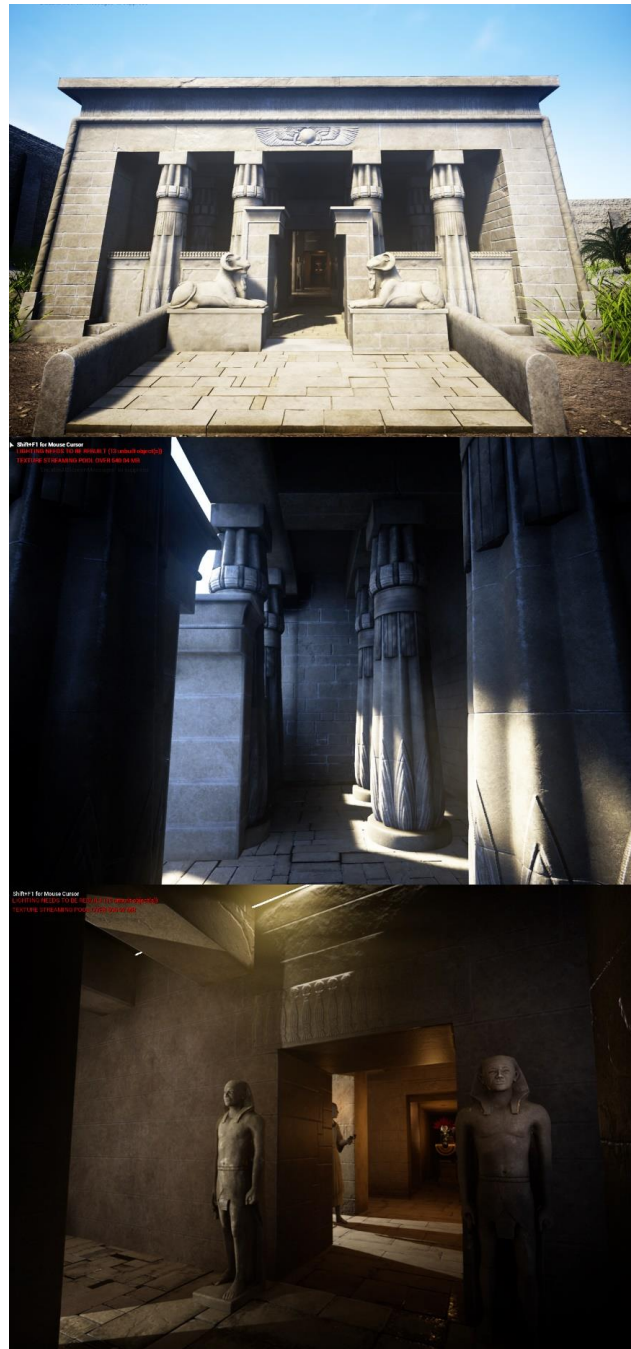
Figure 21. Images of the final temple in the Unreal Engine (Howald, 2017)

Paradata

A paradata blog, **https://elhibeh.blog/**, was created to document the temples construction (see Figure 21). In total, I compiled 14 posts (see Appendix). These largely consisted of screen grabs of the temple in its various states of construction, as well as images from various other sources, such as Adobe Stock.   The blog was viewed 586 times by 124 unique visitors over the course five and a half months. The visitors originated from a variety of countries, including: Canada, France, the United States, United Kingdom, Belgium, China, Albania, Australia, Germany, and Ireland.   My adoption of Twitter as a source for promotion happened later during the construction. Had I been more pro-active in reaching out to the Archaeology community the blog might have garnered more attention. To reach a larger audience in the future, I should post smaller blog articles, more frequently.
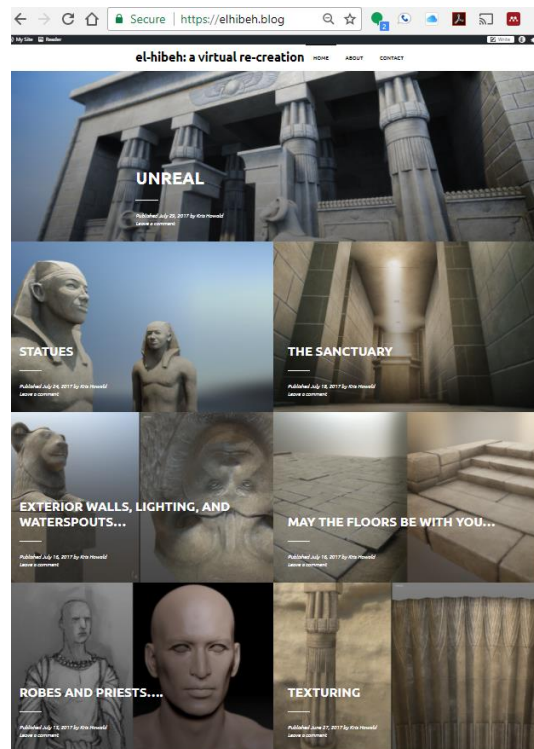
Figure 22. The splash screen for the paradata blog, https://elhibeh.blog/

In addition to views it was an open forum for the archaeology field to post comments. During the five months, I had one comment. The comment, from Professor Carol Redmount, was particularly useful. It pointed me towards Arnold's book *Temples of the Last Pharaohs* (1999), which questioned when the construction of the *Pronaos* and Sanctuary occurred. Reaching a larger audience would hopefully increase this type of valuable input.

CONCLUSION

During the Masters of Digital Media Showcase, I observed the participants' behavior and found it interesting that in the virtual environment they would try navigating around objects as if the digital constructs were real. They wanted to interact with objects, however the virtual illusion would fall apart when viewers reached out to touch the digital models. Their efforts were hampered by the Swayze Effect[6], as their virtual hands would pass through the geometry of the environment. Given more time, I would introduce a higher degree of interactivity. Imagine if the viewer had the ability to pick up and explore objects. This could heighten the connectedness to the environment, and elevate the overall experience.

---

[6] Named after Patrick Swayze's role in the 1990 film Ghost. The Character Swayze played could witness but not interact with the events unfolding around him.

Was a unique, authentic experience created in virtual reality? The temple, as a tool used to connect with the general public, offered the viewer an opportunity to participate with our ancient past. Similar to a museum's ability to let visitors stand in the presence of history, there was an observed enthusiasm when participants dawned the VR headset and travelled back in time to walk through the re-constructed halls of the temple. When all the components of modeling, placement of avatars, textures, materials, lighting, and audio are unified, an authentic experience was created.

Looking beyond the general public, what would be next? Could a phenomenological experience be developed, allowing the viewer to glimpse into the Ancient Egyptian mind? The possibility is there, but much more work would need to done first. It would be important to fully realize the environment. This should include colour, hieroglyphs, accurate representation of plants and animals, placed artifacts, a larger realized area around the temple including the town, and a fully animated population that takes into account ancient customs, rituals, and idiosyncrasies. All of these elements should to be created to the highest standards by a team of digital craftsmen, under the guidance of experts from the field of archeology.

APPENDIX A

Introduction: https://elhibeh.blog/2017/03/01/first-blog-post/

The introductory post that stated my intentions for the following five months. It was also used as

an attempt to address the community, welcoming any professional feedback.

Introduction.....

by Kris Howald • March 1, 2017

Hello,

I'm new to blogging in general, so please keep that in mind as I find my sea legs
over the next few posts. I'm a Masters of Digital Media student at Ryerson
University. Under the supervision of Professor Michael Carter (Director,
Industry Relations) and as a GA to Dr. Jean Li (Department of History), I will
focus my Major Research Project on developing a digital reconstruction of the
temple in **el Hibeh, Egypt**. This 3D model and its surrounding area will be fully
realised as a virtual reality experience, connecting present to the Third
Intermediate Period (c. 1069-664 BCE) when the temple was built. Throughout
this process, I will be open and transparent. My hope is to elicit feedback, input,
and know how from the archeology community through each stage.

Kris Howald

For the last two semesters of Ryerson's Masters of Digital Media program I will
be immersing into the world of Virtual Archeology. My focus is the
reconstruction of the el Hibeh temple in Egypt.

The Wall: https://elhibeh.blog/2017/03/05/the-wall/

Using Professor Jean Li's detective wall as a guide, I laid out the "known knowns" of the temple.

I did this by sorting and categorizing Ranke's illustrations and glass plate photography from the

1913-14 excavation.

The Wall

by Kris Howald • March 5, 2017

The first thing you notice when walking into Prof. Jean Li's office is "the wall". Reminiscent of an article I read a few years ago (the above photo from "A Beautiful Mind" is one of many used in this this article from Esquire http://www.esquire.co.uk/culture/film/news/a7703/detective-show-crazy-walls/), it clearly indicates the "known knowns".
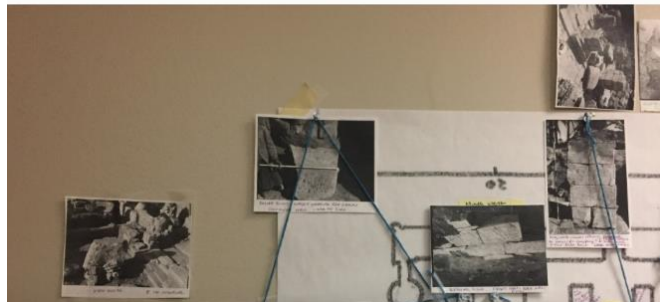
Luckily German archeologist Hermann Ranke was extremely thorough with his sketches. Below is a top view of how he imagined the Temple would have looked when it was fully intact.
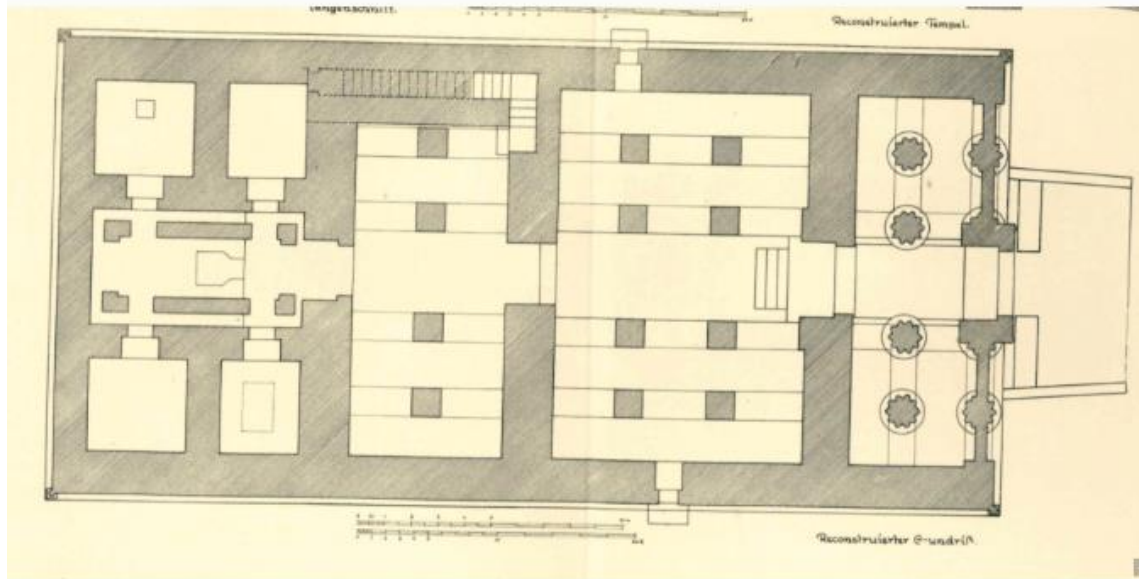
Top view
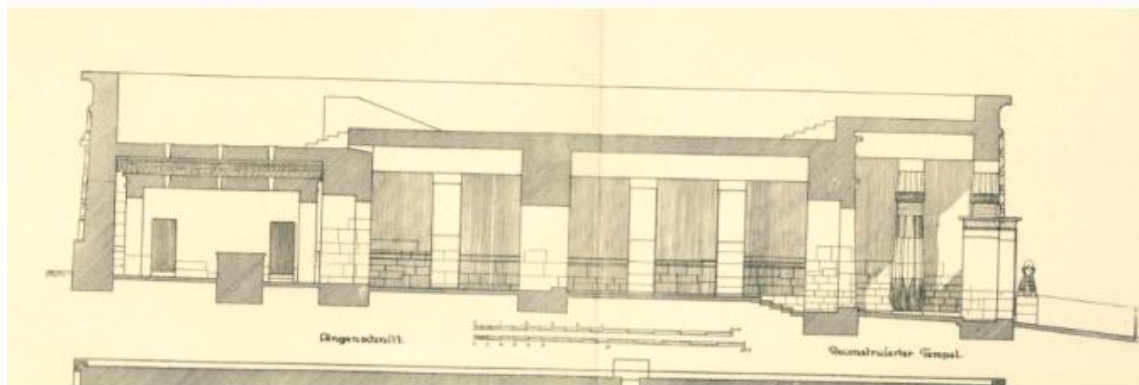
Profile view

Using "the wall" as a reference, I've started to separate the Heidelberg Museum photos into their different sections.

Exterior Walls:

Front Columned Hall:

Again, another detailed image from Herman.
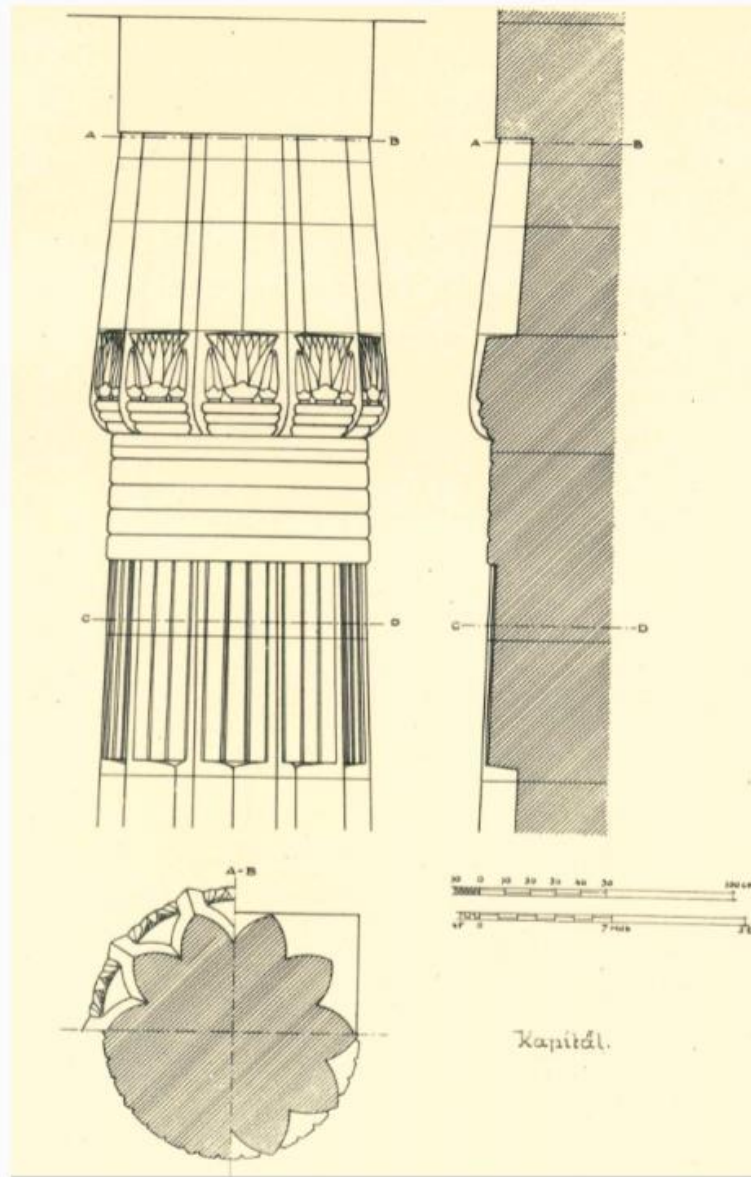
Column detail

2nd pillar on back side
of north end, 1st pillar
hall

Sanctuary:
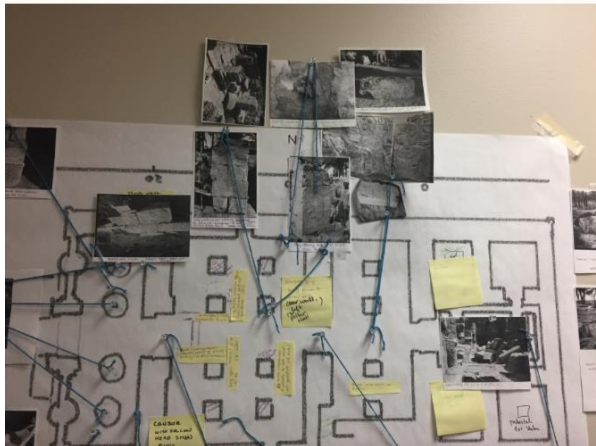
Scale: https://elhibeh.blog/2017/03/08/scale/

I begin the process of building the temple in Maya. I started by importing of Ranke's illustrations, as image planes, to use as sizing references and concluded with the blocking in of the Temple 1 proxy.

Scale

by Kris Howald • March 8, 2017

I'm going to walk through the entire process within these blog posts. Please, feel free to comment if you see any issues, have any questions, or think of something new that could be added or altered. I'm going to be using Autodesk's Maya as the main tool for crafting the model. My goal this semester is to rough in the overall form of the temple, and begin refinement and detailing from May-June.

After cleaning up the Ranke illustrations, I imported the top and side views to use as Image Planes (reference images).
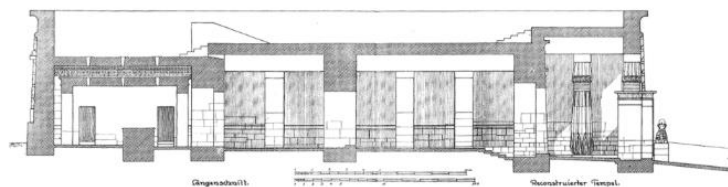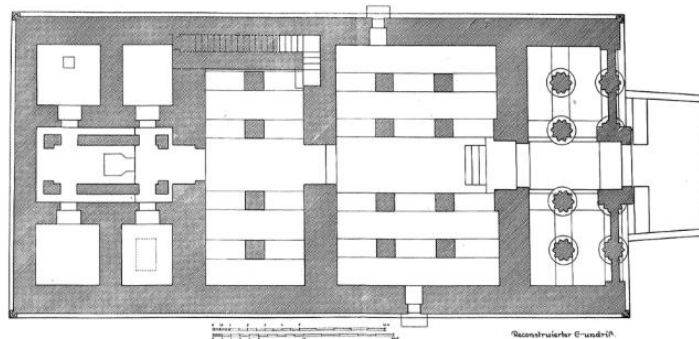
In Maya, the unit size can be modified, so I ended up switching from the default (cm) to feet. This allows me to match Ranke's legend to the grid. I'm going to try to keep everything a accurate as possible, however there will need to be room for interpretation (with help for the community) to reconstruct areas that no longer exist....which seems like quite a bit.

I placed the columns from the 1st Pillar Hall and 2nd Pillar hall and traced around the floor plan so that I could extrude up the interior and exterior walls.
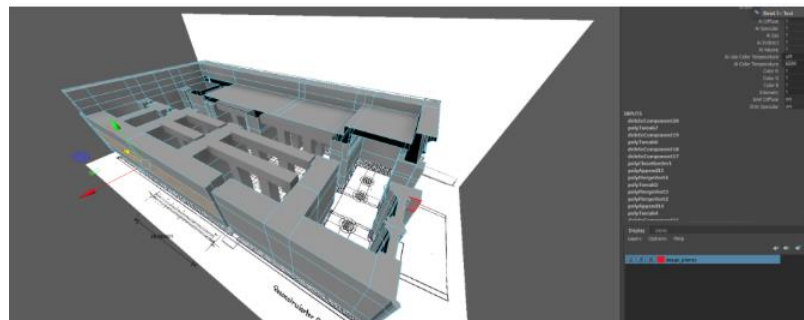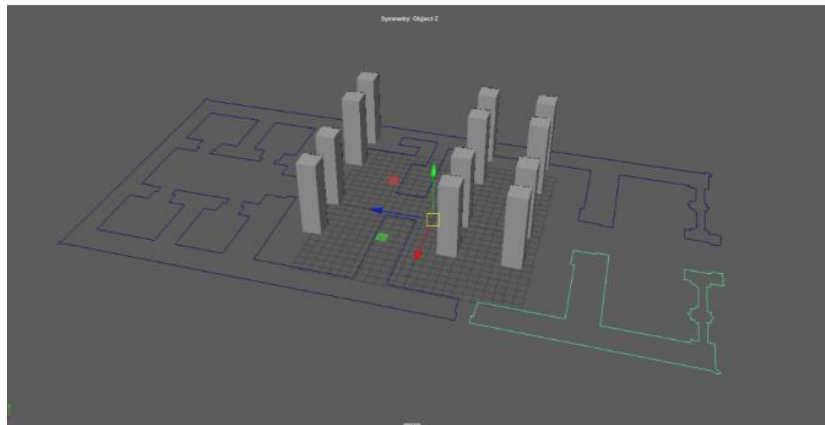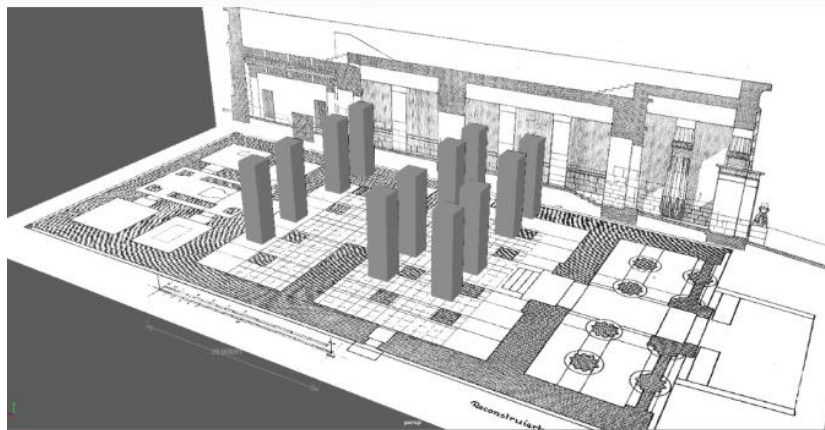
APPENDIX D

Blocking in the Temple: https://elhibeh.blog/2017/04/02/blocking-in-the-temple/

This post continues where *Scale* left off, and ends with the completed proxy model of Temple 1.

