Ancient Egyptian Tomb: CG Reconstruction and Visualization in 3ds Max

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Learning Objectives

- Discover CG technologies related to Egyptology.
- Discover some techniques and workflow used for visualization in 3ds Max.
- Discover a workflow used for visualization in 3ds Max.
- Discover a new vision of architecture visualization.

Description

This class will be an amazing experience. We will show you a new way to use 3ds Max software and other computer graphics (CG) tools in collaboration with historians, such as Egyptologists, to reconstruct heritage architecture and other monuments. The class will consist of two parts. The first part will be a quick review of the ancient Egyptian tombs, the way they were built, and why they have been destroyed. The second part will address techniques used for CG reconstruction of a masterpiece—the tomb of Nefertari. You'll see the complete workflow from idea to final visualization. We'll show how textures were reconstructed in Adobe Photoshop, and how 3D models were created and textured in 3ds Max software, then lit and rendered using Corona Renderer. This reconstruction was presented for a 360-degree clip for planetarium use and a stereoscopic clip for National Geographic.

Speaker

Head of architectural visualization at Architect Design company. I gave presentations at Autodesk events, CG Events. Wrote a book on mental ray; made 3D-reconstructions of Nefertari's tomb; regular sports; photography of urban and natural landscapes.
Before you start reading please download the presentation or watch video recording of this class. Thank you.

https://youtu.be/DDYj5bLkwTM Complete recording of this class.

My report today is focused on the architecture of Ancient Egypt. I want to share a story with you... to tell about my project. It is a reconstruction of the stunningly beautiful Egyptian tomb, which belonged to Nefertari, wife of Rameses the Great.

A little warning, or a disclaimer if you wish. This project was created not by professional historians or Egyptologists, but by people who are simply fond of Ancient Egypt and study its history, religion, art, language, and culture.

Before I start telling you about who Nefertari was, I wish to point out two most significant events in the history of this reconstruction project.

First, I have participated in the temporary exhibition "Queen of Egypt" in 2019 at the National Geographic Museum in Washington DC.

I have provided a 3D model of the reconstruction of the tomb for this exhibition. It was shown on a huge screen. It was a three-minutes stereoscopic documentary.

Special thanks to Catherin and Fred for inviting me. It was a real honor for me to work with these wonderful people.

And the second significant event for the project was a large demonstration on a giant one hundred twenty feet spherical screen, which is located in the planetarium in St. Petersburg. The show was incredible and breathtaking.

Before I start with the technical part of my lecture, let me give you a short historical tour. So, who was Nefertari, whose tomb we will be discussing today?

Nefertari was an Ancient Egyptian Queen, wife of Rameses the Great who ruled Egypt in the 13th century BC. This was the golden age of Egypt. Ramses loved his wife deeply. A proof of that is the temple he ordered to build far in the south of Egypt, dedicated to Hathor, the goddess of Love, and to Nefertari. Nefertari was a highly educated woman. She kept diplomatic correspondence and also held the highest female priestly title, "God’s Wife of Amun" Nefertari passed away when she was about 45 years old, as is evidenced by the analysis of fragments of her mummy.

Now let us move to Luxor, on the western bank of the Nile river. Here we will get acquainted with Nefertari’s tomb, learn some details about it, its value, and the problems associated with it. Now on the screen, you see aerial photographs of the necropolis called Valley of the Queens.

To the left you see the diagram of Nefertari’s tomb and its location in the necropolis. The tomb is marked with a red circle.

The tomb was discovered in 1904 by the Italian archaeological mission led by Ernesto Schiaparelli. Here is a picture of the excavation chronicles. At that time, a complete photographic record of the entire tomb was made. Unfortunately, not all the archive photos have survived to this day.
The tomb was closed for visitors and tourists in the 1930s (nineteen-thirtees). I will tell you why a bit later... Then, in the early 60s, another large photographic record was made – this time, using color film.

Based on these pictures we can assess the condition of the tomb and the colors of its decorations.

A few words about how the tombs were built. This information is important for better understanding of the matter, the purpose of the project and the difficulties I’ve faced on the way. Let’s take a look at this image from right to left. First, the tomb was cut in rock. Then a layer of plaster was applied to the rough walls. On top of it the priest sketched the main images and texts. After that, artists began to work, drawing images in more details for the sculptors. The sculptors then carved the reliefs in plaster, which were later painted by the artists.

Another important thing I have to underline is that the texture of limestone in the Valley of the Queens is very poor. It contains a lot of salt, which starts to crystallize actively as soon as it is exposed to moisture. The salt crystals displace the painted plaster, which has already led to damage of some of the painted reliefs.

When we breathe, we breathe out a small amount of moisture. A large number of tourists visited this magnificent beautiful tomb at the beginning of the last century. This has taken its toll. The salts in the walls started to crystallize actively and pushed out the painted plaster of the tomb walls.

On this slide you can see how drastically fast the tomb started to collapse after its discovery. The picture on the left is an archive photo taken back in 1904. On the right you can see the same wall – this photo was taken only 60 years later. Just imagine, that this extremely valuable cultural, artistic, and religious monument was built more than three thousand years ago.

