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ANTH 258/ CIS 106

Visualizing the Past/Peopling the Past

Assignment 6

December 21, 2018

**Canal and Causeway Navigation in the Bolivian Amazon**

**Introduction**

Individuals today are fascinated by the past. This strong interest is rooted in curiosity of the unknown: from discovering true identities to understanding unique customs that were passed from generation to generation (Gero and Root, 1990). In addition, this fascination of the past connects to the public’s strong intrigue of archeology. However, interest with archeology is heavily built upon the media’s portrayal of this field linked to a sense of discovery. For example, some fictional works that create this sense of discovery are *Indiana Jones*, the *Tomb Raider* series and the *Uncharted* series, which are based on the concept of solving a mystery by discovering an artifact or a city that has been forgotten for centuries (Rubio-Campillo et al. 2017). We can also see this fascination in non-fiction works. For example, *Time Team* and *National Geographic*, promote a sense of wonder while emphasizing the rigorous actions involved in archaeological research (Rubio-Campillo et al. 2017).

We can exploit this fascination with discovery while also explaining what archeology is really about to the public. In this paper, my final project aims to use modern technology to create a static environment scene, which promotes a sense of discovery while displaying key characteristics of the individuals of the Baures Region. These attributes include their modes of transportation and communication, and how their land was modified.

**Background**

*Baures Region*

The Baures Region is an expansive landscape of seasonally flooded grassland savannas, permanent wetlands, lakes, forest islands, and closed canopy forests in the Amazon Basin of northeast Bolivia. Much of the landscape is submerged beneath a thin layer of water during the wet season, leading to rivers and lakes filled with fish and other aquatic species throughout the year which migrate across the savannas during floods. In fact, the Baures Region also experiences a dry season which contrasts the flooding of the wet season, as the water is extremely scarce in the land (Erickson 2009).

*Earthworks and Settlements*

The inhabitants of the Bolivian Amazon created a highly patterned landscape of earthworks and settlements due to this region’s inundation of water during the wet seasons. Earthworks include raised fields, settlement mounds, causeways, canals, reservoirs, and fish weirs (Erickson and Walker 2009). These earthworks all aided in compensating for the extreme flooding of the grasslands, as well as taking of advantages of the flood’s positive effects, such as bringing in fish and other aquatic species to the civilization.

In addition, thousands of forest islands are found in the savannas of the Bolivian Amazon. The forest islands of the Baures region are the eroded natural upwellings of the Brazilian Shield Formation that form low islands raised slightly above the maximum flood level within the grassland savannas and wetlands. Most forest islands in the Bolivian Amazon are largely anthropogenic settlement mounds of small farming communities, house gardens, and orchards that are often surrounded by raised fields, fish weirs, and causeways and canal networks (Erickson 2006). The number and scale of earthworks implies that these native populations were large and thriving.

*Causeways and Canals*

A connection was needed between these large forest islands, leading individuals of Baures in northeastern Bolivia to create a complicated, dense network of long linear causeways and canals (Balée and Erickson 2006). Thousands of kilometers of causeways and canals are present in this zone, most of which are remarkably straight and several kilometers long. Many causeways intersect and some connect to other causeways. In some cases, two to four causeways are constructed parallel to each other to allow individuals to travel across the flooded grasslands efficiently to other forest islands in the region (Erickson 2006). On the other hand, many causeways also form radial patterns from a common source, usually located on a forest island (Erickson 2009), acting as roads to travel to other settlements.

In terms of their physical attributes, causeways are flanked by adjacent canals on one or both sides where earth was removed to raise the raised road platform. Today, causeways are still visible from an aerial view as dark straight lines of trees and other foliage which contrast the vast grasses of the savanna (Figure 1). On the other hand, canals are marked by aquatic vegetation and calm water during the wet season and darker vegetation and soils during the dry season (Erickson and Walker 2009).

In addition, the builders' obsession with straightness over long distances, and the large number of these features suggest that the causeway and canal innovations may have actually had political and ritual functions, possibly associated with astronomy, calendric, or specific ceremonies (Erickson 2006). Furthermore, some other functions of causeways and canals included transport, communication, water management, fisheries, and monumental built environments.

*Modes of Transportation and Communication*

The causeways and canals primarily served for transportation and communication purposes between villages and towns located on forest islands (Erickson 2006). The individuals in the Baures region would utilize these landscape innovations by both foot and by canoe. Foot traffic was utilized on the raised roadways, and throughout much of the year, canoe traffic was used in the canals (Erickson 2006). The causeways and canals were also used for the circulation of farmers and goods between settlements, their fields, and the resources of the river and forest (Erickson and Walker 2009).