This version of the model helped fill in some of the blanks, but unfortunately could not be used.

By the end of the project very little of the original proxy remained.

Blocking in the temple....
by Kris Howald • April 2, 2017

The temple boundaries have started to take shape.

I had the opportunity to show progress of the temple to Christopher Watts' 4th year anthropology class at the University of Waterloo. Although I'm still at a preliminary stage, few questions came up around reference material.

Are the images being used as reference from the same period as the el-Hibeh temple?

Unfortunately there isn't a lot of existing architectural resources around the period Hibeh temple was constructed (during the 22nd dynasty). The illustrations by Ranke, which I'm using for the preliminary model on, are largely based on conjecture (how he imagined the temple *might have* look like). Dealing with only a front, side, and top orthographic images there is quite a bit of information that is being lost in translation. To fill in the gaps, I've begun to use images of similar structures from different periods. For example, I'm using the Temple of Hathor, Dendera (from the 1st century BC) to understand how the front screen was integrated into the first row of columns.
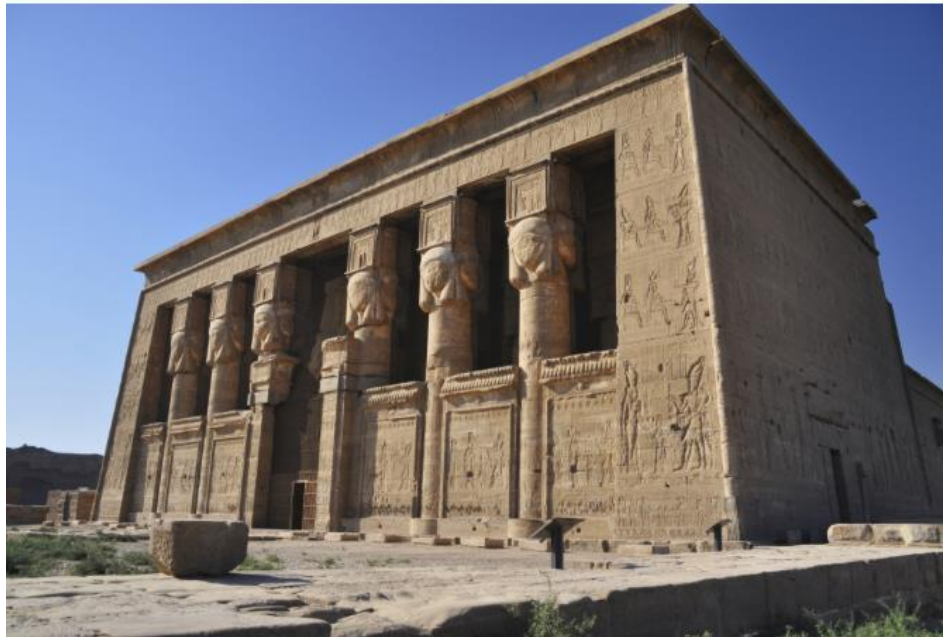
Photo by: Vladimir Bozhilov Licenced from: stock.adobe.com

Columns and Criosphinxes: https://elhibeh.blog/2017/05/17/columns-and-criosphinxes/

The month of May marked the beginning of full fledged construction. My plan was to work from the pronaus to the sancuary, then if time permitted add in the surrounding environmnet, digital avatars, and artifacts. I began by detailing the columns, and adding in the two criosphixes.

Columns and Criosphinxes
May 17, 2017

Published by Kris Howald

There is very little to go by when constructing the columns from the first pillar hall and twin sphinx (possible?) statues at the temple's entrance. Jean Li suggested that the columns are more than likely papyriform columns. This assumtion is based on the discovered decorative ring from the base of the capital.

This ring depicts open buds, however Ranke's interpretations show a closed bud variation. We've decided to go with Ranke's version for the initial construction.
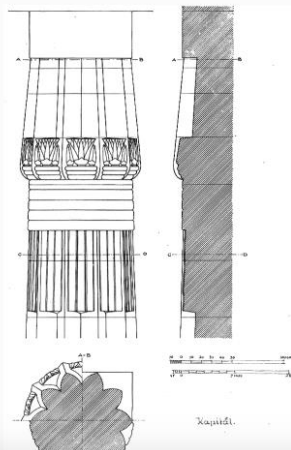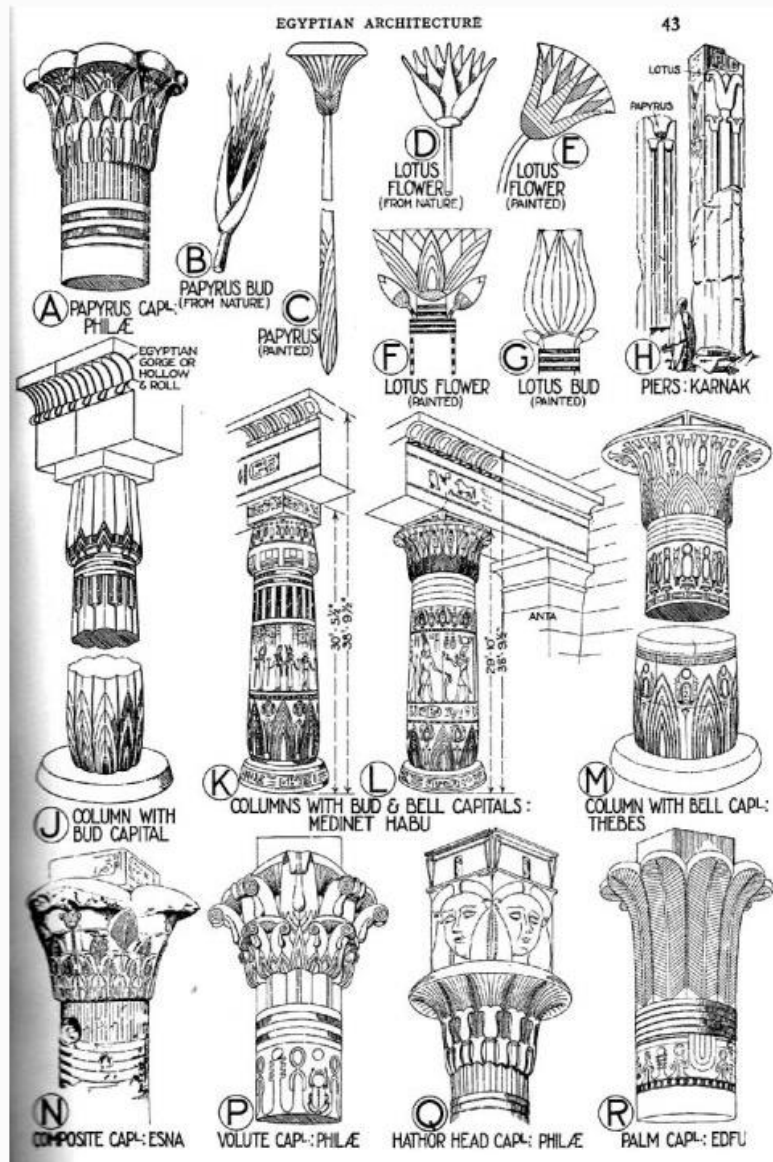
EGYPTIAN ARCHITECTURE   43

The columns at Karnak Temple, Luxor, Egypt — Stock photos, royalty-free images, graphics, vectors & videos | Adobe Stock © Vladimir Voronin

Ruin of Karnak Temple. Luxor, Egypt, Africa — Stock photos, royalty-free images, graphics, vectors & videos | Adobe Stock © Andrei Nekrassov

Colonnade in the Luxor Temple — Stock photos, royalty-free images, graphics, vectors & videos | Adobe Stock Leonid Andronov

47

This detailing will be part of texturing process.
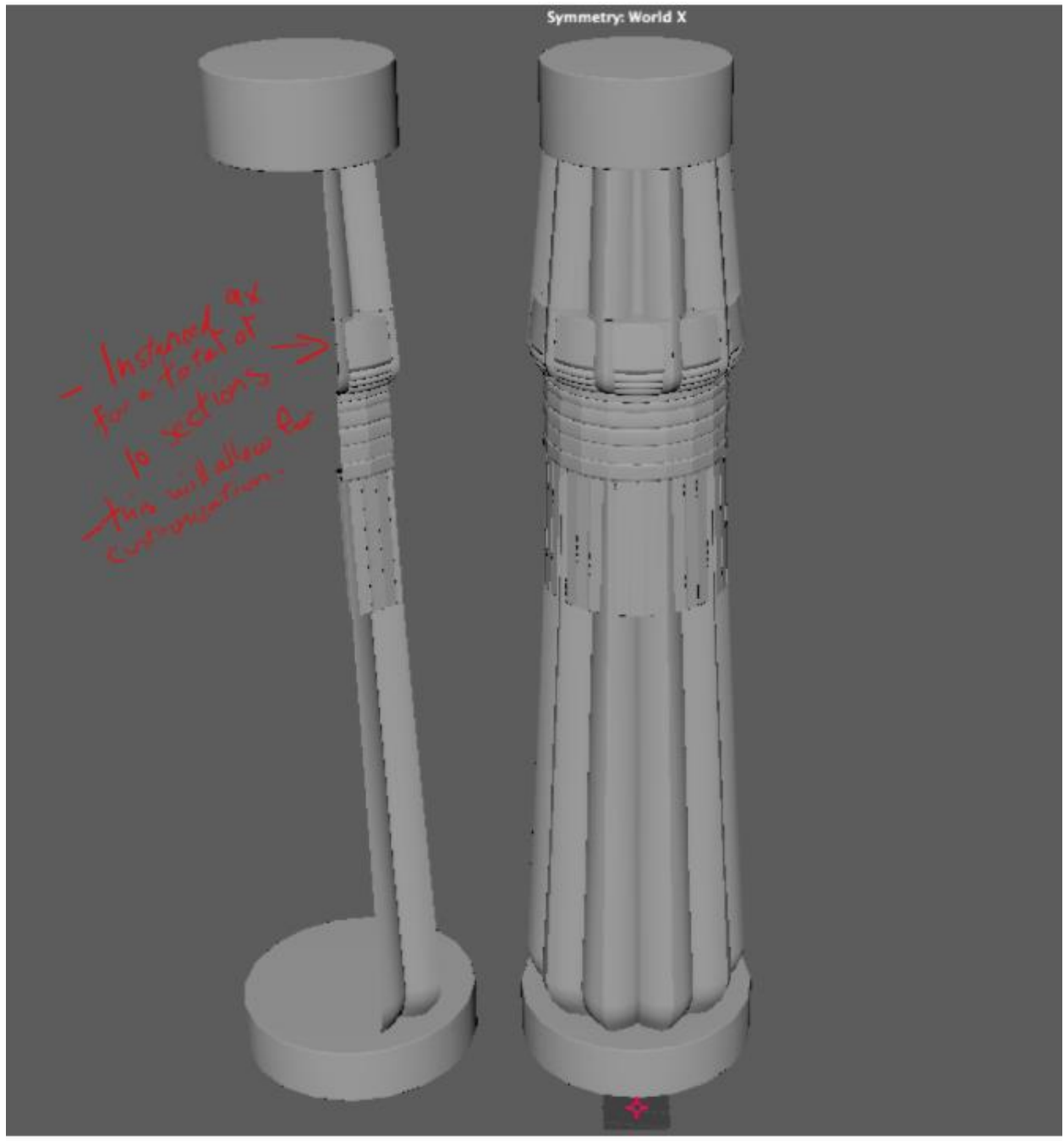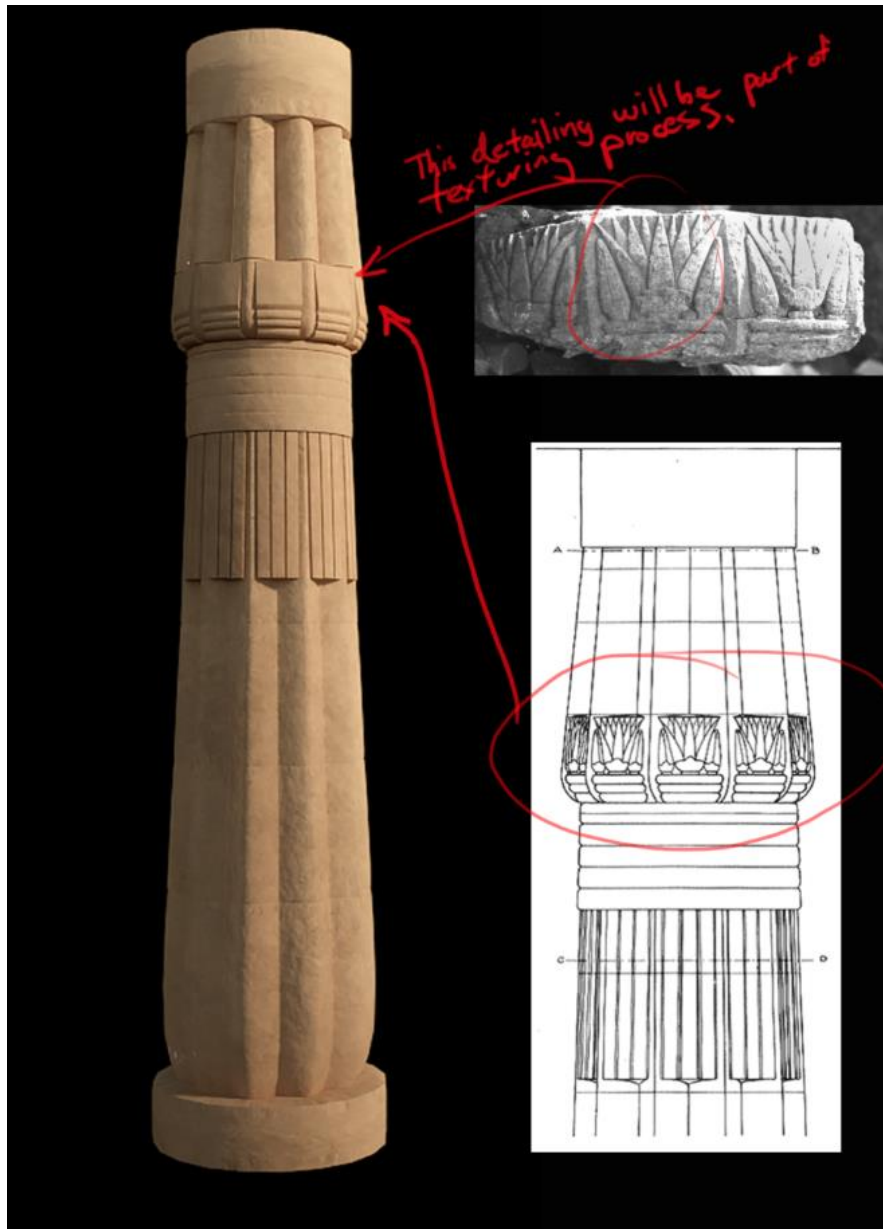
The small statues are believed to be criosphinxes. I haven't been able to find many references of statues Ranke depicts in his illustration.
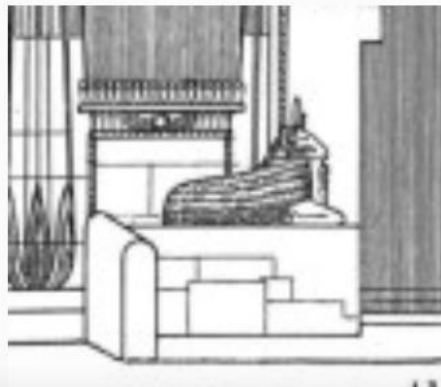
I'm going in the direction of the what is seen at the Karnak temple.

A blocked in version of the croisphinx so far. The pedestal is next on my list.

Ancient ruins of Karnak temple in Egypt – Stock photos, royalty-free images, graphics, vectors & videos | Adobe Stock Photographer: Pakhnyushchyy

Ram sphinxes at Karnak Temple in Luxor — Stock photos, royalty-free images, graphics, vectors & videos | Adobe Stock Photographer: © Paul Vinten

Alley of the ram-headed sphinges in front of Karnak Temple at Luxor, Egypt — Stock photos, royalty-free images, graphics, vectors & videos | Adobe Stock Photographer: JackF

Ram-headed Sphinxes Statue In Karnak Temple, Luxor, Egypt — Stock photos, royalty-free images, graphics, vectors & videos | Adobe Stock Photographer: © Andrey Popov

APPENDIX F

Thinking outside the blocks: https://elhibeh.blog/2017/05/31/think-outside-the-blocks/

By the end of May I had a strategy for creating the floors. Ultimately, I wasn't happy with this approach, and I eventually changed direction.

Thinking outside the blocks....

by Kris Howald • May 31, 2017

For the past week I've been debating on how I should handle all of the stone blocks that are used extensively throughout the temple (for the walls, floors, columns...etc). Part of this process is to insure that I am mindful of the actual placement of these elements. I've been comparing the Heidelberg photographs to Ranke's site illustrations. From what I can see they seem very accurate.
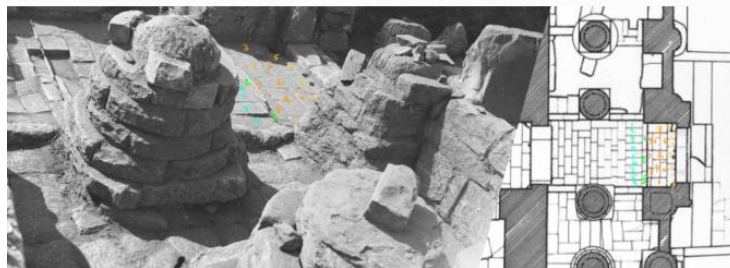
I've started placing proxy bricks (basic polygonal cubes) in the Pronaos and ramp.

I'm testing a few approaches to see which one might hold up better in VR. Initialy I thought I would break the various elements up into sections, then using either Mudbox or Zbrush, I would detail the proxy cubes and extract a normal map back onto a more simplistic type of geometry. I tested this on the ramp, which kind of works. However, because this is just a bump map if someone where to view this on a shear angle, the illusion of detail would flatten. Just a side note, once I get into the Unreal Engine I might revisit this approach with displacement maps....or possibly vector displacement maps.
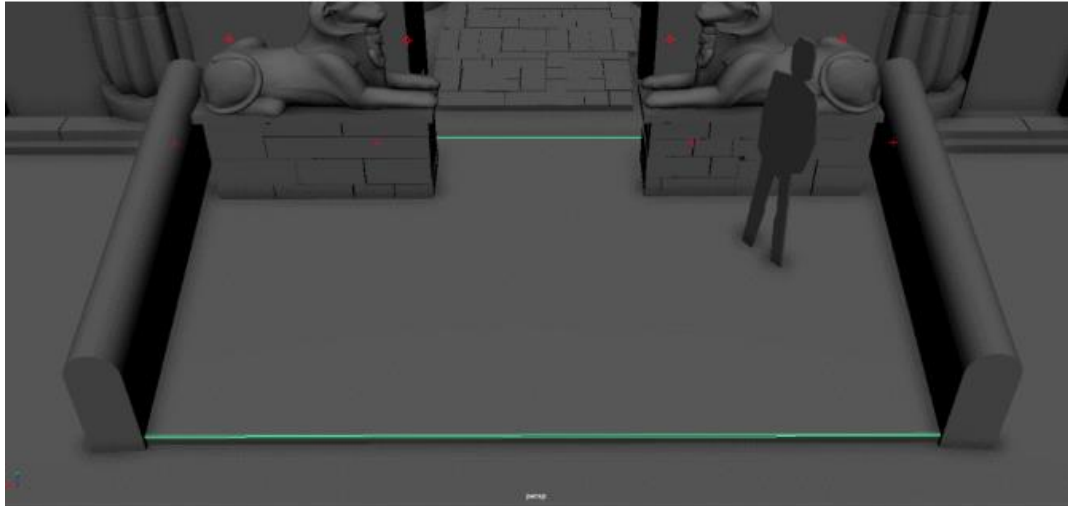
This is simplified geometry that will get the tile texture generated in Zbrush and Mudbox.
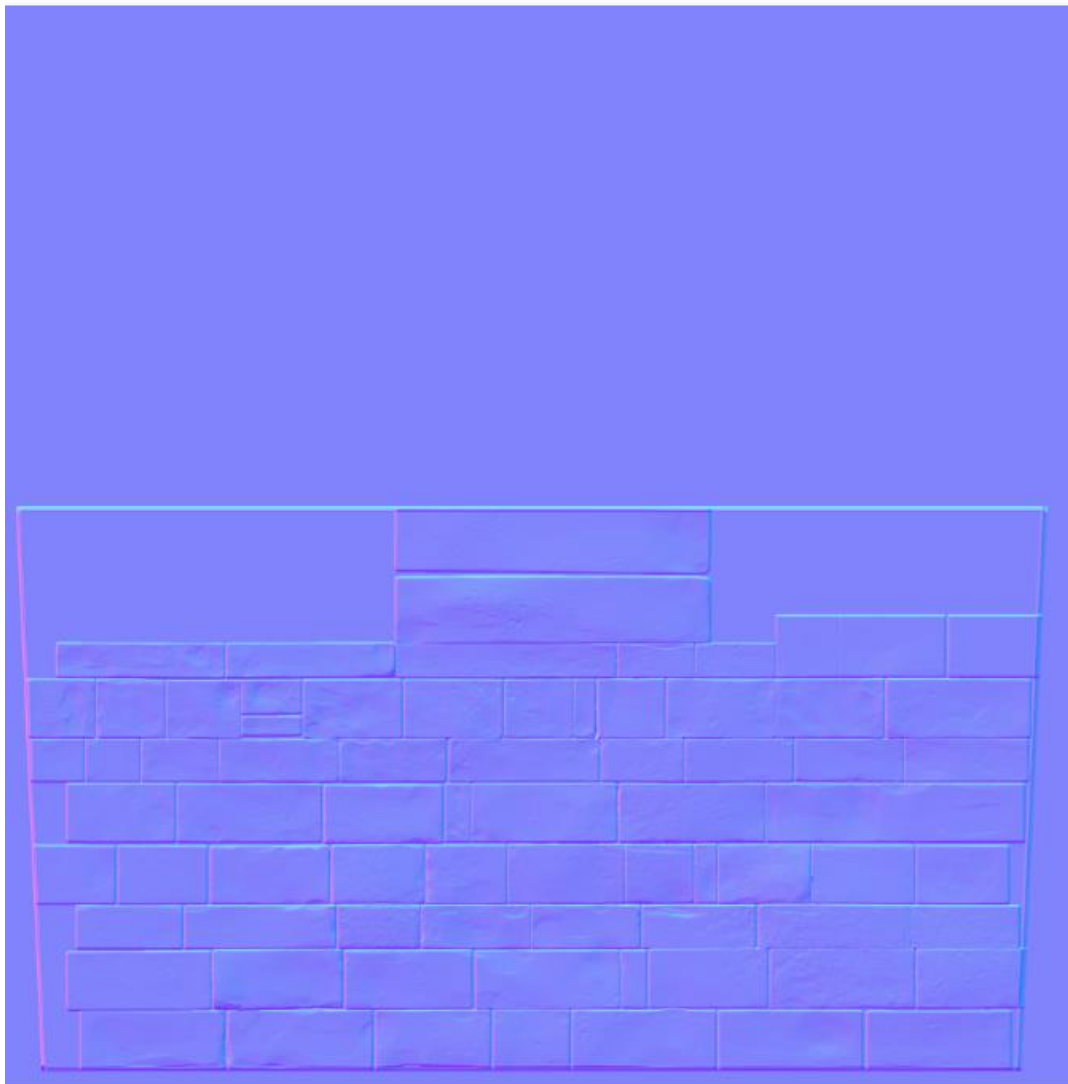
The normal map generated by the higher resolution tiles.