From 1986 to 1992, the Getty Conservation Institute, along with the Egyptian Ministry of Antiquities, carried out work on the conservation of Nefertari’s Tomb in order to protect it from further destruction. Here are several photos.

On the left we see a photo of the tomb’s state in 1904 right after its discovery. On the right is a modern photo taken after the work performed by the Getty Conservation Institute.

Now let’s proceed directly to the technical part of the project.

Like any 3D project, it all starts with modeling.

I want to note that I did not have any sketches. All I had was a top view plan and one section. This plan didn’t even have dimensions. I have taken the dimensions from books and articles describing the tomb. Then I’ve adjusted the scale roughly.

After some time I have found more accurate charts and additional sections in one of the books. And only this spring I got a chance to visit the Museum of Egyptian Antiquities in Turin, Italy. As part of our agreement on a joint project, the museum employees have showed me the exact charts. As a result, the 3D tomb was re-modeled three times.

There is an Egyptology website, osirisnet.net. It has a rough 3D model of the tomb in very low texture resolution. However, thanks to that model, I was able to build a template for texts and images arrangement of the entire tomb.

Very few items were found in the tomb of Nefertari, and most of them were badly damaged.
I made some 3D models of objects and artifacts from the tomb of Nefertari itself, using the fragments that have survived. I have also created additional objects based on the objects from other tombs of the same historical period. I did this to give a better idea of what Nefertari's tomb might have looked like at the time of its construction. However, as of now I've made very few items. There were actually many more.

And how many more? You can imagine if you remember Tutankhamun’s tomb. And just think, his tomb is 5 times smaller than the tomb of Nefertari. Perhaps in the future, once I have studied more grave goods that have survived from similar tombs, I will create even more objects to convey the mood of the Ancient Egyptian tomb. Thus, not only the walls will be restored, but also the grave goods.

On the initial stages of my work, in order to create textures I was using photos from open sources on the Internet.

After a while on social networks, I called out to the fans of Ancient Egypt to share theirs ... And people responded, shared their photos and thereby also contributed to the development of this project. So special thanks to them.

Before I start talking about texturing, I want to tell you about the work we have done together with

Olga Ermakova, an experienced translator of Ancient Egyptian texts.

For 2 years I've been studying the basics of Ancient Egyptian Hieroglyphic writing. Then Olga and I have restored images and texts of the tomb from its archive and contemporary photos.

The Tomb of Nefertari, in fact, contains images and texts from the so-called Book of the Dead.

We have restored the text fragments which were lost irretrievably based on the similar chapters of the Book of the Dead, of the same historical period.

A colossal work was done, with help of my friends, who are proficient in Adobe Photoshop. Special thanks to Alexei Panov, who has helped me on the initial stages of the project and taught me the tools and techniques for the tasks at hand.

Now I want to tell you more about texture maps. This is the most important and the most complex part of the project. First, I've collected a palette of all primary colors and their shades. Then I started drawing texture maps.

I've combined different photos into a single image. To some arts I had to give the finishing touch, while some of them I had to draw from scratch.

I drew some textures from scratch. The images were on curved surfaces.

As I have already mentioned earlier, at first, I made some kind of template. Then on top of it I drew the images collected from numerous photos from various sources.

The crumbling parts were restored in Adobe Photoshop by the standard method of cloning adjacent areas of the image. However, there were other, more difficult tasks. For example, it was necessary to restore an image of an Egyptian deity that has not survived. As a basis I used a similar image from another tomb. Then I redrew it, bringing it in line with the general style of Nefertari’s tomb.
Thanks to Alexey Panov for these techniques and tips for working in Photoshop. We have spent much time studying Ancient Egyptian texts and understanding Ancient Egyptian art. The whole process of restoring the textures took about four years.

And so, in a separate layer, I created the "collapse" mask. We need it to be able to work with a 3D model of Nefertari’s tomb in two states:

First, what the tomb looked like at the time of its construction in the 13th century BC, ... here's an example of overlaying the masks ... Second, here is how it has survived to the present day.

I’ve created Normal and Displacement maps in the free Materialize application. Its only drawback is that 8K normal maps produce artifacts, so for Normal and Displacement maps I had to use 6K resolution.

As a result, I got the following basic texture maps of the tomb walls. In case someone is interested in statistics. All texture maps are in 6-8K resolution. The total amount of data occupies 6.5 Gigabytes on the disk.

It's time to talk about shaders. At first, I was using very complex shaders. A separate stone shader, highlighted in red, was mixed in a Blend shader with the surviving paintings to give a look of wholeness to the entire tomb.

The stone shader is highlighted on the screen, with a lot of texture maps having coordinates of Real-World Map Size.

To simplify the work with texture maps and their sizes, I came up with a trick. I used texture maps with the same aspect ratio. I also used one controller to set a single value for UV coordinates, i.e. in width and height.

And to animate the transition from one state of the tomb to another I used an animated Noise Map with a "collapse" mask.