Although numerous rivers provided the most accessible year-round means of transportation and communication for canoe-using communities, these straight artificial causeways and canals parallel to the rivers were more direct routes than following the winding river, ultimately reducing travel time. Most settlements were dispersed on numerous forest islands throughout the region, often far form rivers; thus, the causeways and canals opened up the possibility for farmers to live any place on the landscape and still maintain social connections (Erickson and Walker 2009).

The dynamic landscape attracted pre-Columbian farmers of the Bolivian Amazon who took advantage of the seasonal cycles of water inundation. The farmers planted their crops on raised fields duringthe period of flooding, benefitting from the water management provided by the variety of earthworks including causeways, canals, and fish weirs (Erickson and Walker 2009).

*Conclusions*

The main role of causeways and canals in the Bolivian Amazon were for transportation and communication: moving people, goods, and information between settlements in the savanna and along rivers. Canals were particularly useful for moving heavy agricultural produce in canoes from field to settlement and supplying people with resources such as fish, construction materials, wood, and fruits from orchards. To move pedestrians or long, heavily loaded dugout canoes between two points in the landscapes, direct paths provided by canals and causeways is most effective (Erickson 2009).

**Goals**

The initial goal of the project was to create an immersive experience in Unreal Engine 4, where the audience would observe a large section of the Baures Pre-Columbian landscape, showing the connections created from causeways and canals between the forest islands, similar to the artwork by Daniel Brinkmeier (Figure 2). The viewer would navigate through a virtual camera, seeing the large landscape, and stopping at a smaller scaled scene of men and woman getting ready to embark on the canal (Figure 3).

I specifically drew inspiration from a specific painting by Daniel Brinkmeier, a reconstruction of the use of major causeways and canals in the Baures Region. Brinkmeier worked in the Bolivian Amazon and made several trips to Baures and the rest of the region. His artwork displays that he performed extensive research on the material culture, people, dress, sky, vegetation, and landscape for an established context and time. The art shows a busy scene of daily activities of the Baures people (Figure 4). These activities included men loading baskets into canoes in canals, women cooking fish over a fire, and individuals transporting goods along the causeways.

The special aspect of this image that caught my attention was the clear perspective of the canal and causeway, and that the image is easy for an audience to understand. In this reconstruction scene, we see one end of the canal with multiple individuals performing their actions, and we see this canal disappear in the distance, showing the great length of the canals and causeways, and how they were used. In addition, settlement mounds are also present in the background, which completes that missing piece of where these canals go. On first seeing this image, I knew that I wanted to bring this painting to life through the use of the most innovative technology possible.

Once the people, props, earthworks, foliage, and general landscape were modelled and placed in the scene, I would animate the different aspects and have the viewer paddle down the canal with Baure individuals of this Pre-Columbian culture. This first-person experience would surely give the viewer a fully immersive experience of what transportation and communication methods were like in Pre-Columbian society.

Finally, when constructing my landscape scene, it is critical to think about the placement of the various assets to convey a certain message to the audience, as well as in adding content to make the scene come to life. I hope to have my final render encompass three main attributes: having a sense of adventure; having communication between the people; and for the individuals in the civilization to display teamwork.

**Process**

*Unreal Engine 4*

I started my process of creating the Pre-Columbian landscape in the Unreal Engine 4 gaming software. This program is heavily utilized in the gaming industry due to its straightforward approach of creating large landforms. The Sculpt and Erosion Tools were first used to elevate certain parts of the landscape to give the default plane a more natural look of abrasion over time. The Spline Tool was used to create straight lines on the landscape, which enabled these straight lines to be manipulated in a way that was easy to raise and lower these whole sections at once. This was a more efficient way to create the canals and causeways in the landscape, as opposed to manually raising and lowering small portions of the landscape one at a time.

I then created different foliage types varying from palm trees of various sizes and shapes to small bushes to populate my landscape. These foliage types were from the Low-Poly Rain Forest Library in the Unity program. These different types of plants and trees were then painted throughout the landscape similar to reference images of Baures today (Figure 1).

*AutoDesk Maya*

Although Unreal Engine 4 was a great software to utilize, the project was moved to the Maya program due to visual difficulties in the use of the Unreal Engine. Maya is a unique software where modeling, rigging, shading, lighting, and rendering of large scale scenes could all be executed simultaneously, which is an efficient and powerful tool.

*Modeling of the Landscape*

Because of the intentionality, design, and engineering used in the Baures construction, causeways and canals are classified as formal roadsrather than informal trails or paths. (Erickson and Walker 2009). Due to the great engineering of the causeways and canals, it was important to have my reconstruction landscape scene have these two landscape innovations as the main focal points.