The normal map applied to the ramp.

My hope in using this approach is to keep the interactivity within the virtual world crisp and speedy. I wasn't particularly happy with the initial results, although untextured (lacking diffuse colour, specular maps....etc) I could tell that there was a fidelity issue, particularly from extreme angles.

My second approach is to texture 2-3 groupings of individual low resolution blocks then hand place each one (similar to how I placed the proxy cubes to begin with).
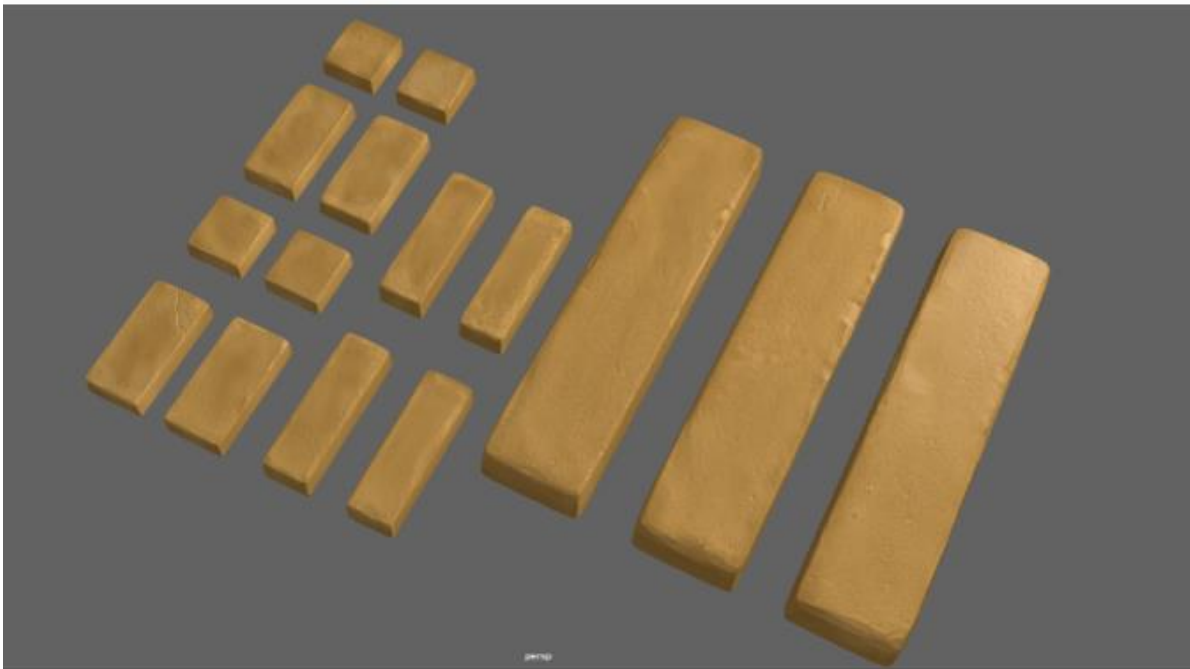
A test grouping (not the final textures)
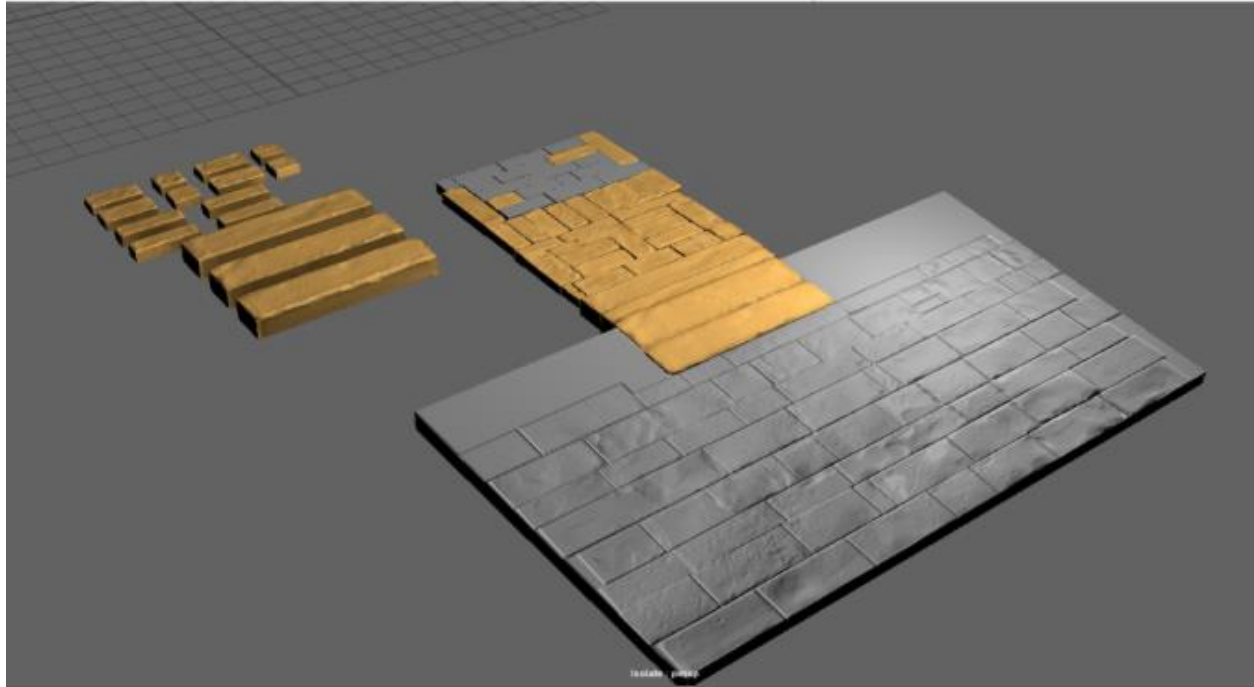
Beginning to hand place each block.....
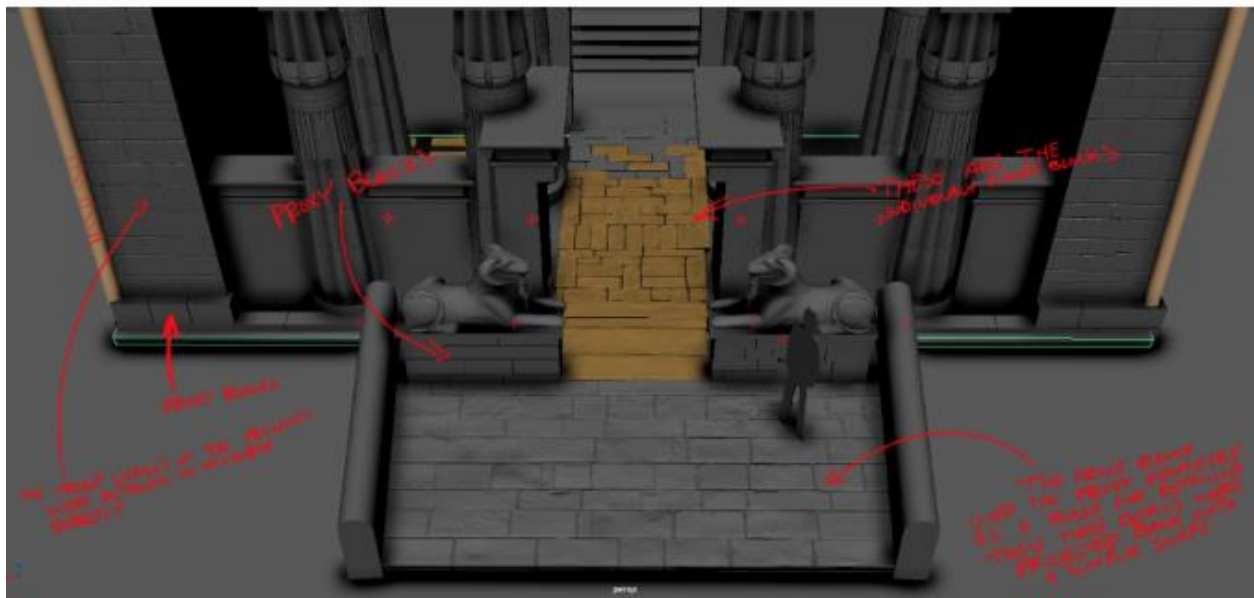
UPDATE: The known floor tiles (according to Ranke) have been placed, as of June 8th. I'll need to fill in the gaps with a similar patterning. But I'm moving onto the interior walls first.

APPENDIX G
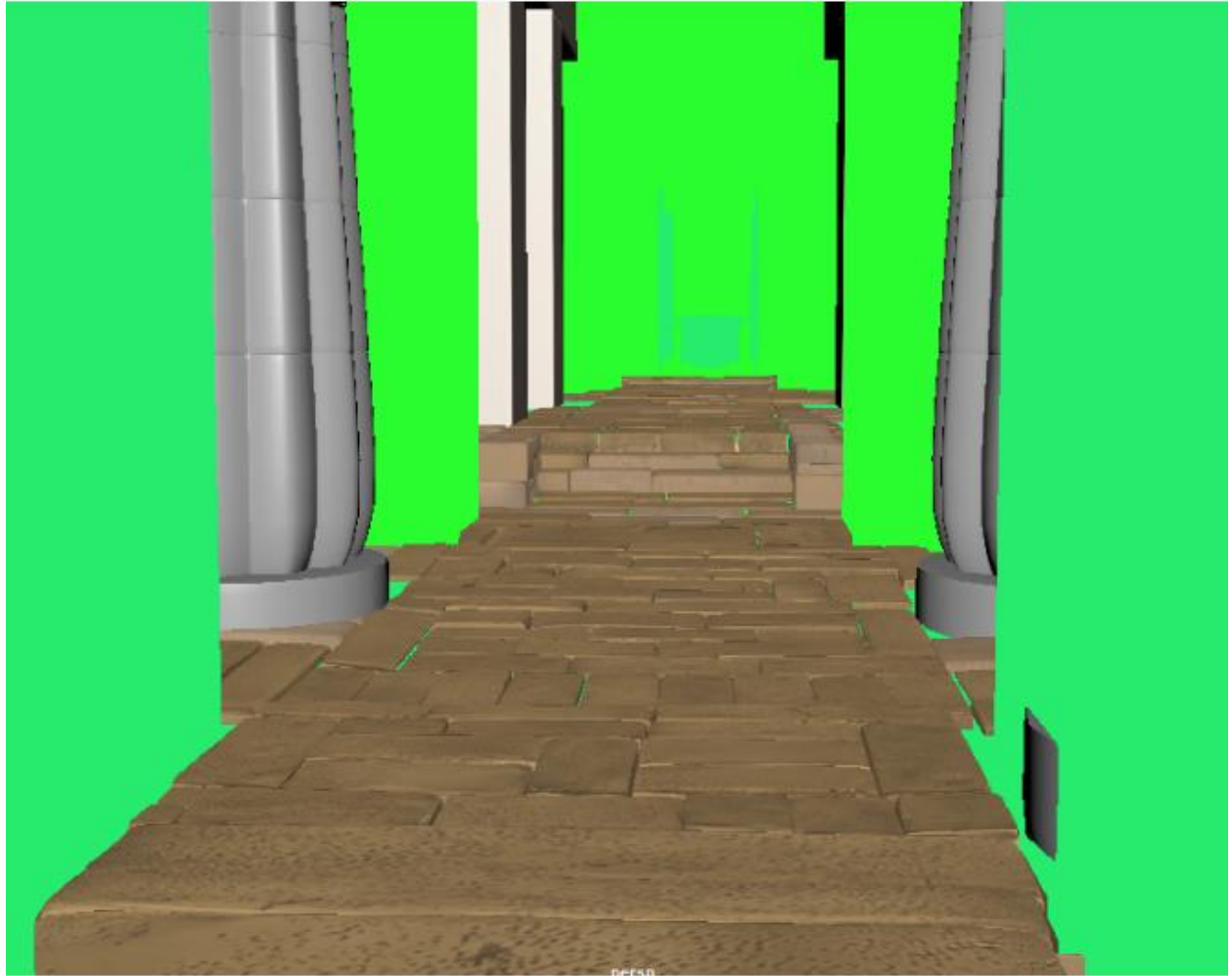
Field trip: https://elhibeh.blog/2017/06/16/field-trip/

Professor Jean Li gave me a guided tour of the Royal Ontario Museum's Egyptian section. I came away with a new appreciation for Egyptian carvings, I had no idea how intricate they could be. Also, the trip answered some questions around vague details indicated in Ranke's illustrations.

APPENDIX H

Texturing: https://elhibeh.blog/2017/06/27/texturing/

By mid-June I had laid out most of the UVs and was ready to start the texturing process. This

process involved several types of software: Autodesk's Mudbox, Sketchbook, Pixologic's

Zbrush, and gave me the opportunity to learn Allegorithmic's Substance Painter.

Texturing

by Kris Howald • June 27, 2017

I'm finally at a stage where I can begin to texture the various components. It has become a slower process than I initially thought, largely due to the amount of existing information in the lower quarter of the temple. I've been hand painting/sculpting each section before I can then go back and apply the hieroglyphs. I haven't had a chance to really use Allegorithmic's Substance Painter before this project, so I thought I would brush up on some new software. It definitely seems to be allowing me to pick up the pace somewhat.

Below are some of the elements I've begun to address.

My first attempt at a limestone ended being a little too pink, and had some odd ridging when scrutinized up close.

I've decided to have exterior surfaces more weathered as they would be constantly exposed to the environmental conditions.

59

I should point out that I was way off with how I originally though the screen components between the columns were constructed. I had built the cornice encircling the entire top of the component, not realizing (at the time) how these elements were almost fused with the columns.
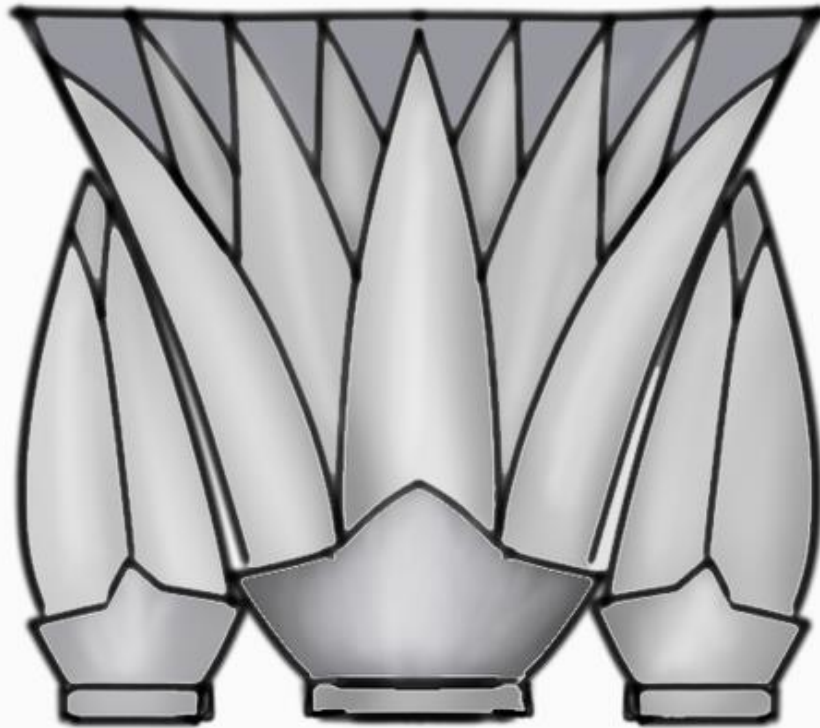
Above are the textures I created for the relief on the columns.
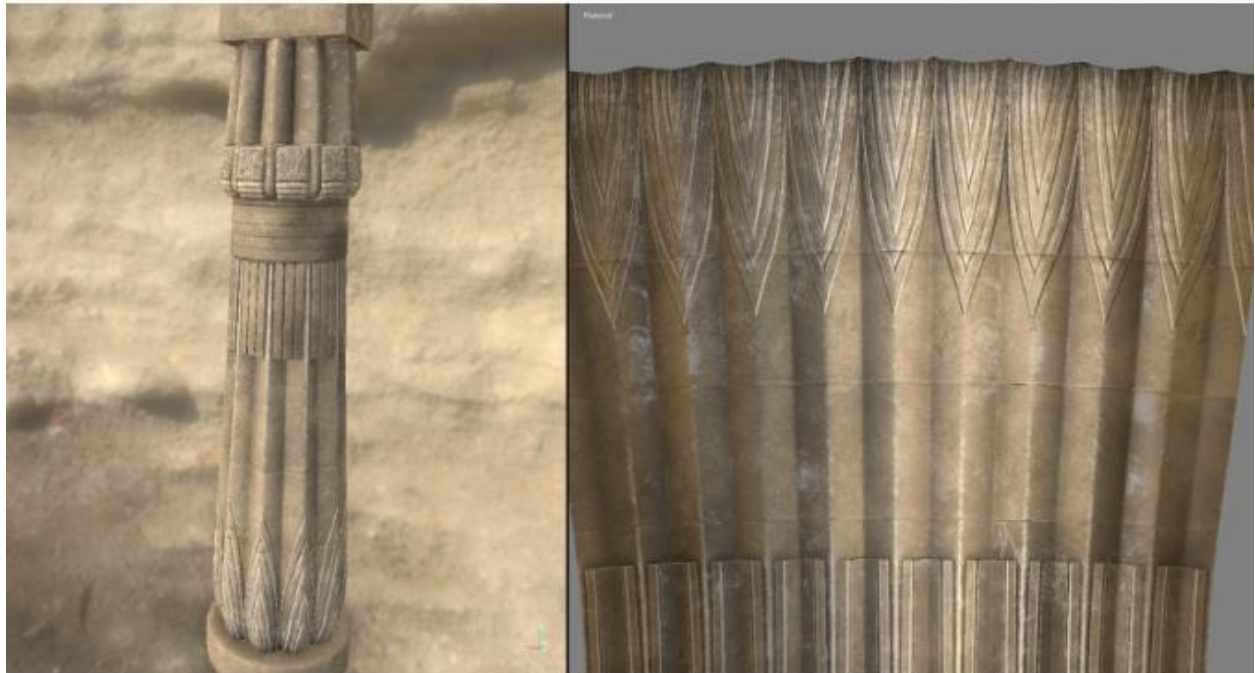
I revisited the criosphinx. Hard to believe it started as this:
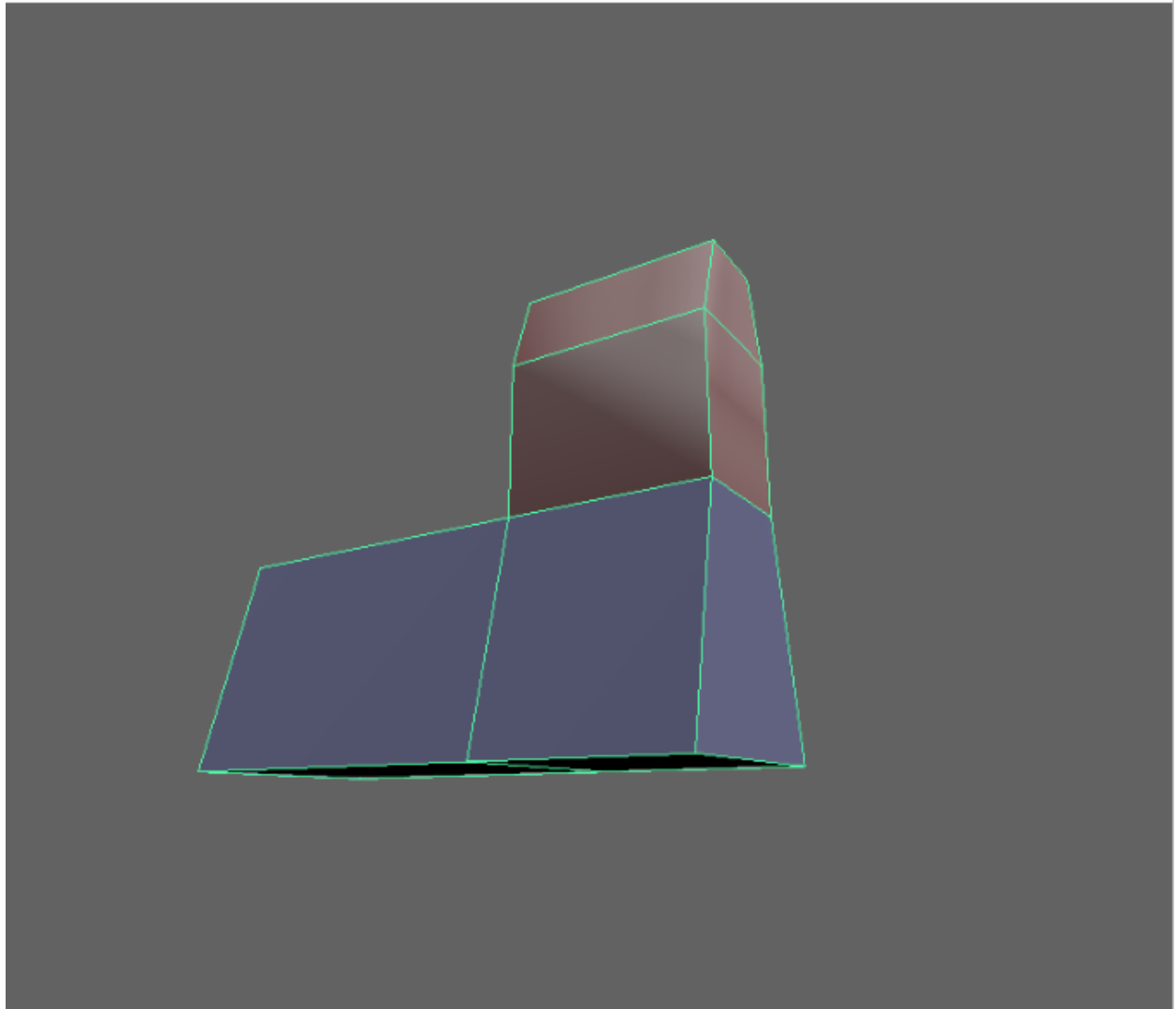
I forgot to include this in an earlier posting. It's a time-lapse construction of the criosphinx (captured in Zbrush).