Here is the result of this most complex shader. You can see the smooth transition of partially destroyed walls to fully restored ones. And pay attention to the lighting, its play, overflows and flickering. Now I will share my technique, how I achieved this kind of lighting. How I’ve given a hint of magic and mystery to the tomb.

Now let's do some light magic.

For the lighting, I used CoronaLight and controllers for the intensity and color temperature of the light.

Then I applied a List controller to these two parameters to set two managing controllers. The first is Noise Float – it gives a little randomness to the intensity and color values. The second is Linear Float to control an integer value for luminous intensity and color.

This is the result you can get with simple manipulations with controllers. To create some randomness, I used copies of the lights with different Seed values in their parameters.

I want to show you a couple of examples of real photography and 3D reconstruction. This is the upper level room of the tomb. This is the lower room, the so-called burial chamber with a restored sarcophagus in the center.

I would like to express my joy and thanks to the Autodesk 3ds Max development team.
Let me remind you that the project is already more than five years old. Technologies have leaped forward significantly. Thanks to that, the appearance of the tomb can be further improved.

Please pay attention to the highlighted area.

In 3ds max 2021, the updated Chamfer tool has a function to save the projection of texture coordinates. Corona Render 5 introduces a 2.5D-displacement function that does not require a huge amount of memory for calculations.

Using these two new functions, you can set the softness of the edges and the roughness of the relief. They add even more realism to the tomb model.

All this can be used as modifiers without complicating the geometry of the base model.

Having placed all objects and light sources, having applied all texture maps, I can start the rendering process. I’ve already mentioned that I am using Corona Renderer. Now I will briefly tell you why.

I like Corona Renderer because it has a minimal amount of settings and optimizations. All your time can be devoted to the creative, not the technical component of the project.

I especially like the paradigm of setting render times for static images and limiting the passes for animation rendering.

I would also like to note one very useful and convenient updated tool called Bake to Texture. Thanks to the tool I’ve baked the model textures for placement on Sketchfab. Then I applied these textures to a 3d model of the tomb, exported it in FBX format and posted it on the Sketchfab website.

As a result of the work done, the restoration of wall paintings, the preservation of the so-called "collapse mask", it became possible to look at the digital model of the tomb in its current state and its restored state. This can be useful for professional Egyptologists for a comprehensive study of the tomb. The 3D model allows you to see patterns and relationships that might be missed while looking at the photos of each wall separately.

Also the restored 3D model will help you not imagine what could have been there, but rather see this visualization. That, in turn, will simplify the task of deciphering the symbolism, images and texts of the tomb.

In addition, thanks to digital technology and Egyptological research, one can not only imagine, but also see the restored tomb. It should be an interesting and exciting sight for ordinary people, not professionals, but simply people who are interested in the culture and art of Ancient Egypt.

By the way, speaking of the fans of Ancient Egypt. I was very fortunate. In course of my studies of the language, culture and art of Ancient Egypt, I have met many interesting people, both professional Egyptologists and simply fans. Many of them became my friends and colleagues in this project. I want to thank all my friends, colleagues and relatives who have supported and helped me with this project over the years.

Regarding the sources ... All the information, photographs and drawings used have been borrowed from various printed publications and Internet resources.

But that's not all. What does the future hold for us? In fact, the future is already here.
Earlier I have mentioned the sketchfab service. So, even now you can already see both versions of the tomb, in its current state and its restored state.

Just go to sketfab.com and search for Nefertari. The results will include three versions.

The first version is a restored tomb with authentic lamps and a light temperature of about 2000 degrees Kelvin;

The second version is an intermediate version and a light version that will open even on your cell-phone;

The third option is a 3D model of the tomb, in the state it is in now. I have used fluorescent lamps and a light temperature of 6000 degrees on the Kelvin scale on purpose. So that you could see the real colors of the tomb.

As you watch a 3D model on a sufficiently powerful computer, I recommend turning on the "Textures in high resolution" option.

If you have VR equipment, you can walk around Nefertari’s tomb in any of its versions. Admire the art of Ancient Egypt and the subtleties of artistic execution of reliefs created by ancient artisans ...

In conclusion, a couple of words about the project, about what it used to be and what it has become. At the end of 2015, I just got carried away with Egyptian culture. I started listening to lectures and watching documentaries about Ancient Egypt. I decided to make a simple 3D model for myself, just like a hobby. However, this fascinated me so much, as a result, not only me alone ... And this simple 3D model has grown into a scientific, non-commercial project for the digital restoration of Nefertari’s tomb. The project was noticed by National Geographic. There were several articles about it in Egyptian periodicals. There was a radio broadcast in Russia on a federal radio station. I hope that I was able not only to tell you about some interesting technical features of working with Autodesk 3ds Max, but also to inspire you to fulfill your own ideas. After all, technologies and software allow you to fulfill your dreams today!

If you have any questions or suggestions regarding technologies or the project itself, feel free to contact me directly via e-mail scionik@mail.ru. Thank you all for your attention.