The landscape started with a simple plane in Maya which was greatly manipulated to look like a causeway and canal system. Although the original earthwork construction was done using simple wooden digging sticks and earth moved in baskets (Erickson 2009), I used the Extrusion tool in Maya, to help simulate their processes of creating canals and causeways. The first part of creating the causeway and canals was making a series of extrusions from the simple plane.

A series of faces were selected from the landscape plane for the canal and then these faces were extruded downward to mimic how canals were created where land was dug out of the ground in the landscape. On the other hand, multiple faces on the sides of the canal were also selected and extruded upward to exaggerate the causeways’ raised height.

Once this general shape was finalized on the landscape, I then used a tool in Maya called Transform Components, where I selected all of the vertices in the landscape mesh, and randomly moved them around either up or down, giving the overall landscape a more abraded feel, as the Transform Components tool makes the landscape look a bit more eroded through use and age, rather than perfectly straight and fake looking architectural features.

Another AutoDesk tool was also used called Paint Effects, which is a library of procedurally generated assets from hair to foliage, which I found useful. This tool was used to generate the palm trees; however, I had to do many manipulations to the Paint Effects models to convert them to polygons to allow these models to be recognized as objects when rendered.

*Modeling of Props*

The modeling of props, which are smaller scaled assets, was another important component to my scene as they acted as the main medium to show human interactions with their surroundings. These smaller assets included canoes, pots, and paddles.

The canoes were the first props that I modeled as they are the main focal point of the canal and causeway scene illustrated by Daniel Brinkmeier (Figure 4). Native people in this region and throughout Amazonia relied heavily on water transport. The canoe was a key characteristic of Tropical Forest Culture, and played a prominent role in alliances, warfare, and trade. In fact, canoe transportation is still highly valued in the Baures region today (Erickson 2009).

The canoe was modeled as close as possible to how a real-life canoe is created through manual cutting, carving, and shaping of a large tree trunk. The model started with a large rectangle, and a series of extrusions into the rectangle were made, creating a hollow cavity of the canoe. Then this geometric model was manipulated to create the curved front and back of the canoe using the Soft Selection Tool.

The pottery vessels and baskets were individually modeled by drawing different shaped CV curves, and then revolving these curves around a certain axis depending upon their orientation. This created a single piece of geometry which could be manipulated in various ways to create pottery vessels and baskets that would match the shape and size of those in the scene and work well with the lighting.

*Rigging*

Considerable time was spent on the rigging of two human 3D models: one male and one female (Figures 7 - 8). The gestures and poses of these models had to be recognizable to a viewer since I made the decision that the final scene would be static rather than animated. I tried multiple variations of a specific pose to ultimately create a final body placement pose for each individual in the scene, which I thought an audience would be able to comprehend (Figure 9).

*Shading*

Utilizing another AutoDesk software called Mudbox, I hand painted most of the textures in my landscape scene. This beneficial tool used color to draw the audiences’ attention to certain parts of the scene. For instance, the strong yellow landscape in the bottom right corner of my final render, as well as the saturated blue canal in the bottom left corner of the image emphasizes the distinction between the causeways and canals (Figure 9*)*.

In addition, Bump Maps were applied to every model in the scene after they were finished in the modelling stage and placed in the scene correctly. Bump Maps give the illusion that textures applied to the objects are three dimensional. An example is the man packing up his canoe. The pottery vessels and baskets in the canoe have a bump map applied to each of them with woven and clay textures, which gives the impression that it was actually woven or created from clay (Figure 10).

*Lighting*

To enhance the individual models in the landscape scene, as well as to catch the viewer’s eyes to highlight certain aspects as the main focal points, approximately 30 Area Lights were strategically placed. Certain aspects of each light were taken into consideration such as the color, intensity and exposure. For example, in my final render scene, the bottom right corner has a warmer yellow light projected on it, as opposed to the bottom left corner which has a cooler blue color (Figure 9).

In addition, a Skydome Light was added around the whole scene which also helped illuminate all of the aspects. In the original artwork by Daniel Brinkmeier, the sky is filled with smoke from the annual burning of the savanna, so I tried to simulate warm toned smoke in the distance of my reconstruction model (Figures 4, 5, 11, 12).

*Rendering*

The Arnold Renderer was used to render the final image. Arnold is a physically-based rendering system where all of the lights in the scene are reflected off of certain objects based on their physical attributes, ultimately lighting up other components of the scene as well. This tool simulates how natural lighting works in real life, and was the perfect rendering system to utilize as I wanted to bring a stylized painting to a more realistic-looking image.