I found the front and rear paws to be a little too rounded, so I went through and added more definition.
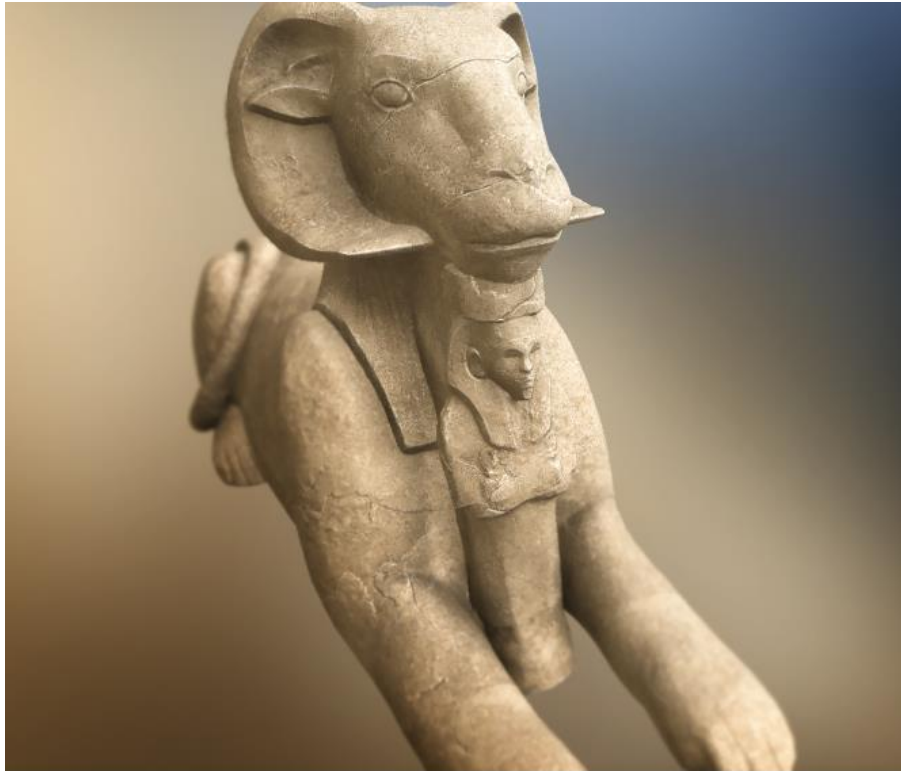
The North Criosphinx base. I might go back (time permitting) and add a small cornice around the top of the pedestals (similar to the ones found at Karnak).
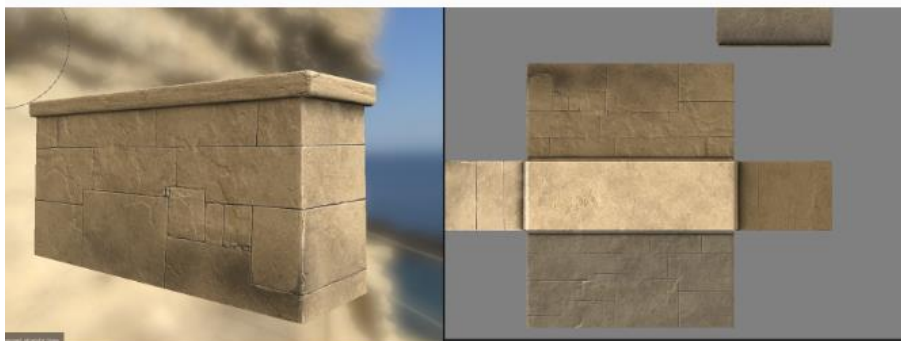
Using Autodesk Sketchbook (which has some fantastic line creation tools), I created a winged sundisk that can be used throughout the temple. Variation of this can be made after it's stencilled onto the geometry.
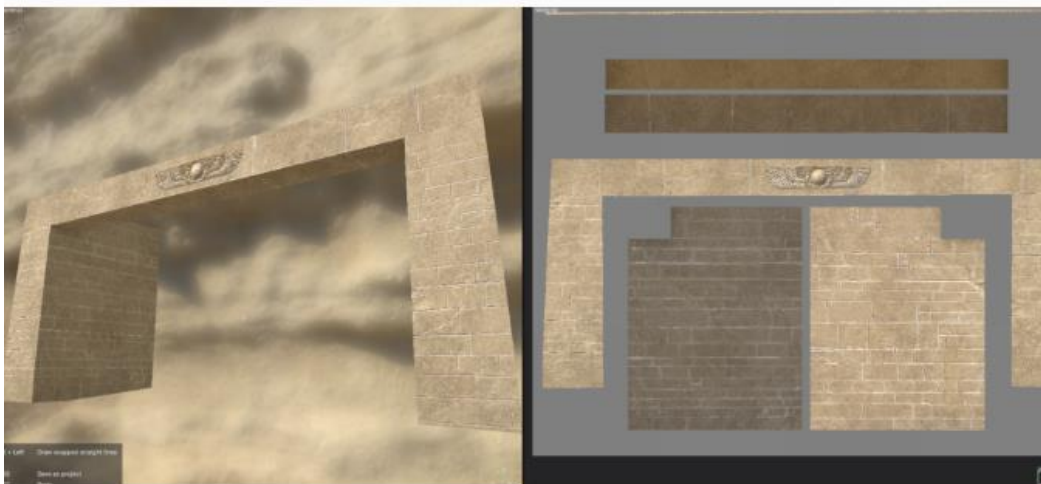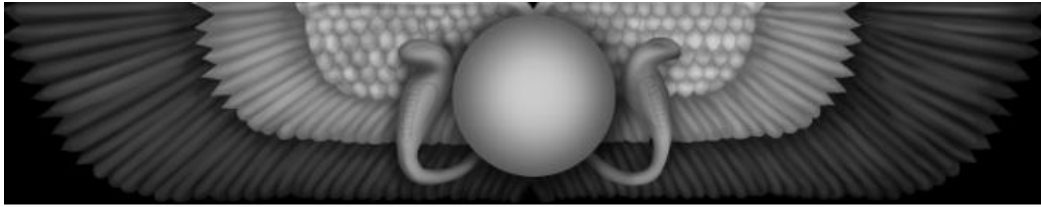
Below are the alpha's used for the Torus Moulding.
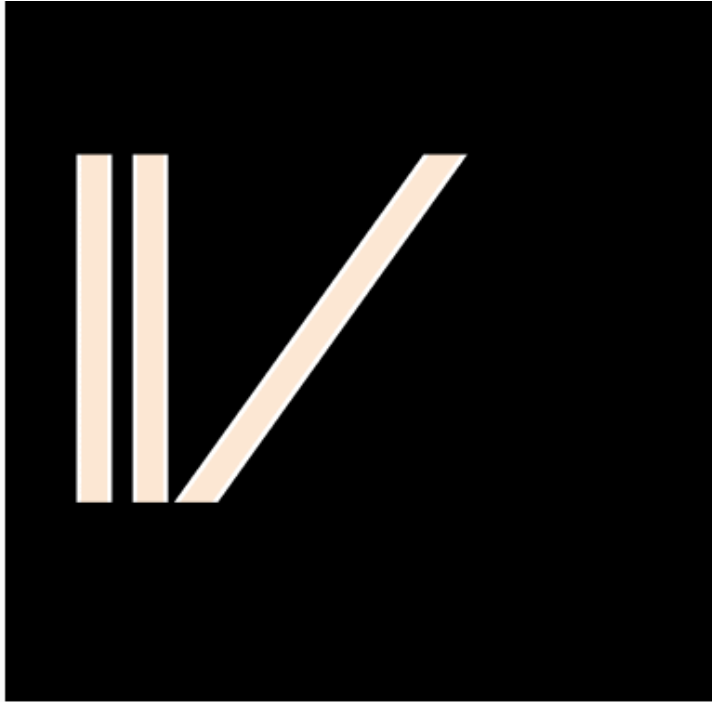
So, the cartouche I used was completely off the mark. I found it during an initial search (this is from a was at Karnak).
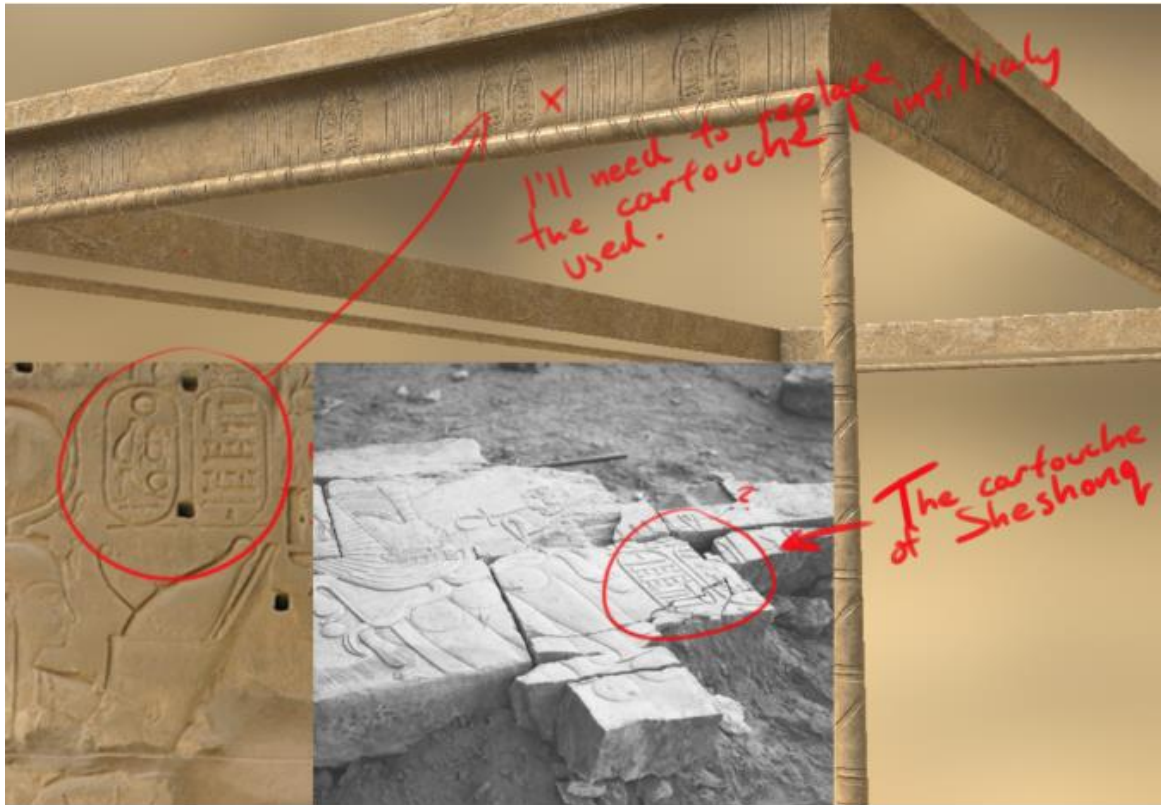
Below is the new cartouche relief (thanks to Jean for pointing me in the right direction) that will be stencilled around the cornice on the outside of the the temple.
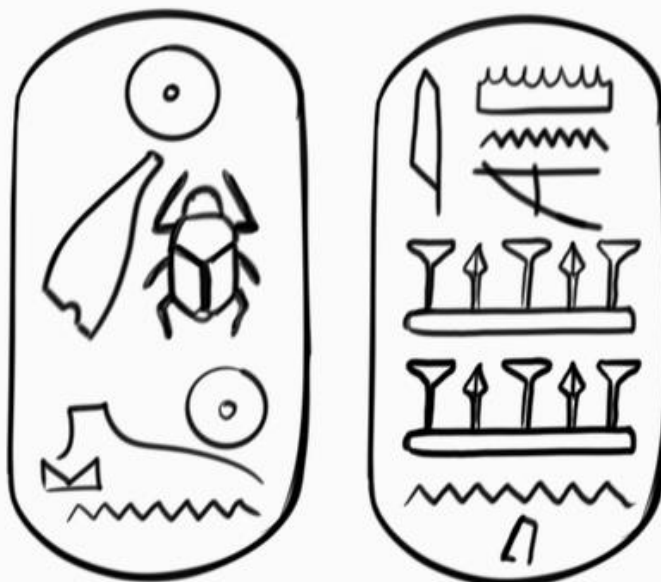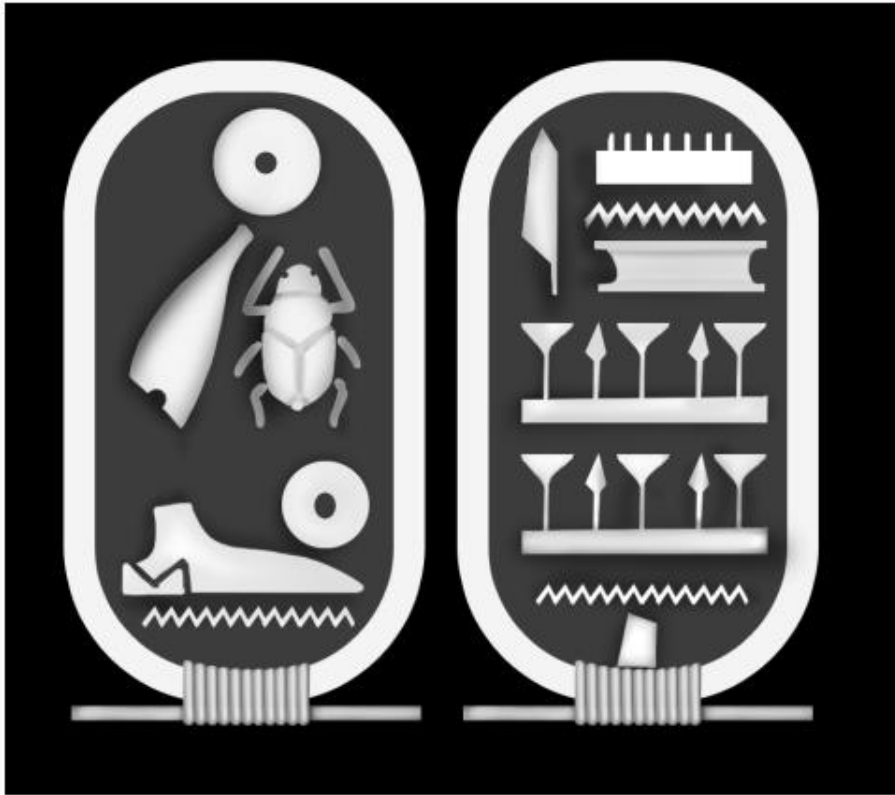
The entrance to the first pillar hall.

The covetto cornice at the Royal Ontario Museum is the initial inspiration for the entrance to the first pillar hall.
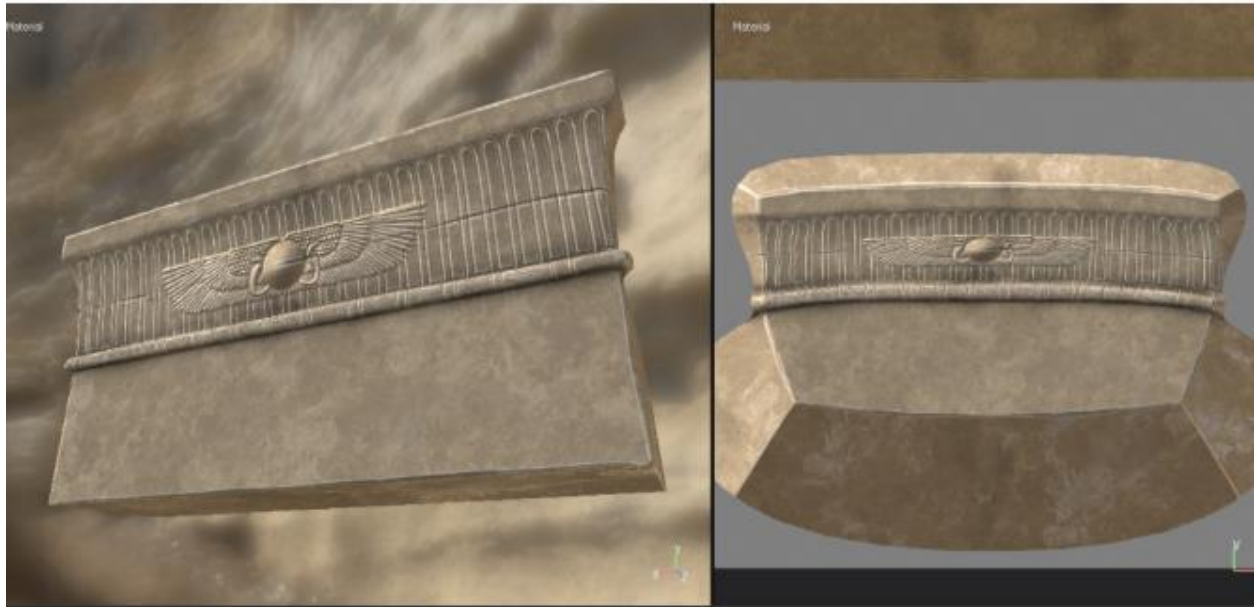
I've been working through the interior temple this past week.

Trying to figure out which pillars go where.
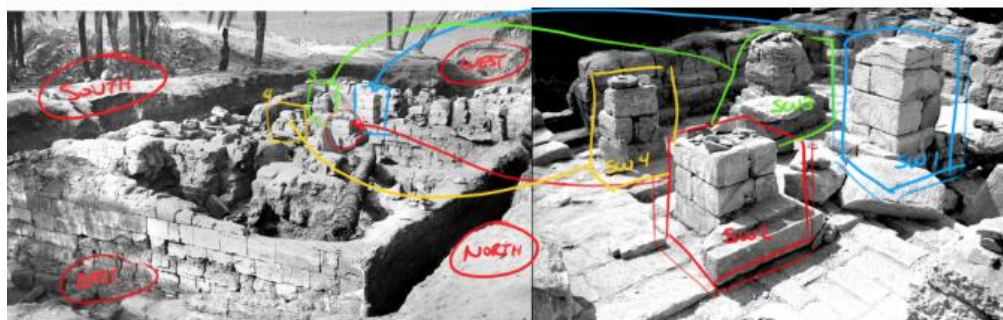
It has become the proverbial two steps forward, one step back as I find I'm constantly rebuilding elements from where I started.

For example, the entire model was built as one continuous shell.
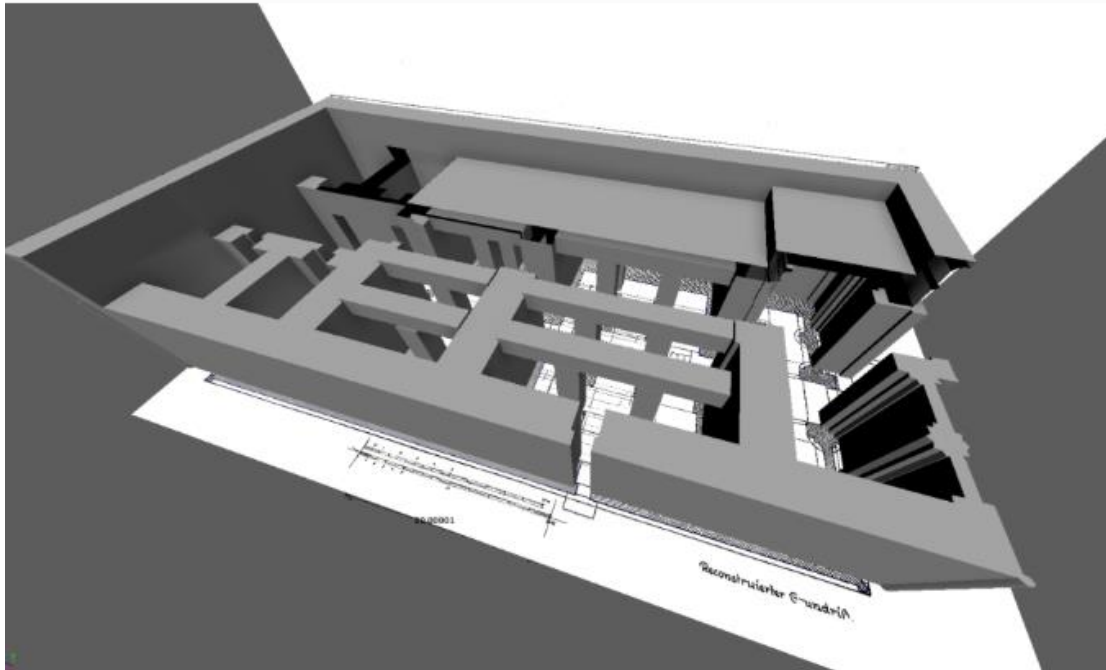
I thought that this would make it easy to texture. This approach ended up making modifications a time consuming and tedious task.

Instead, I have been dividing up the various components archetecturally. Which is also taking a little more time than I thought, but the end result will be more structurally accurate.
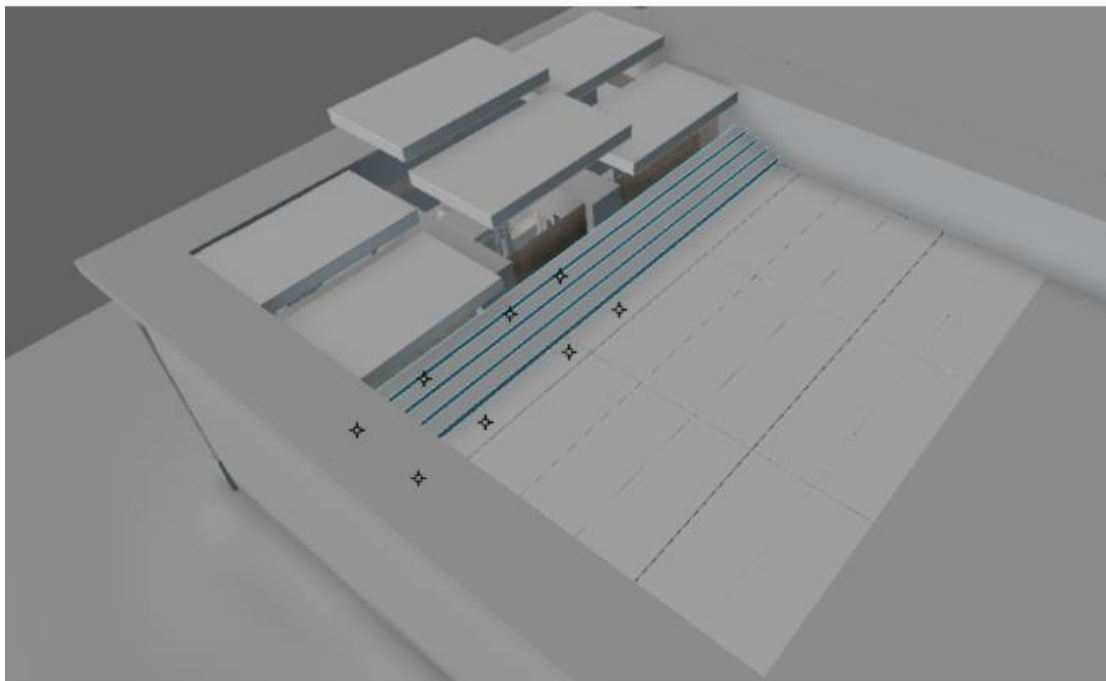
I've separated out the ceiling into individual slaps. I'll need to adjust the size slightly (they might be a little too small at the moment).

Robes and Priests: https://elhibeh.blog/2017/07/15/robes-and-priests/

The schedule was beginning to look a little dire by this point. All of the models needed to be imported into the Unreal Engine by the first week of August. The environment was feeling too empty. I decided to expand the team to make sure the deadlines were met.

Robes and Priests....

by Kris Howald • July 15, 2017

I'm investigating populating the temple with a few Priests. I think this will help establish a true sense of scale during the VR experience. Given existing time constraints, these will be non-animated characters. But, I am hoping to have them posed (similar to the dioramas at the Museum of Natural History in New York). I'm not sure if they'll be doing their daily rituals or if it would be a slice of time during some kind of narrative.

Diorama from Museum of Natural History Licensed through stock.adobe.com

Besides establishing height, I'd like to focus on the model's clothing. I'm having a bit of a challenging time finding specifics on what priests would wear during that time period. Looking over statues, and hieroglyphs of priests, it appeared that the main priest wore a leopard skin slung around their left shoulder.

Standing Priest Wearing Leopard Skin, from the Walter's Art Museum

Berlin, Neues Museum

After doing an initial sketch (trying to make sense of how the clothing is draped) I discovered that that's not the type of priest I was looking for.....which as it turns out is the UAB (or Wab) priest.

From the Turin Egyptian Museum.

I did a few sketches based off of the images I found.
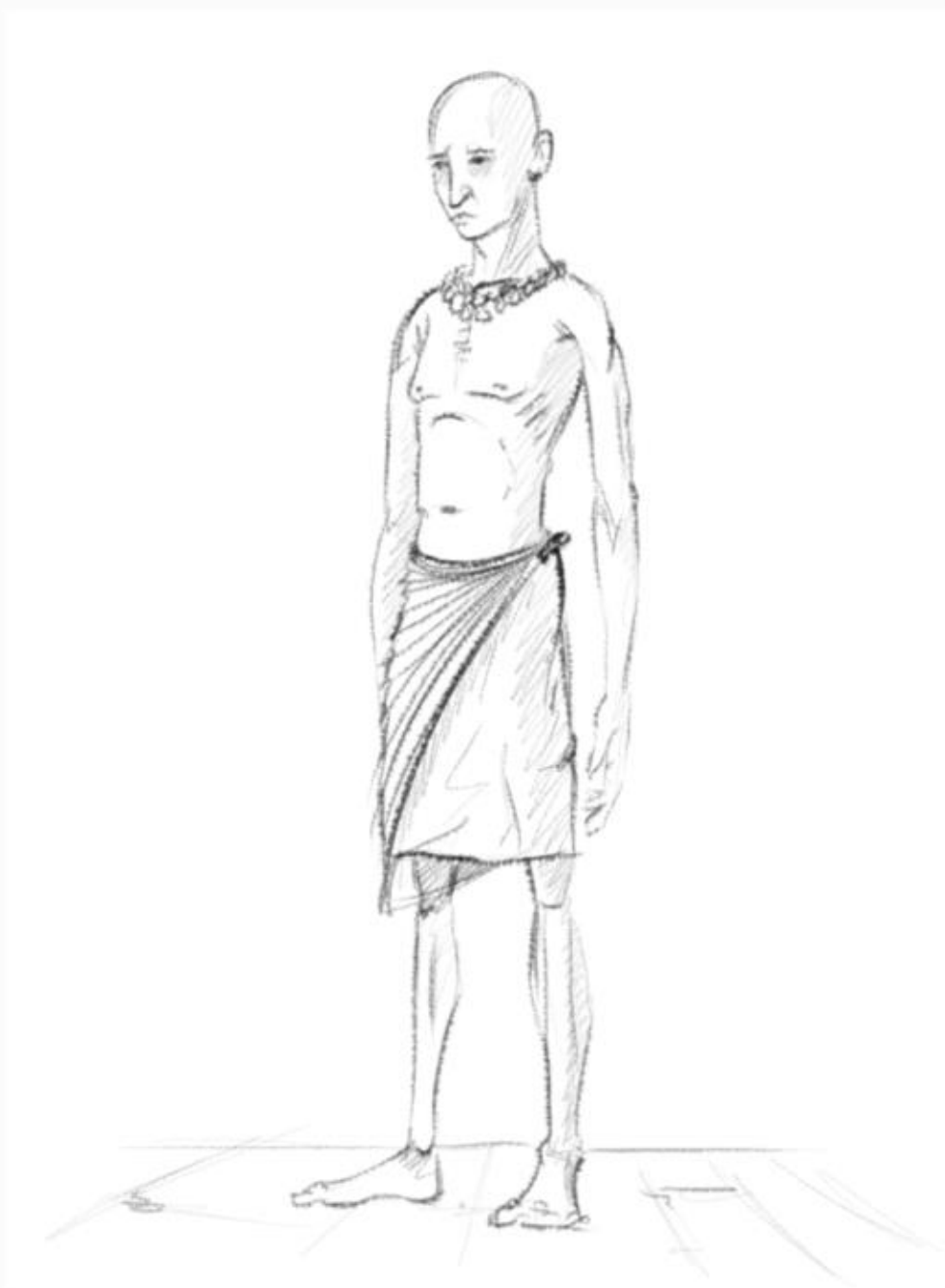
I wasn't sure how the sleeves were attached. At first I thought they were float somehow....which didn't really make sense. I then read that they were sleeves of a shirt (obviously), so I updated the illustration below.

I noticed that the priest seem to wear some kind of necklace. I'm trying to track down some reference, and found this (see below).....however I'm not sure if this was just for the pharaoh or also worn by priests.

Cairo Egyptian Museum The Treasure of the Royal Tombs of Tanis

Now that I'm getting close to the final stretch, I'm bringing on some additional hands to help with some of the outstanding elements. Sean Zhang, an excellent character modeler from Ubisoft, is going to help build the priests. My initial idea would be to treat the human element more stylized and representational, so that the focus would be the clothing. But, it would be cool to have a little more details, maybe the skin could be colourless and have a different texture, like that of a mannequin?

Here are a few of pics of Sean's initial sculpts.

We're looking into Marvelous Designer for the clothes creation. Have a look at their impressive showreel.

A new updated Marvelous Designer Demo

APPENDIX J

May the floors be with you: https://elhibeh.blog/2017/07/16/may-the-floors-be-with-you/

With an expanded team, I was now able to address areas that needed some rethinking.

May the floors be with you...

by Kris Howald • July 16, 2017

Just to preface this post, over the next two days I'm going to be a blog posting machine. I've been sitting on a few unfinished postings that need to go out before I get to far along in the process. I was debating whether or not I should combine them into one giant omnibus blog posting, but I think I'll keep them separated for easier viewing.

Now on to the floors.......

......which I needed to rethink. The more I looked at the them the more I realized they were a little too rounded....almost puffy, and I wasn't loving the direction the textures had taken. Seen below, the floor slabs are much tighter than my original attempt.

Anscient Temple of Karnak in Luxor – Ruined Thebes Egypt. Licensed through stock.adobe.com

Columns In Dendera Temple. Licensed through stock.adobe.com

I ended up combining the floors in each room, added a lattice to each section and flattened the top quarter to get rid of the puffiness.
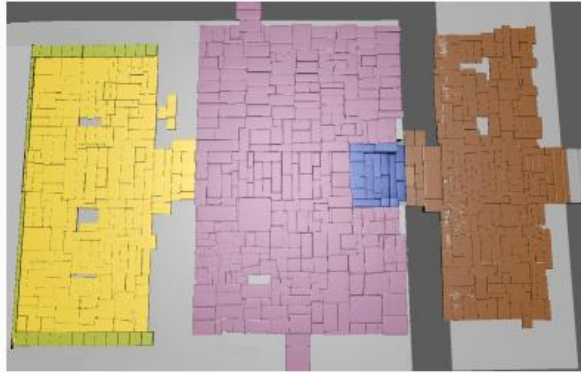
Three of the four floor sections: The Column Hall, 1st Pillar Hall, and 2nd Pillar Hall

After that, I went around sharpening some of the corners. The UV's were reapplied to each area as a whole, which would make future updates an easier task to accomplish.
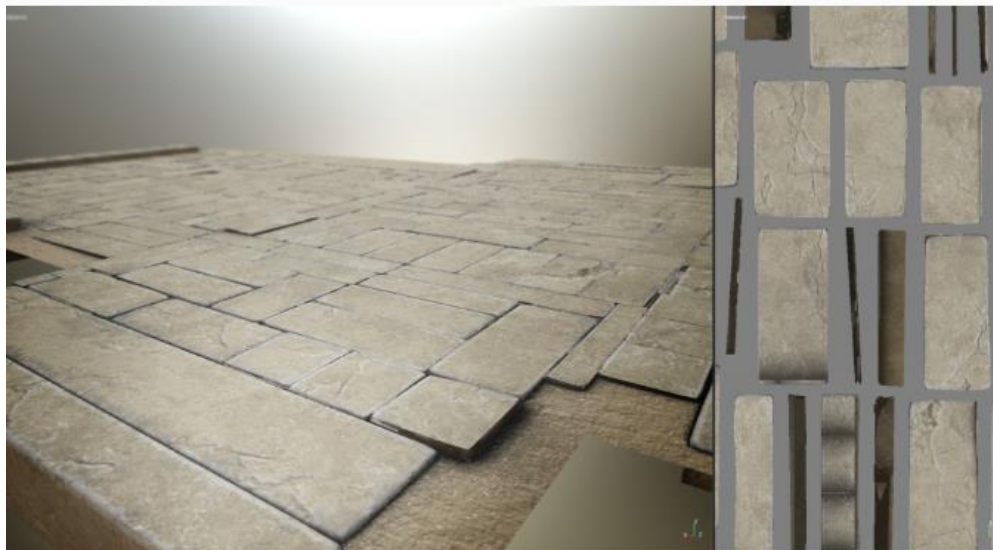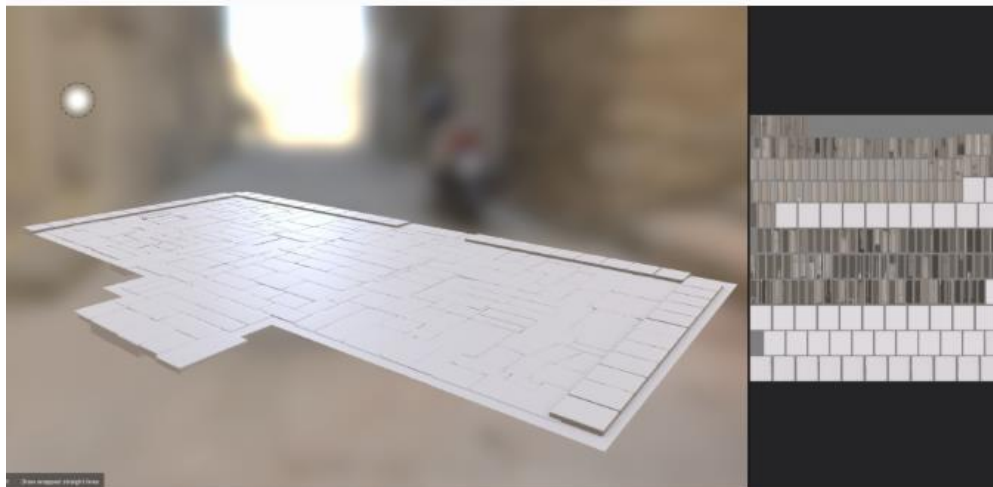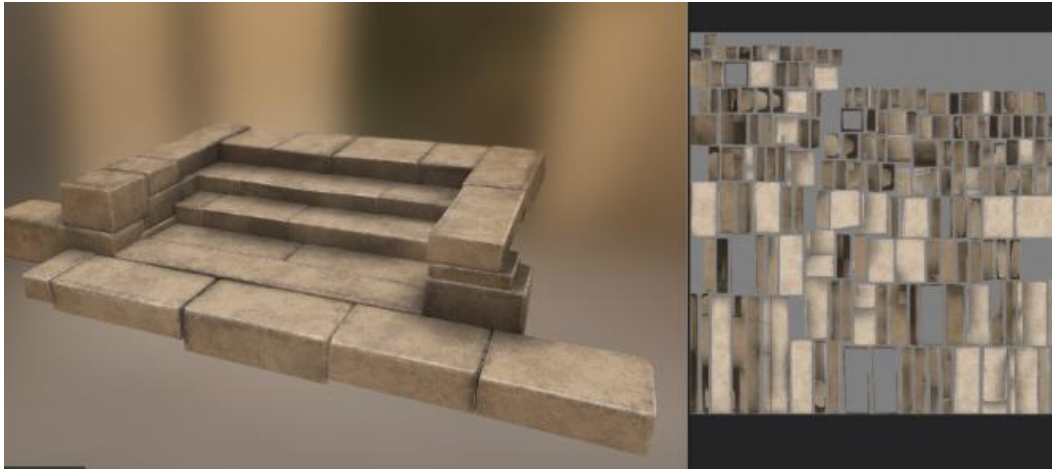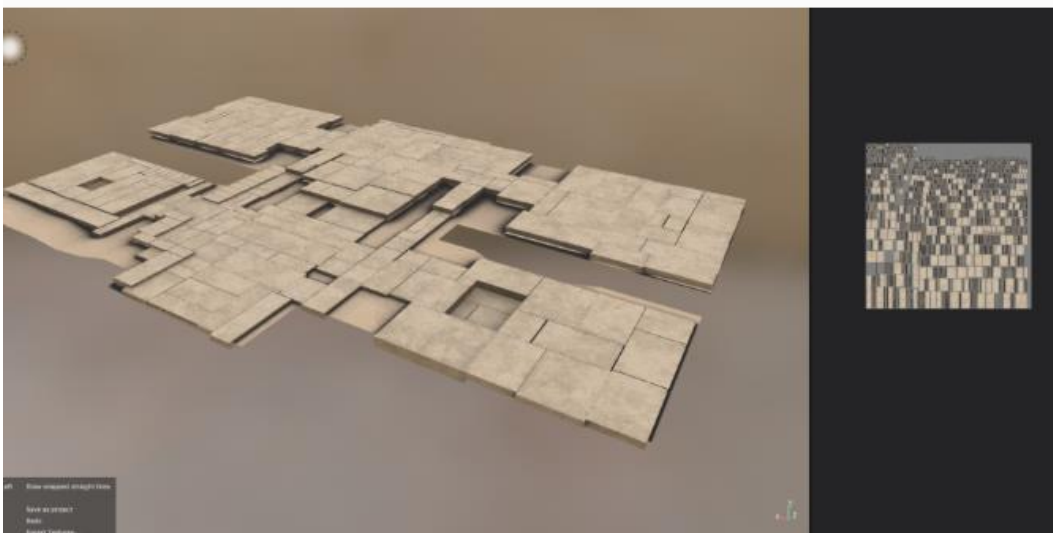
The stairs leading from the column hall to the first pillar hall.
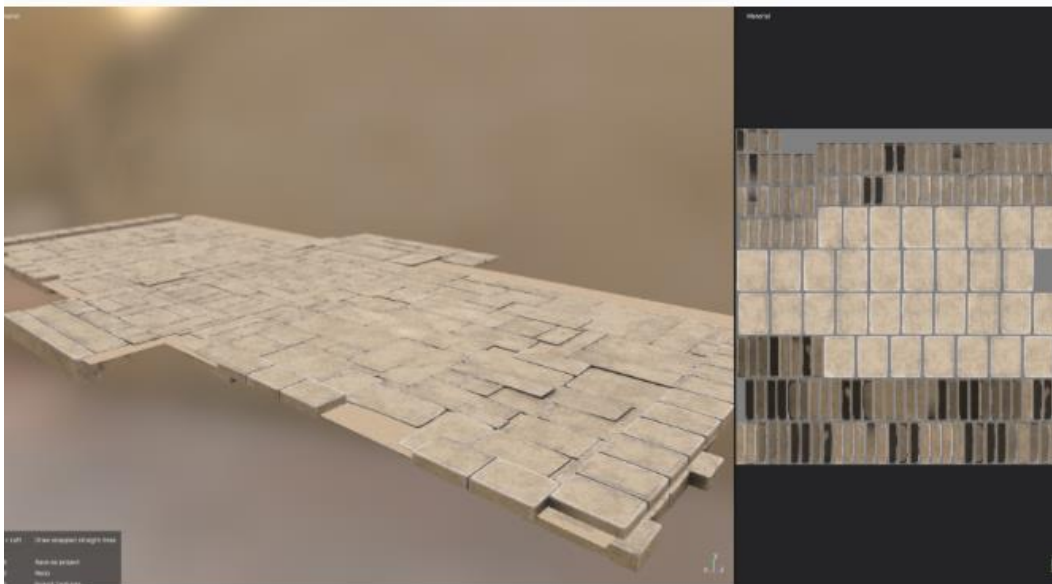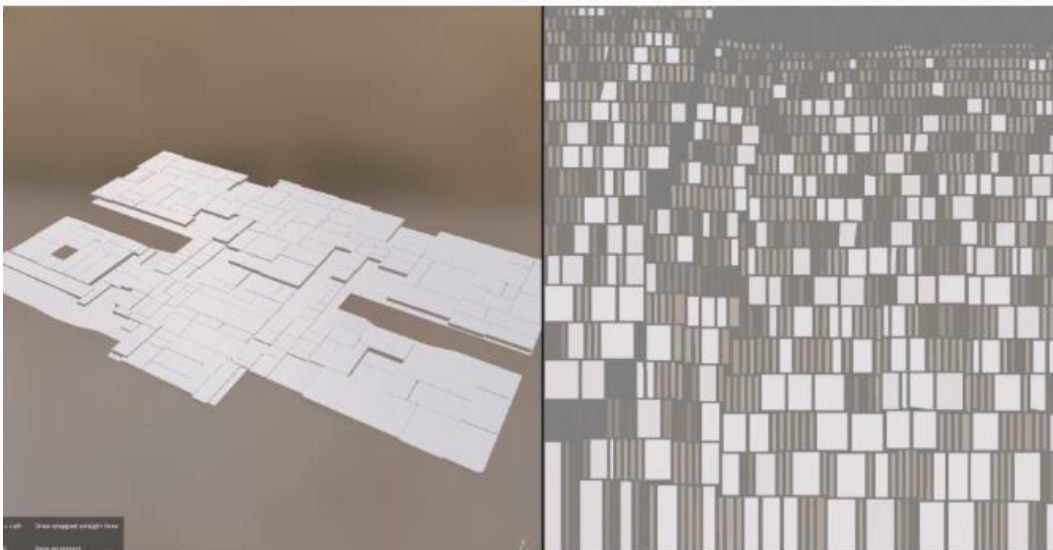
The floors for the sanctuary and adjacent storage rooms.