**Data**

I rendered five different views of the scene to give the audience various perspectives of the model I created. Each image of one of the scenes took about 10 minutes to render (Figures 9, 10, 11, 12, 13). Ten minutes was a reasonable time for an image to render considering the size and amount of assets in the scene. However, the file was about 250 Mega Bytes and difficult to open the entire scene without crashing or freezing the Maya software.

If this project was repeated, I would use a smaller scale for all assets. In other words, I would have all components stay within the default plane, rather than keep expanding my landscape from the default Maya size when I needed more space for my assets. My large landscape scene and the addition of using Paint Effects with high poly-count for each of the objects produced large files.

**Results**

It was rewarding to see that my three artistic choices of having a sense of adventure; having communication between the people; and for the individuals in the civilization to display teamwork came to fruition in my final renders.

*Sense of Adventure*

Throughout the semester, many of the famous films, comic books, magazines and other modern multimedia about archeology stressed the importance of creating a sense of adventure and discovery (Rubio-Campillo et al. 2017). When developing my landscape scene, I wanted the audience to see the person getting ready for his adventure front and center. This then draws the viewers’ attention down the long canal and causeway to other people that are already on their journeys to distant unspecified places, leading to a feeling of mystery and adventure (Figure 10).

*Communication*

I also wanted to make sure my causeways and canals had great detail and human models placed on them with unique gestures. Foot traffic was used on these raised causeways for transportation and communication between settlements, fields, fish weirs, forests, and rivers. All of these activities rely on physical and social connections between the people across the landscape. The vast network of causeways and canals facilitated and solidified these social processes and integration of a large population (Erickson 2009).

In most reconstruction of the past through images and digital media, clear social interaction between individuals tends to be lacking. So, when I was rigging, I made sure that their gestures suggested that they know that people are around them and for them to appear as if they are interacting (Figure 11).

*Teamwork*

In addition, the causeways and canals were built and used for the circulation of food and other goods between settlements. My final image showed typical everyday products, such as baskets and clay pottery, were being transported in this landscape scene. In the far left of one of my renders two men are shown working together to carry large wooden poles, replicating tree trunks, as well as different types of vessels in the canoes (Figure 12). This part of the scene is based on a photograph of a group of men working together to carry a large heavy log from a forest to their village (Figure 6). In addition, most of the people in the scene are clustered to present an active sense of teamwork by families and neighbors which first captivated my attention in the painting by Daniel Brinkmeier. In the far right of the landscape scene, three men are walking together back to the forest island as well (Figure 12).

**Future Work**

*Modifications to the Final Project*

Since, the pre-Columbian Baure were dispersed over the vast landscape and made use of a complex network of causeways and canals to commute to fields and share labor with neighbors in times of need (Erickson and Walker 2009), I would fill the pottery vessels, baskets, and canoes with agricultural goods and other resources. This addition will give the audience more context on how these individuals lived.

Finally, I would add activity and movement of everyday life to my landscape scene through motion capture and animation of multiple 3D humans. All of the people in the landscape scene are properly rigged; however, this process would require that the props and landscape would also have to be synced to the human model’s motions. With these animations, it would also be great to add everyday sounds of the Baure people and the landscape, as well as enlarging the scene by adding more individuals to show and hear more people interactions.

*Virtual Reality and Games*

Other types of media that I could further develop this project into is video games and virtual reality. This would require me to bring my assets back into the Unreal Engine 4 and create commands on how I would want the player to navigate through the scene to learn more about the civilization. Video games are frequently judged negatively in terms of education, and many scholars have been so focused on analyzing whether they can affect social and individual behavior, that they often ignore their potential benefits (Rubio-Campillo et al. 2017). However, video games can provide a rich perspective on the past that is different than other media such as books or documentaries, which I feel will be beneficial for future generations.

**Conclusion**

We can explain what archeology is really about while incorporating the public’s fascination with discovery. Although many forms of digital and multi-media display the field of archeology and ancient civilizations in a Hollywood-like manner, educating an audience on the process of how the past is depicted is difficult to execute. However, a strong passion for learning about cultural heritage exists in modern culture today. Therefore, due to the public’s steadfast value of the past, these interpretations have the potential to be altered by displaying the past in an accurate representation in future media.

So why are these correct representations in media important? What many Americans know about archaeology comes directly from modern media, or at least serves as an introduction to the subject of the past (Gero and Root 1990). The version of archaeology and the past presented in films, TV shows, magazines, and games are extremely effective in fixing images and transmitting messages about the past into American homes, so it is important when creating these forms of media to include an accurate representation of past civilizations.

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