APPENDIX K

Exterior Walls, lighting, and waterspouts: https://elhibeh.blog/2017/07/16/exterior-walls-lighting-and-waterspouts/

In addition to texturing the temples outer walls, I had to rebuild elements of them to address how light entered the structure. I also examined the ancient waterspouts, and how they were used to drain excess water on the roof.
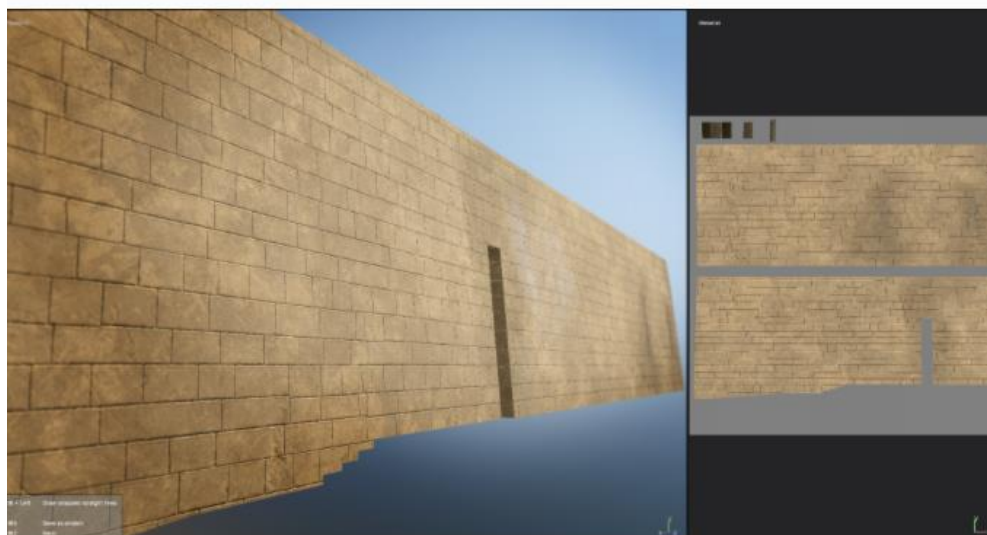
North exterior wall.

The rear outer wall.

South exterior wall.

Lighting

Lighting still poses some questions. Ranke suggested several ways of allowing natural light into the space. In the 1st pillar hall the main door would allow light to stream in. He believed there was a 13cm gap in the ceiling slabs at the back of the room to allow the darker areas to be illuminated. I added in a row of celestial windows to the 2nd pillar hall.

Celestial windows at Karnak. Source from the website: https://arsartisticadventureofmankind.wordpress.com/2013/03/11/art-of-ancient-egypt-during-middle-and-new-kingdom-periods-the-egyptian-temple/

These could only be placed on the north side of this hall, the south side needed allowances for the stairs to the roof. The 4 storage rooms in the sanctuary had narrow vertical slits in the exterior wall that allowed light to enter. I'm having trouble finding additional means of illumination. Were there oil lamps or some kind?

Roof lighting sources


Exterior placement of the windows.

Waterspouts

I've added two waterspouts to the upper north and south corners of the temple. These are based on the spouts found at Dendera. The roofs had small openings at the rear of the temple to allow excessive water to drain off. I wonder if the roof was slightly slanted to direct the water towards the back of the the temple?
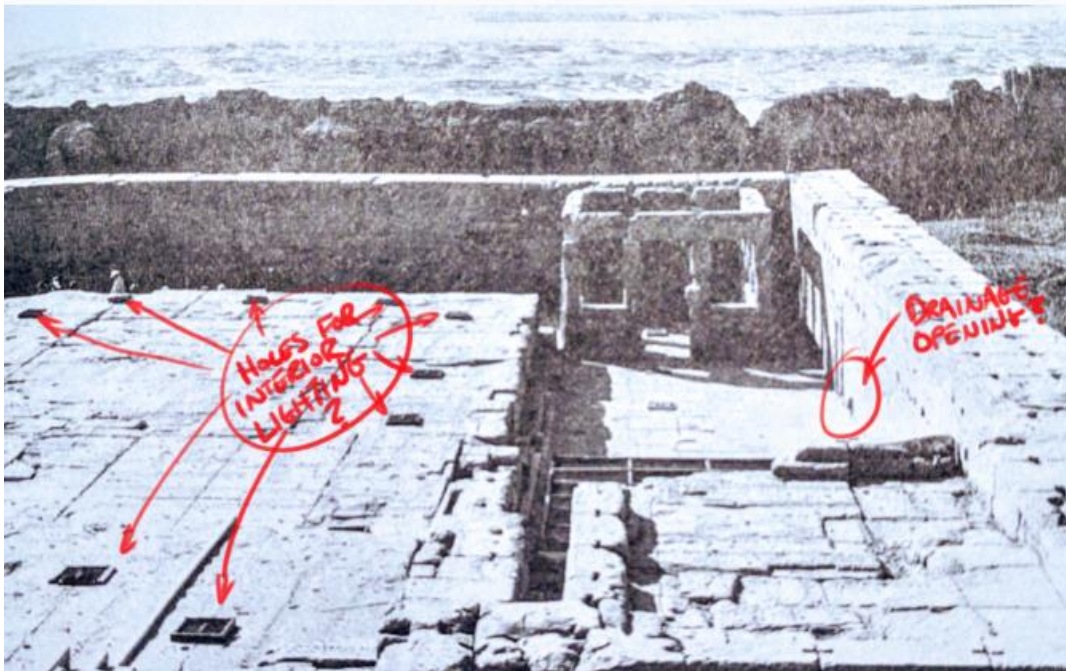
Arnold, D., Bell, L., Finnestad, R. B., Haery, C., & Shafer, B. E. (1997). Temples of Ancient Egypt. Ithaca, NY: Cornell University Press. p223

I noticed that there are some hieroglyphs on the bottom portion of the spout at Dendera, but they're a little hard to make out because of the resolution of the various images I've sourced. If anyone has higher resolution images of this, it would be of great help.

91
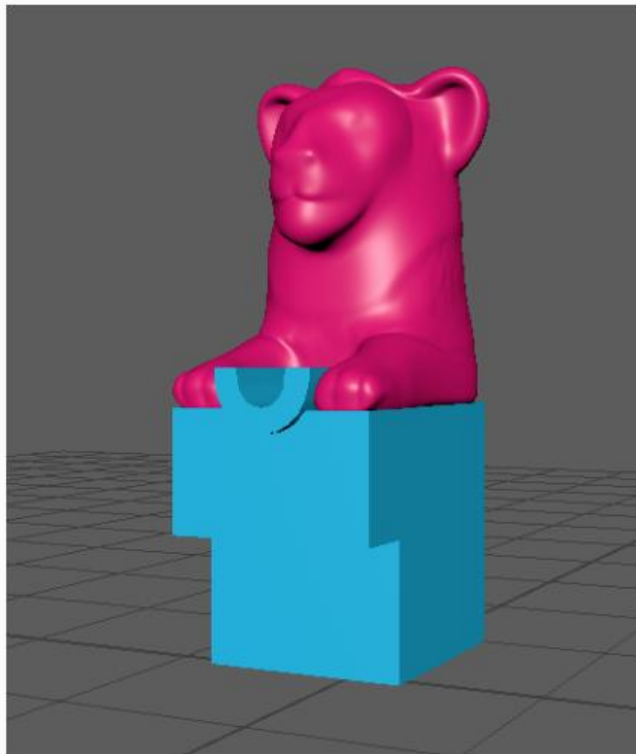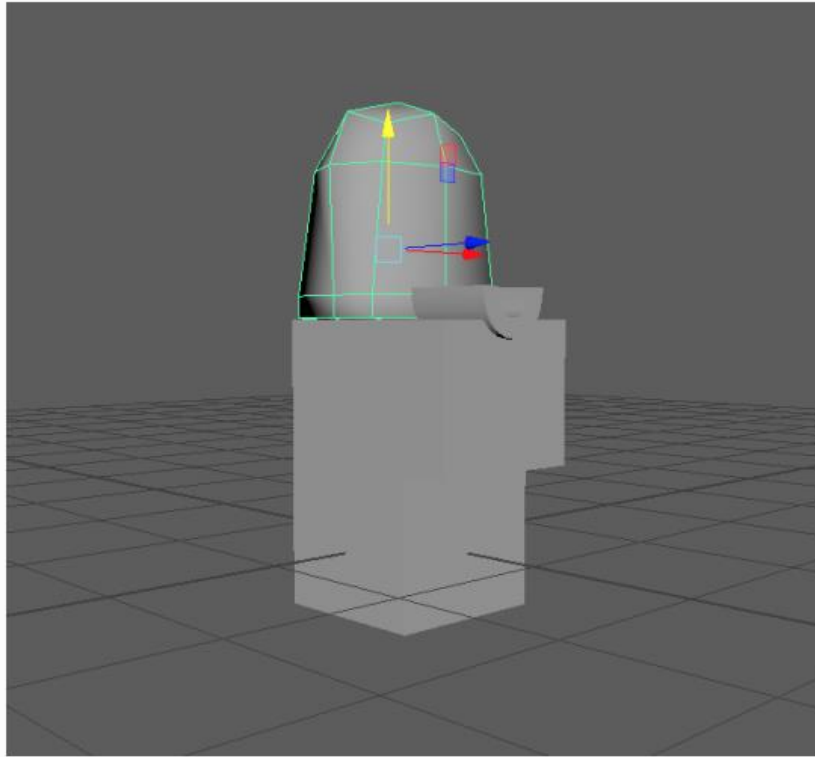
The above is a time-lapse of the sculpt I did for the lion portion of the spot. Hopefully there will be time to go back and update the a few of the proportions of the lion. The lion and base were brought into Substance Painter for detailing.

APPENDIX L

The Sanctuary: https://elhibeh.blog/2017/07/18/the-sanctuary/

The sanctuary and its four connecting storage rooms was one of the last areas to texture. This post also discusses the initial construction of the ceremonial barque.

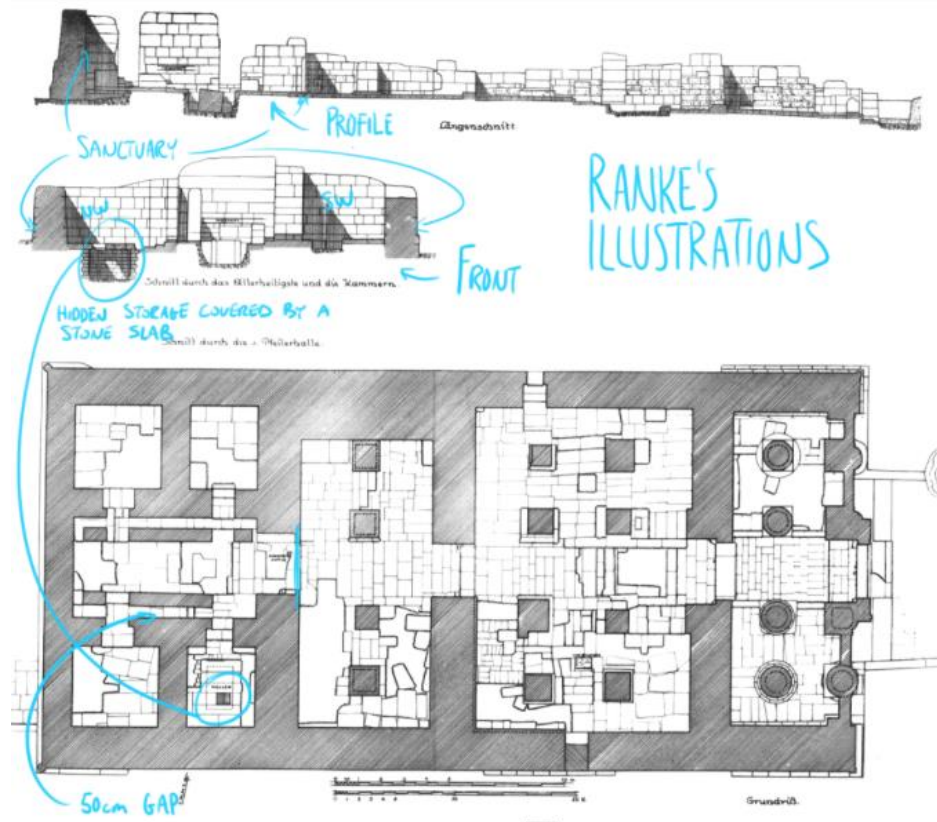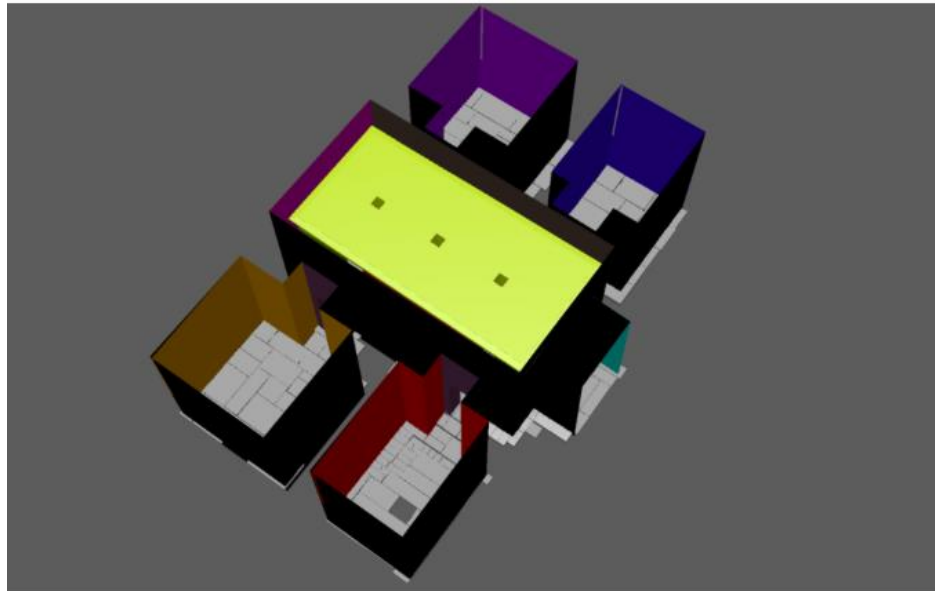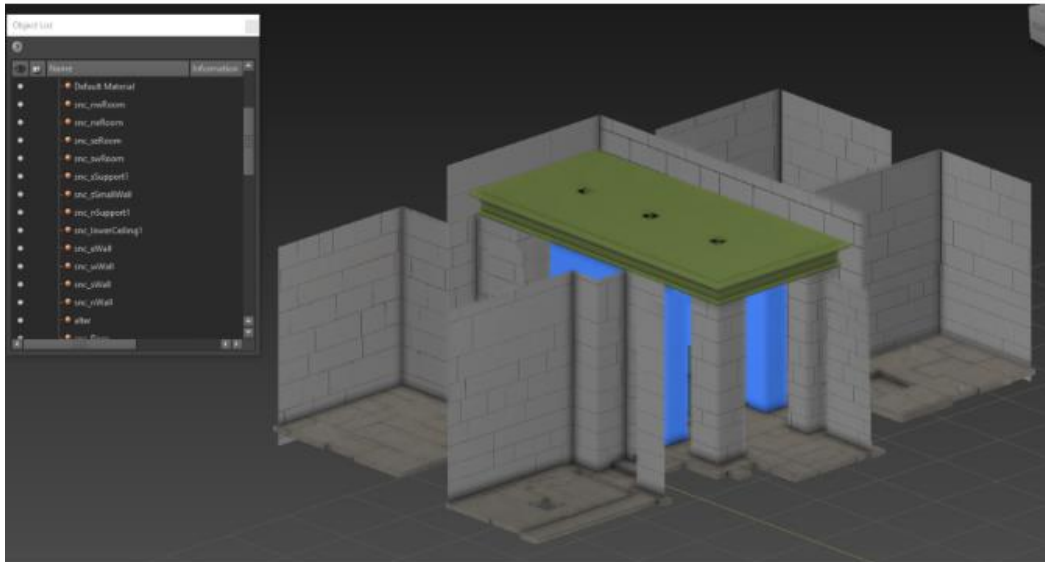I ended up sectioning off each area by material in Maya. Substance Painter organizes objects based on their material association, making it easy to isolate areas to work on.

Before taking the FBX into Substance, I made a pit stop in Mudbox to paint the the bump maps for the stone placement. For some reason I find this process to be faster.

I assigned the bumps and generated normal maps within Substance, which will work with my customized Smart Materials.

After applying and modifying the materials, I noticed that the spacing between the blocks is a little to much (the brush I used was a little thicker this time around causing a larger gap...which works from a distance, but not so good when you get close-up). I'll need to budget time when I go back to add the hieroglyphs to fix this.
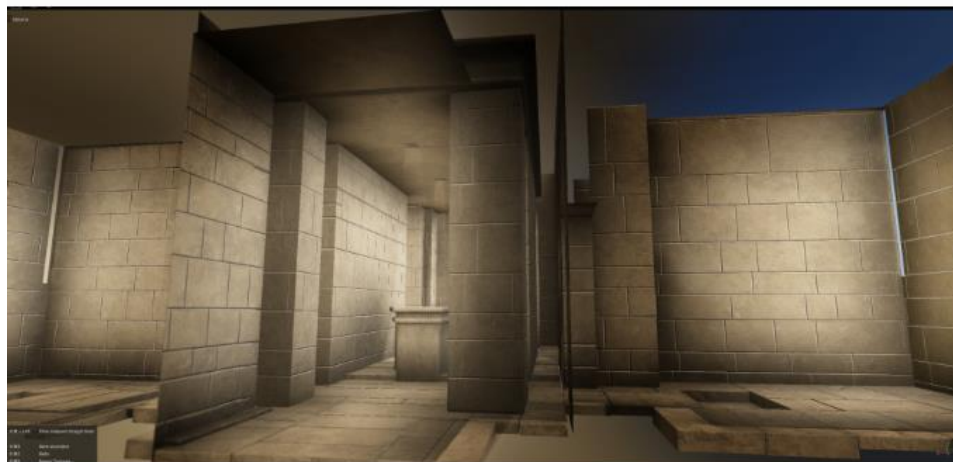
The Storage Rooms and Barque

The rooms to the north and self were used to house various items used in daily practices around the temple. These items still need to be modelled, and will be necessary to flesh out the details by adding compositional clutter.
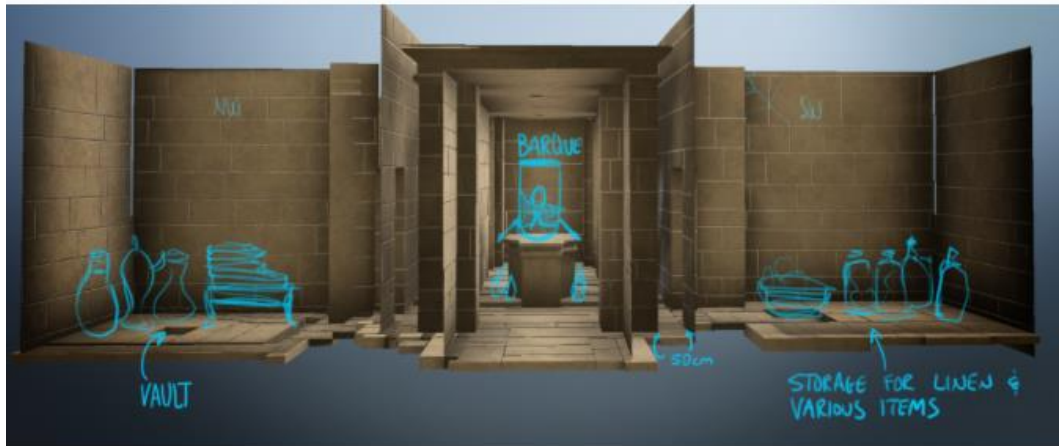
The Barque of Horus. Sourced from: http://publicvr.org/egypt/MedHabuGlyphs/Images/DSC08316.JPG

As I mentioned in a previous post, I'm bringing on additional help in the final stretch. Joe Chao, another excellent modelling and surfacing artist, is building the barque of Amun that sits in the middle of the sanctuary.
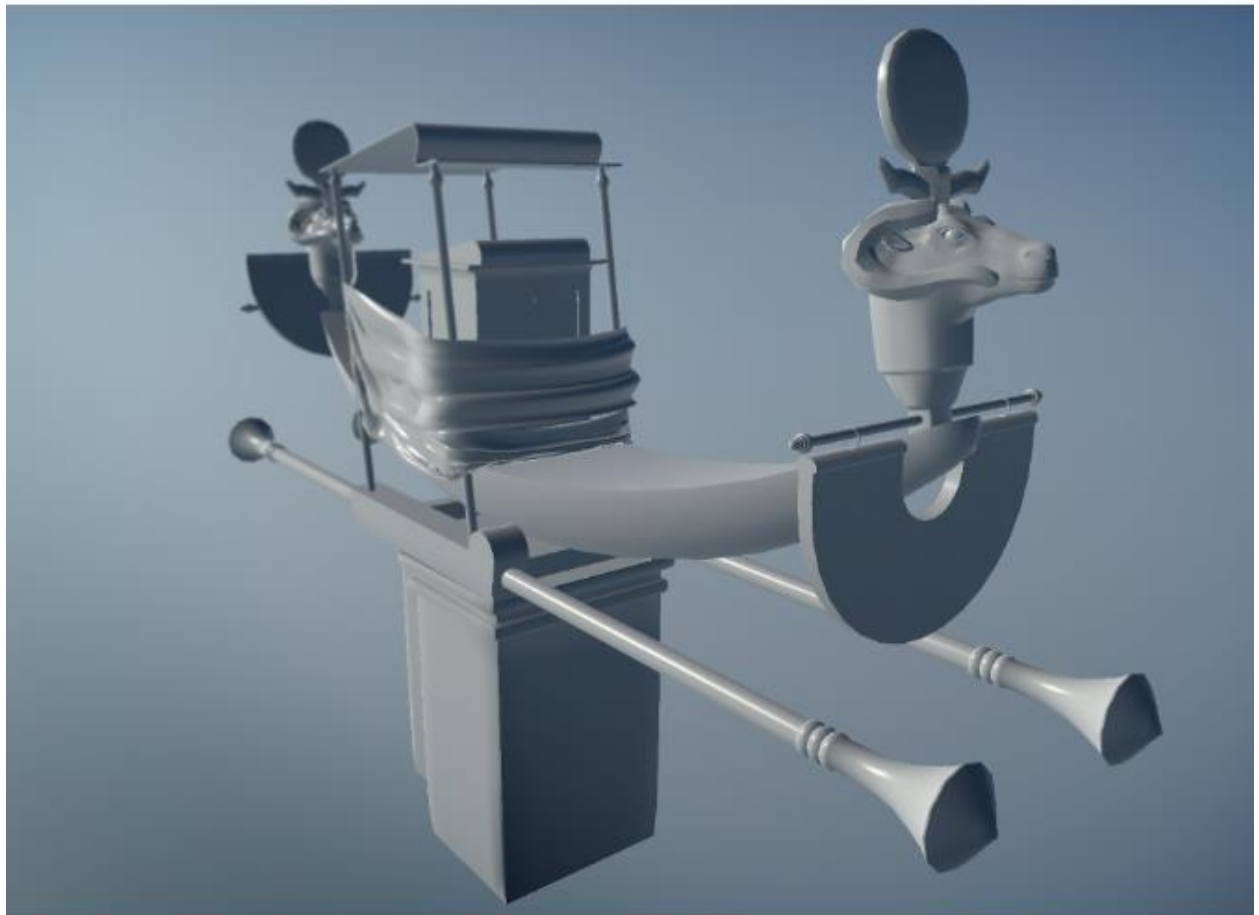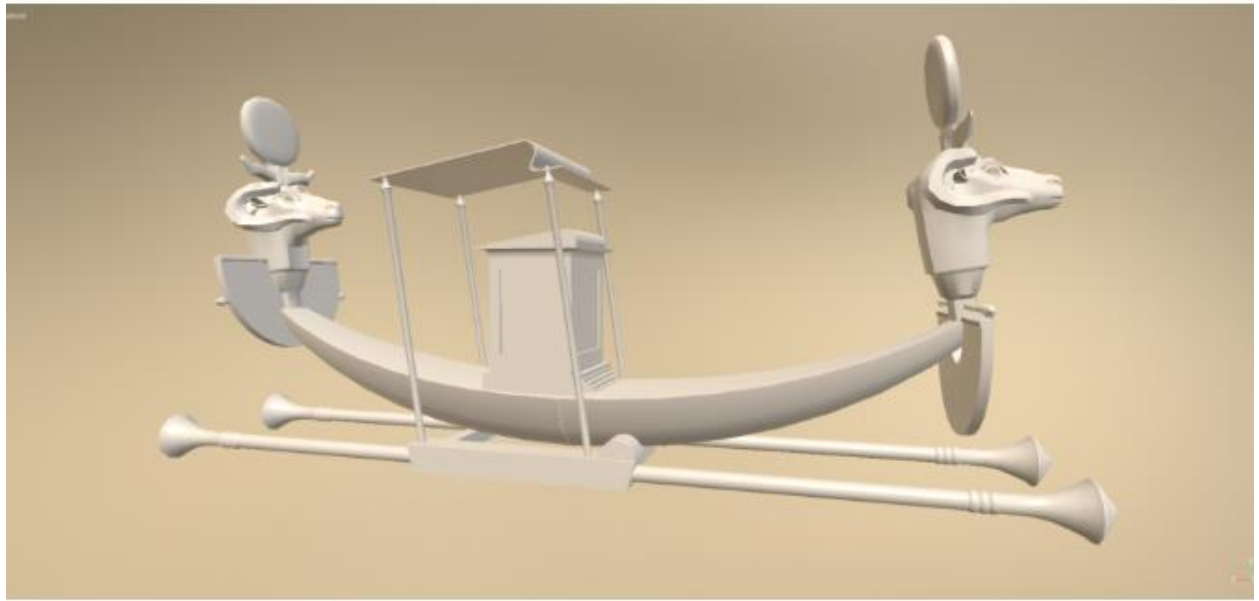
I believe the Barque of Amun would feature the head of the Ram mounted on the bow and stern of the boat. I've found several references to this. Joe also came across come good reference images taken at the Egyptian display during the World Fair in Shanghai.

Below are some of Joe's progression stills. I'll post more in the next week.

100

APPENDIX M
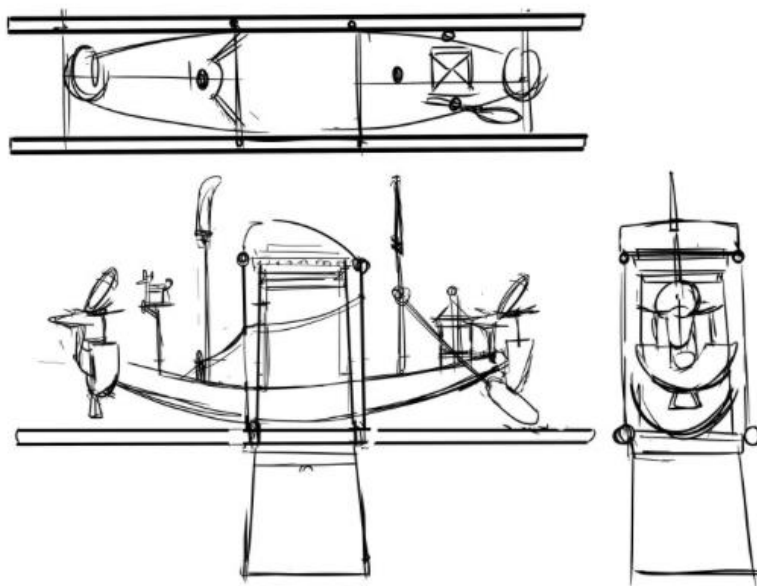
Statues: https://elhibeh.blog/2017/07/24/statues/

Reconstructing the statues was an enjoyable exercise in sleuthing. The two king statues found during the excavation were largely destroyed. If you didn't notice both halves have the waist wrapping, they would come across as being two sides of the same statue.
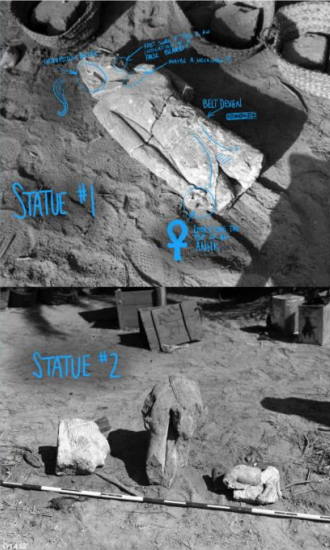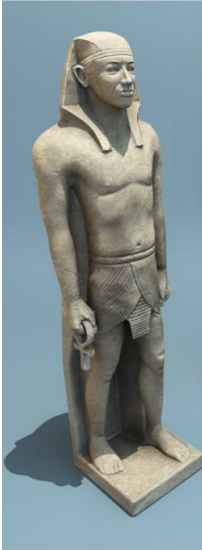
Statues

by Kris Howald • July 24, 2017

This is the week I finally start bringing everything into the Unreal Engine. In prep I've been doing some house cleaning (file organization...etc). Additionally, I've been building elements to populate the interior.

During Ranke's dig, sections from two statues were found in the first pillar hall. Both statues were largely damaged. Statue one consisted of the hips, torso, and head. The right hand looks like it is holding an Anhk, the left arm and legs are missing. The majority of the face is missing, their might be an indication of a small false beard, but it's really to difficult to tell.

Statue two is essentially the hips and right leg. The belt and wrap are similar to statue one, leading me to speculate that these statues were a pair. The overall heigh is a little difficult to judge. Statue two was photographed on a odd angle with a yard stick. and the other was surrounded by boot prints. It's a guess, but I appears these would have been close to life size, around 5 feet high.

Before building, I studied similarities and differences between a variety of statues. I was surprised to discover that these statues were not truly free standing,   They seemed to be more of a dimensional relief, as if they were stepping out of the blocks they were chiseled from (I realize that's not the symbolism).

Menkaure and his queen. Sourced from:
http://www.imgrum.org/media/1304530506985418259_2252824780

Male Figure Standing (746-335 BC). Sourced from: https://commons.wikimedia.org/wiki/

Sourced from: http://www.historyforkids.net/images/Egyptian-sculpture.jpg
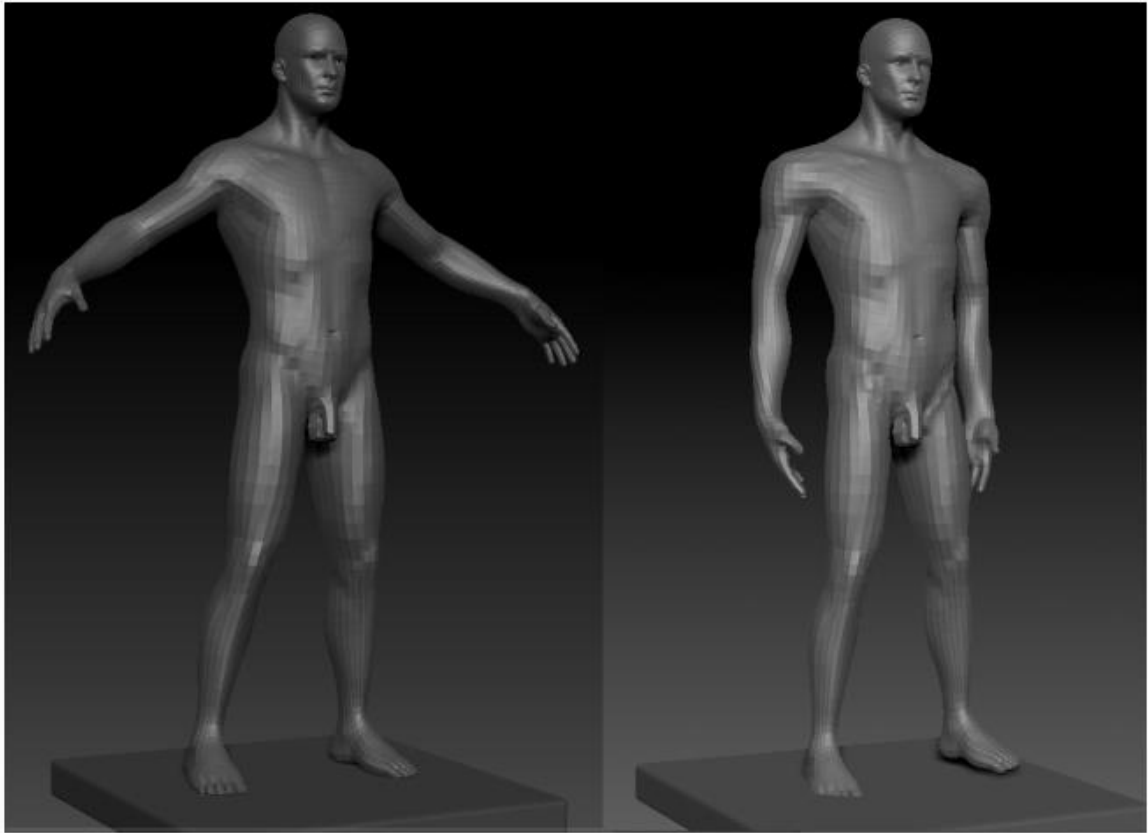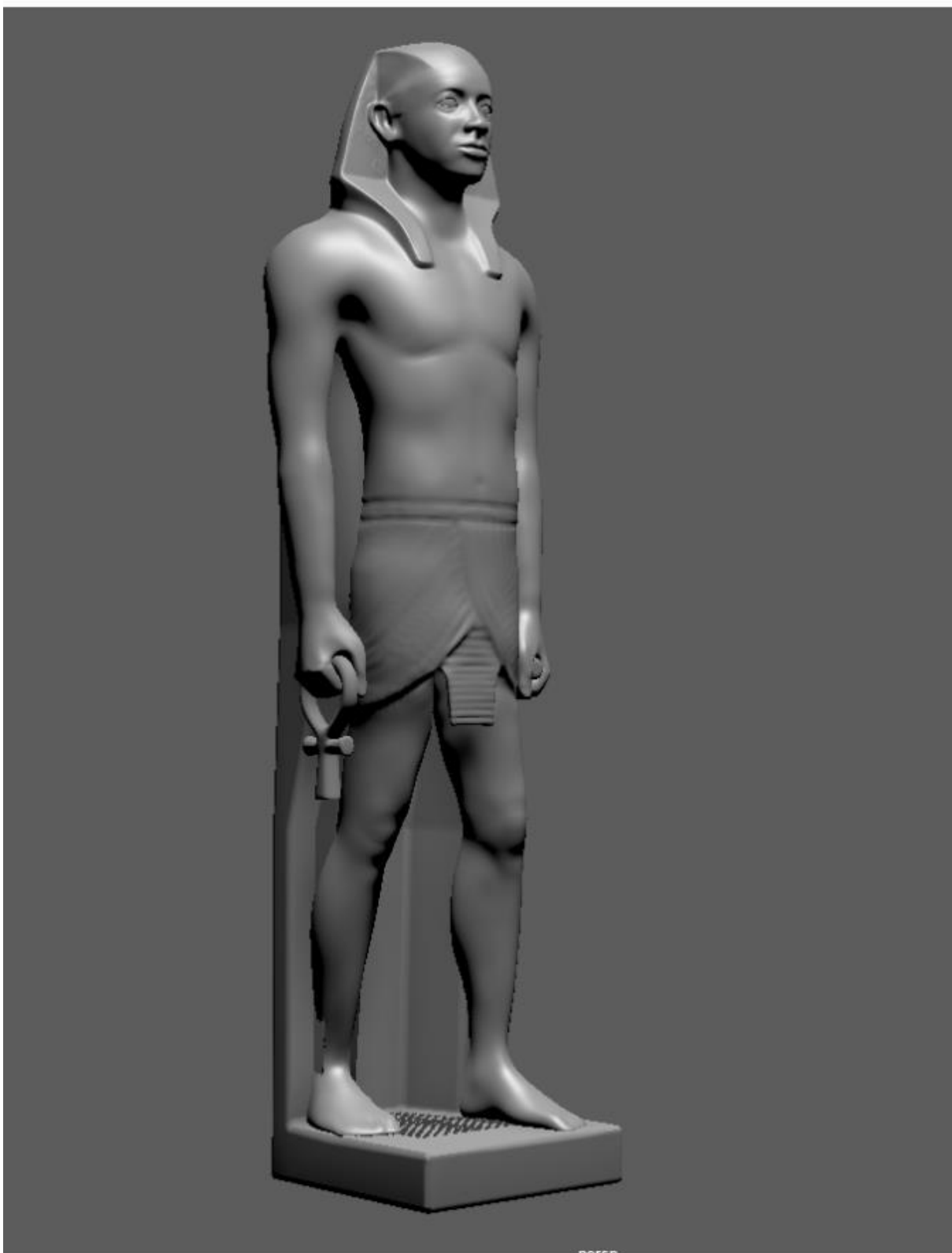

Statues of Karnak. Sourced from: https://commons.wikimedia.org/wiki/File:Karnak_temple_statues.jpg

I began with a default human mesh in Zbrush, which gave me quick proportions....although these had to be heavily modified.

104

The base and ankh were modelled in maya. And the final was sent to Substance Painter for detailing.

APPENDIX N
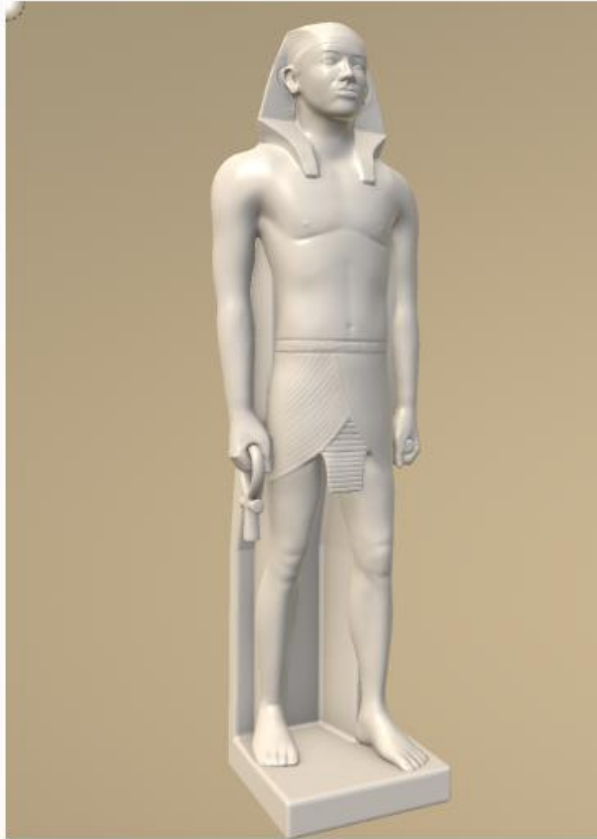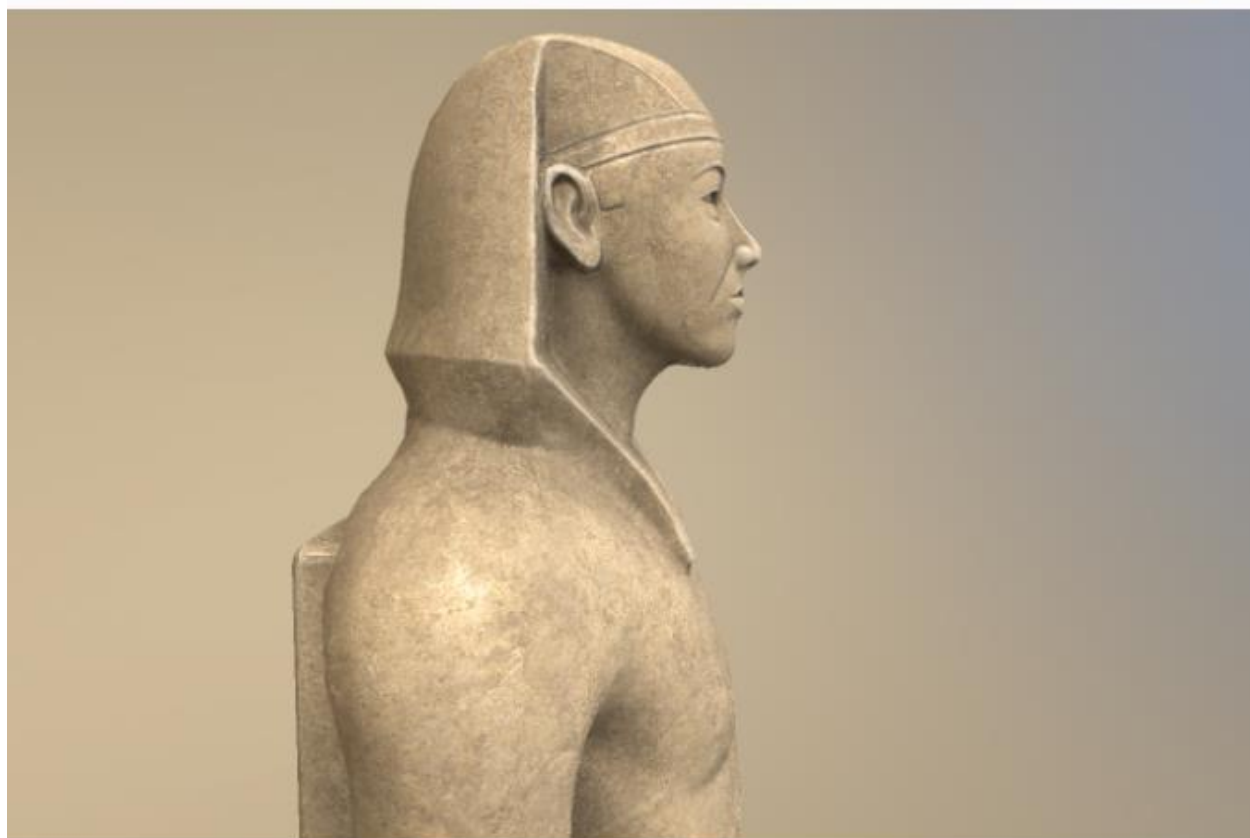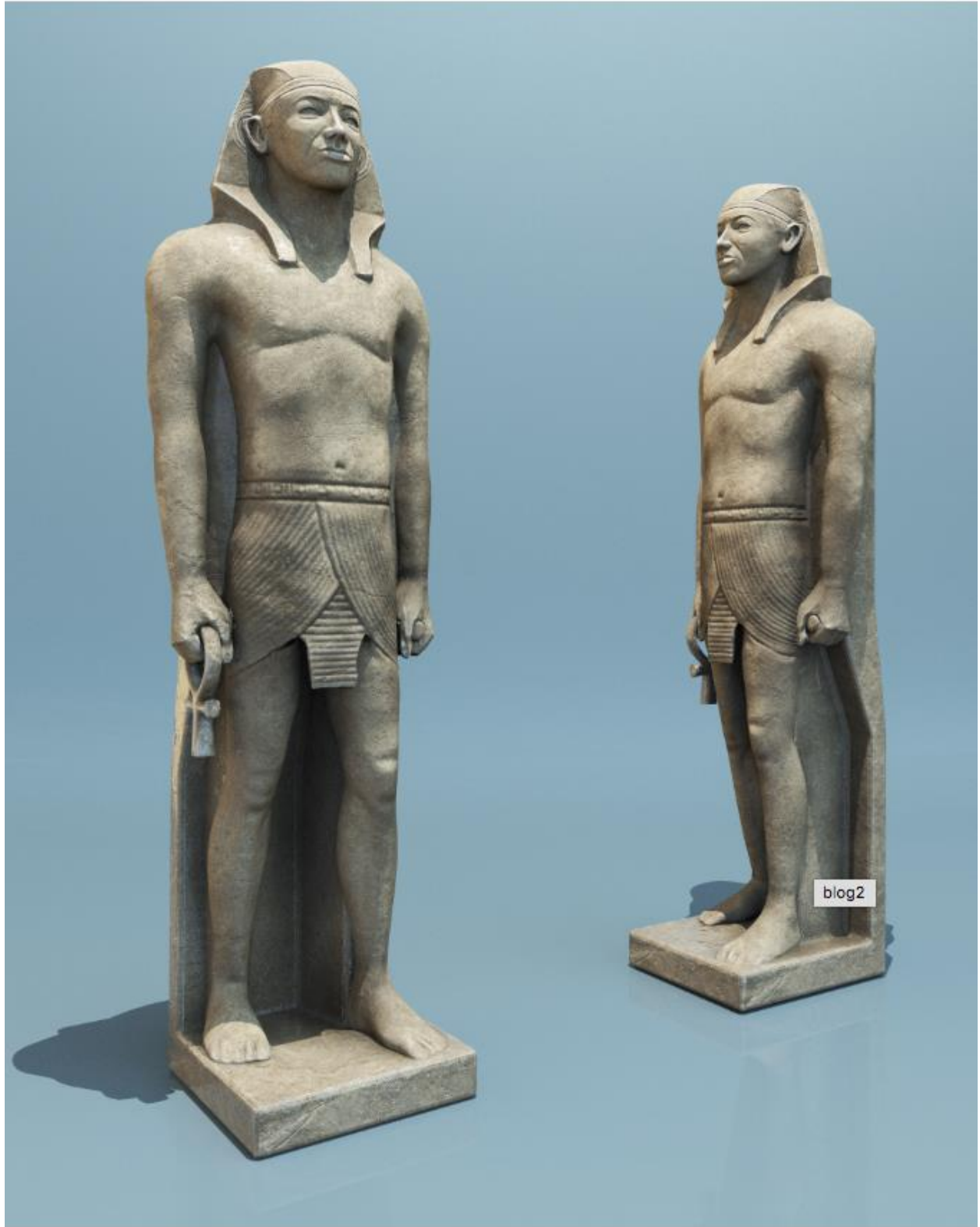
Unreal: https://elhibeh.blog/2017/07/29/unreal/

Texturing the walls and hidden stairway was the last part of the temple to be textured. I was able to bring all the components into Unreal on time. In Unreal, I began to look at lighting. This posed some technical issues, particularly when baking out a lighmass. However, these set backs were eventualy overcome.
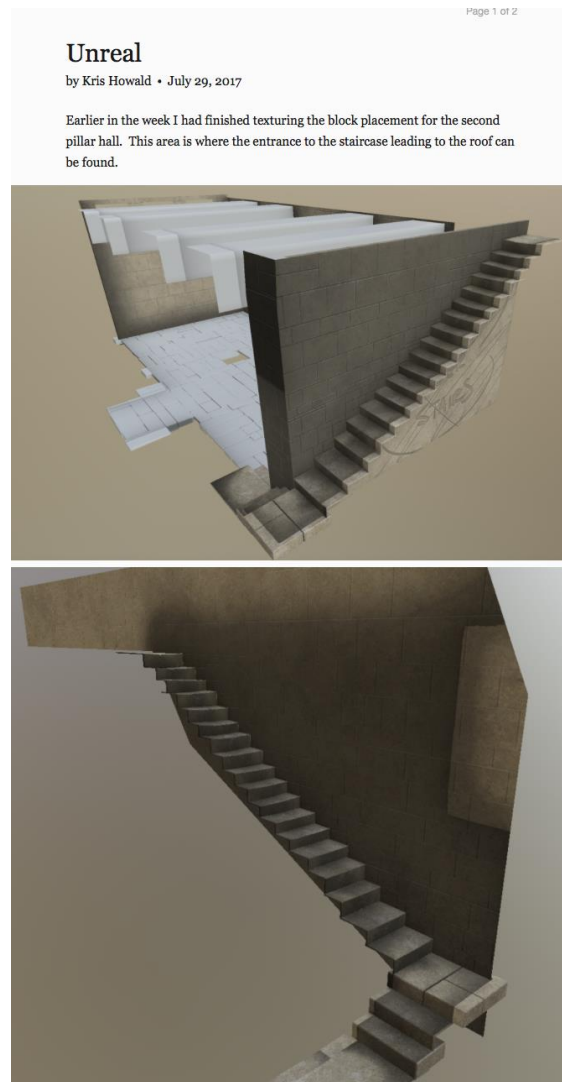
So, yesterday after a lot of fussing with naming conventions in Maya, I brought the temple into the Unreal Engine. It's a big milestone for me. I had been testing the process out over the past few months on smaller sections, but this time the entire temple was exported out. From this point on, the majority of the work will be done in unreal, with the exception of texture enhancements (like adding in hieroglyphs).
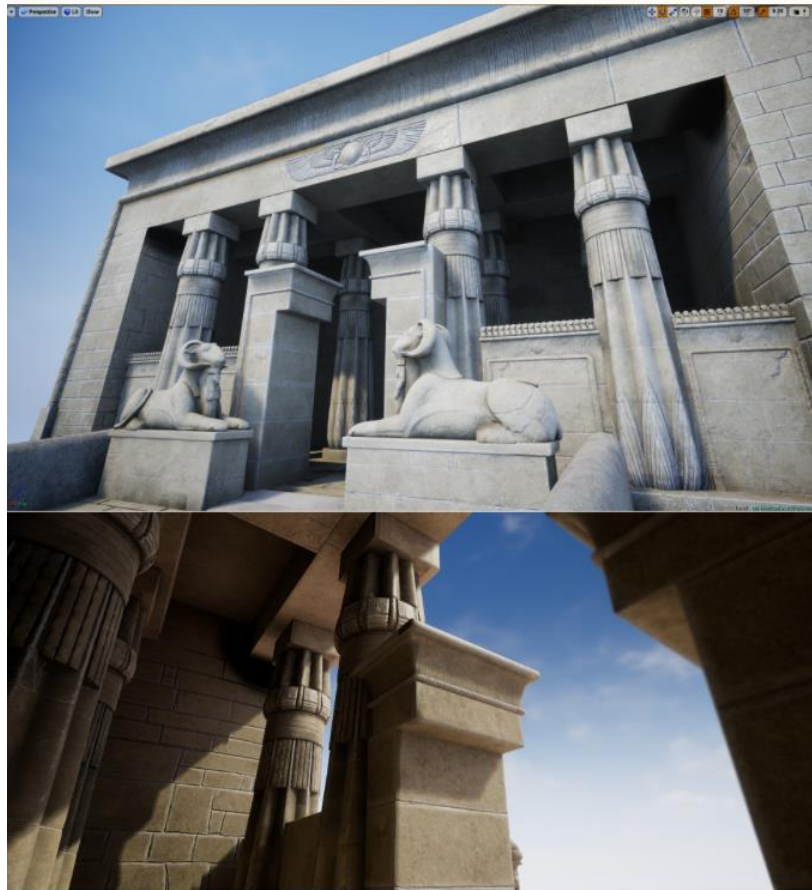
I'm impressed with the dynamic lighting capabilities of the software (even though I still need to read up on Unreal's ins and outs). I particularly like how the lighting adjusts as you move into darker areas...very cool.

I did run into some issues with the floor tiles. It seems, that there is an issue with the light maps that are generated in the shadowy areas, causing the floor to look very quilted. Hopefully I can solve this without going back to Maya and Substance.

AFTER—
BLOTCHY AREAS
IN SHADOWS
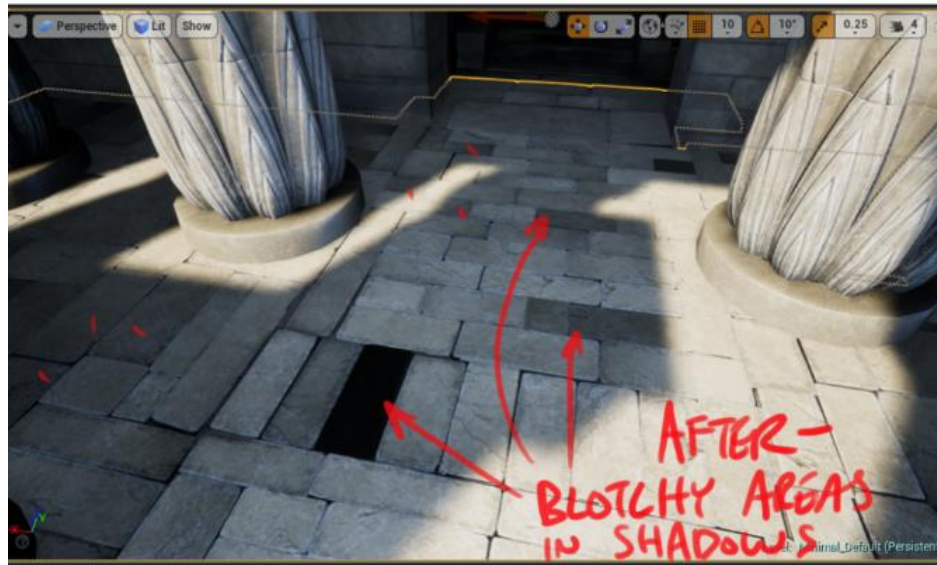
Carlos Santos did a fantastic job translating the topological data of the surrounding area into 3D. I'm going to bring this model into Unreal, to use as reference. I'd like to experiment a little with Unreal's terrain builder. I believe it is optimized for larger areas of geometry.

SURROUNDING MUD BRICK WALL

STPT2 STPT1

STT 1-9 (MAIN)

STT B

EL HIBEH EXCAVATIONS 2002
Temenos Area and
Areas of Excavation

SCALE 1m=750m
0   18.75   37.5

SCALE 1m=3000m
0   75   150

AREA FOR VIRTUAL ENVIRONMENT
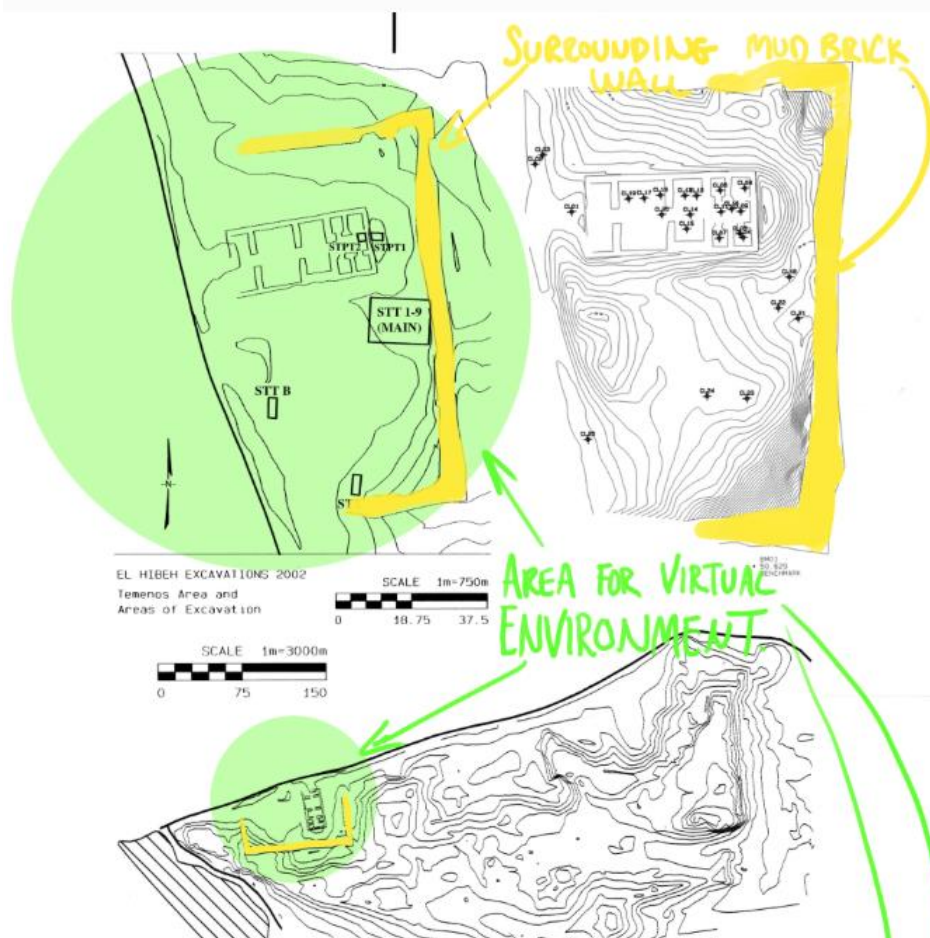
A reasonable area for the virtual environment.
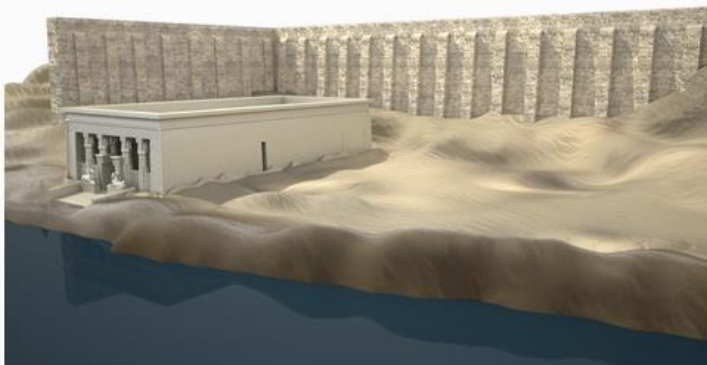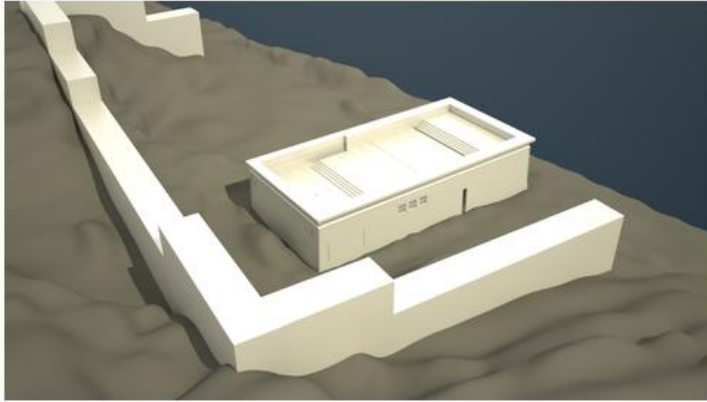
REFERENCES

Arnold, D. (1999). Temples of the last pharaohs. Oxford University Press, USA.

Beale, G., & Reilly, P. (2014). Additive Archaeology: the spirit of virtual archaeology reprinted. *Archaeological Research in the Digital Age: Proceedings of the 1st Conference on Computer Applications and Quantitative Methods in Archaeology Greek Chapter (CAA-GR), Institute for Mediterranean Studies - Foundation of Research and Technology (IMS-FORTH)*, (1996), 122–130.

Benjamin, W. (1936). The work of art in the age of mechanical reproduction The Work of Art in the Age of Mechanical Reproduction, (1936), 211–244. https://doi.org/10.1525/rep.1999.66.1.01p0039u

Boismier, W. A., & Reilly, P. (1988). Expanding the Role of Computer Graphics in the Analysis of Survey Data. *Computer and Quantitative Methods in Archaeology*, 221–225.

Carter, M. (2017). The Life of Attributes : Meta and Paradata As 3D Point and Object Dna for Heritage Providence.

Dawson, P., Levy, R., & Lyons, N. (2011). " Breaking the fourth wall ": 3D virtual worlds as tools for knowledge repatriation in archaeology. https://doi.org/10.1177/1469605311417064

Digital Trends Staff. (2016). Oculus Rift vs. HTC Vive | Spec Comparison | Digital Trends. Retrieved August 31, 2017, from https://www.digitaltrends.com/virtual-reality/oculus-rift-vs-htc-vive/

Ewen, M. (2015, January). Question of the Week: How tall were ancient Egyptians? Retrieved August 31, 2017, from https://blogs.ucl.ac.uk/researchers-in-museums/2015/01/21/question-of-the-week-how-tall-were-ancient-egyptians/

Forte, M., Issavi, J., Onsurez, L., & Lercari, N. (2012). 3D Archaeology at Çatalhöyük. *International Journal of Heritage in the Digital Era*, *1*(3), 351–378.

Hardawar, D. (2017). Watch HTC Vive's wireless VR adapter and object tracker in action. Retrieved April 18, 2017, from https://www.engadget.com/2017/01/07/watch-htc-vive-s-wireless-adapter-and-object-tracker-in-action/

Huggett, J. (2015). Challenging Digital Archaeology. *Open Archaeology*, *1*(1), 79–85. https://doi.org/10.1515/opar-2015-0003

Ingold, T. (2011). *Being Alive: Essays on Movement, Knowledge and Description*. Routledge.

Jeffrey, S. (2015). Challenging Heritage Visualisation: Beauty, Aura and Democratisation. *Open*

Archaeology, *1*, 144–152. https://doi.org/10.1515/opar-2015-0008

Latour, B., & Lowe, A. (2011). « La migration de l'aura ou comment explorer un original par le biais de ses fac-similés » Bruno Latour, Adam Lowe et Eduardo Ralickas. *History and Theory*, (17), 173–191. https://doi.org/10.7202/1005756ar

Moon, M. (2017). HTC Vive can do wireless VR with this $220 add-on. Retrieved April 20, 2017, from https://www.engadget.com/2016/11/10/220-htc-vive-wireless-add-on/

Ranke, H., Abel, H., & Breith, B. (1926). Koptische Friedhöfe bei Karâra und der Amontempel Scheschonks I bei El Hibe. Bericht über die badischen Grabungen in Agypten in den Wintern 1913 und 1914 ... Unter Mitwirkung von Hans Abel und Karl Breith herausgegeben von H. Ranke. [With plates.]. Pp. vii. 69. Berlin & Leipzig

Reilly, P. (1988). *Three-Dimensional Graphics at Sutton Hoo: Some Preliminary Investigations*.

Reilly, P. (1989). Data visualization in archaeology. *IBM Systems Journal*, *28*(4), 569–579. https://doi.org/10.1147/sj.284.0569

Reilly, P. (1991). Towards a Virtual Archaeology. *CAA90. Computer Applications and Quantitative Methods in Archaeology 1990*, 132–139. Retrieved from http://caaconference.org/proceedings/paper/21_reilly_caa_1990/

Reilly, P. (1996a). Access to Insights: Stimulating archaeological visualisation in the 1990's. In I. Gedai (Ed.), *The Future of Our Past "93—"95 Access to Insights: stimulating archaeological visualisation in the 1990's* (pp. 38–51). Hungarian National Museum.

Reilly, P. (1996b). Access to Insights: stimulating archaeological visualisation in the 1990s. In *The Future of Our Past "93-"95* (pp. 38–51). International Conference of Infomatics.

Reilly, P. (2015). Palimpsests of Immaterial Assemblages Taken out of Context: Tracing Pompeians from the Void into the Digital. *Norwegian Archaeological Review*, *3652*(November), 1–16. https://doi.org/10.1080/00293652.2015.1086812

Reilly, P., Todd, S., & Walter, A. (2016). Rediscovering and modernising the digital Old Minster of Winchester. *Digital Applications in Archaeology and Cultural Heritage*, *3*(2), 33–41. https://doi.org/10.1016/j.daach.2016.04.001

Seymour, M. (2014). Disney's new Production Renderer "Hyperion" – Yes, Disney! | fxguide. Retrieved August 21, 2017, from https://www.fxguide.com/featured/disneys-new-production-renderer-hyperion-yes-disney/

Shanks, M., & Tilley, C. (1987). Re-Constructing Archaeology. *Re-Constructing Archaeology*, 287.

Slater, M., & Wilbur, S. (1997). A Framework for Immersive Virtual Environments (FIVE): Speculations on the Role of Presence in Virtual Environments, *6*(6), 603–616.

Sullivan, E. (2016). Potential Pasts: Taking a Humanistic Approach to Computer Visualization of Ancient Landscapes, 71–88.

Vlemmix, B. (2017). Press Release: Manus VR Development Kit Now Available. Retrieved April 20, 2017, from https://manus-vr.com/blogview.php?blog=20170301article

Watterson, A. (2015). Beyond Digital Dwelling: Re-thinking Interpretive Visualisation in Archaeology. *Open Archaeology*, *1*(1), 119–130. https://doi.org/10.1515/opar-2015-0006

Wenke, R. J. (1984). *Archaeological Investigations at El-Hibeh 1980: Preliminary Report (American Research Center in Egypt Reports 9)*. Undena, Malibu.

Witcomb, A. (2010). Remembering the dead by affecting the living : the case of a miniature model of Treblinka. In S. H. Dudley (Ed.), *Museum materialities : objects, engagements, interpretations* (p. 14). New York, N.Y.: Routledge. Retrieved from http://hdl.handle.net/10536/DRO/DU:30029418