

Pictures to Models- Dinosaur Photogrammetry

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Introduction

- Specimens Modeled:
 - *Chasmosaurus belli* (UALVP 52613, aka Baby)- This is a baby Chasmosaurus, which was a relative of a Triceratops
 - *Sauronitholestes langstoni* (UALVP 5370) is the North American cousin of the Asian Velociraptor.
 - *Champsosaurus lindoei* (UALVP 931) is not actually a dinosaur! It is an extinct genus of diapsid reptile, that lived a lot like modern crocodiles and alligators.
 - *Aspideretoides allani* (UALVP 1, aka Trionychoidea) An order of soft-shelled fresh water turtles that originated in the Late Jurassic which still has living representatives. This specimen was also the very first in the university's collection
- Technique Used: Photogrammetry
 - The process of taking hundreds of photographs from all sides of a 3D object and then using a program which uses AI and trigonometry to digitally recreate the 3D object in 3D space complete with it's original texture

Modelling

- Step 1: Take hundreds of photos from all sides of the specimen. For this step, a tripod and digital camera were used to ensure the photos taken were not blurry.

Baby	Sauronitholestes	Champsosaurus	Trionychoidea
175 Pictures	244 Pictures	233 Pictures	152 Pictures



Figure 1- Baby being photographed using a digital camera and tripod

Program One: Metashape™

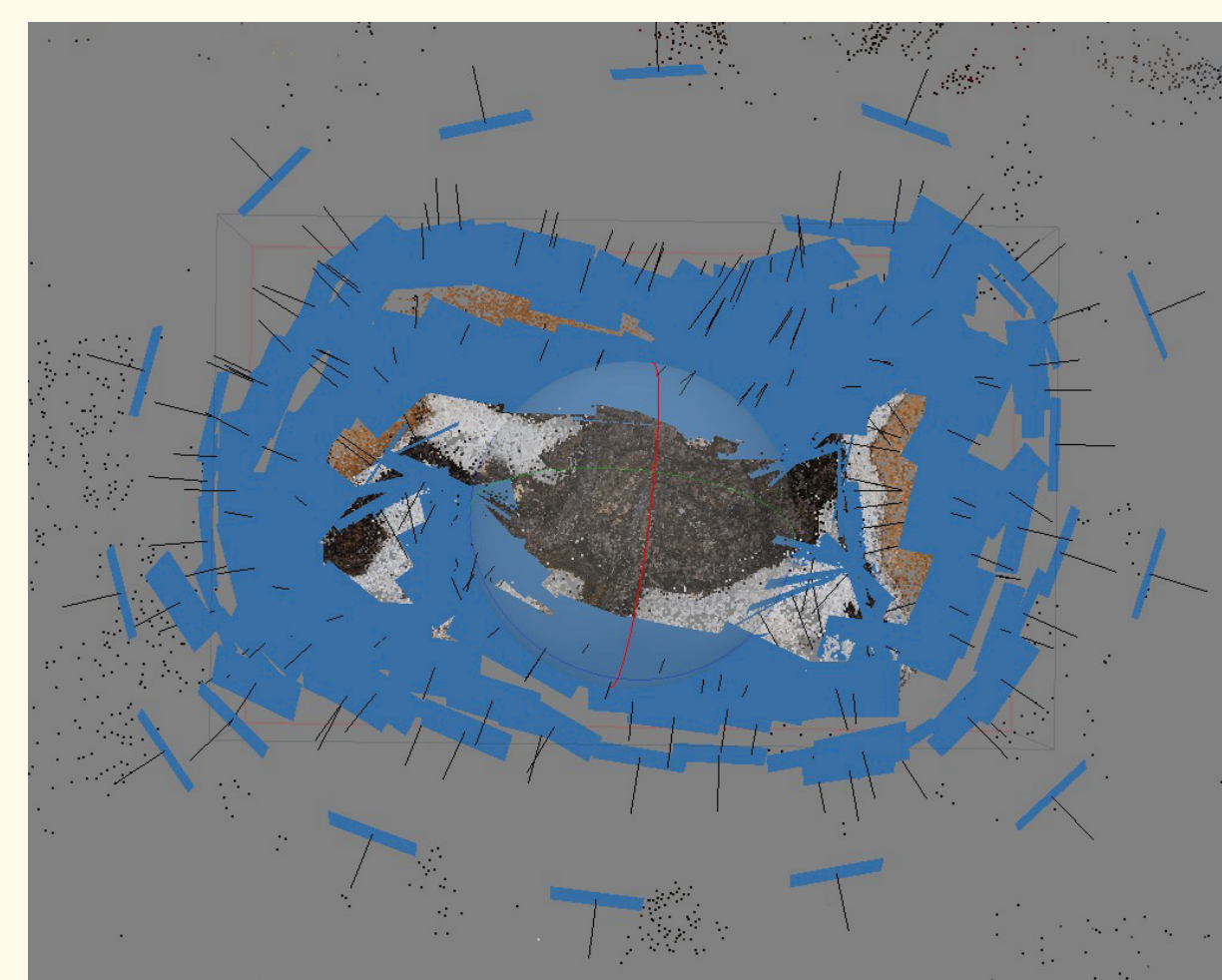
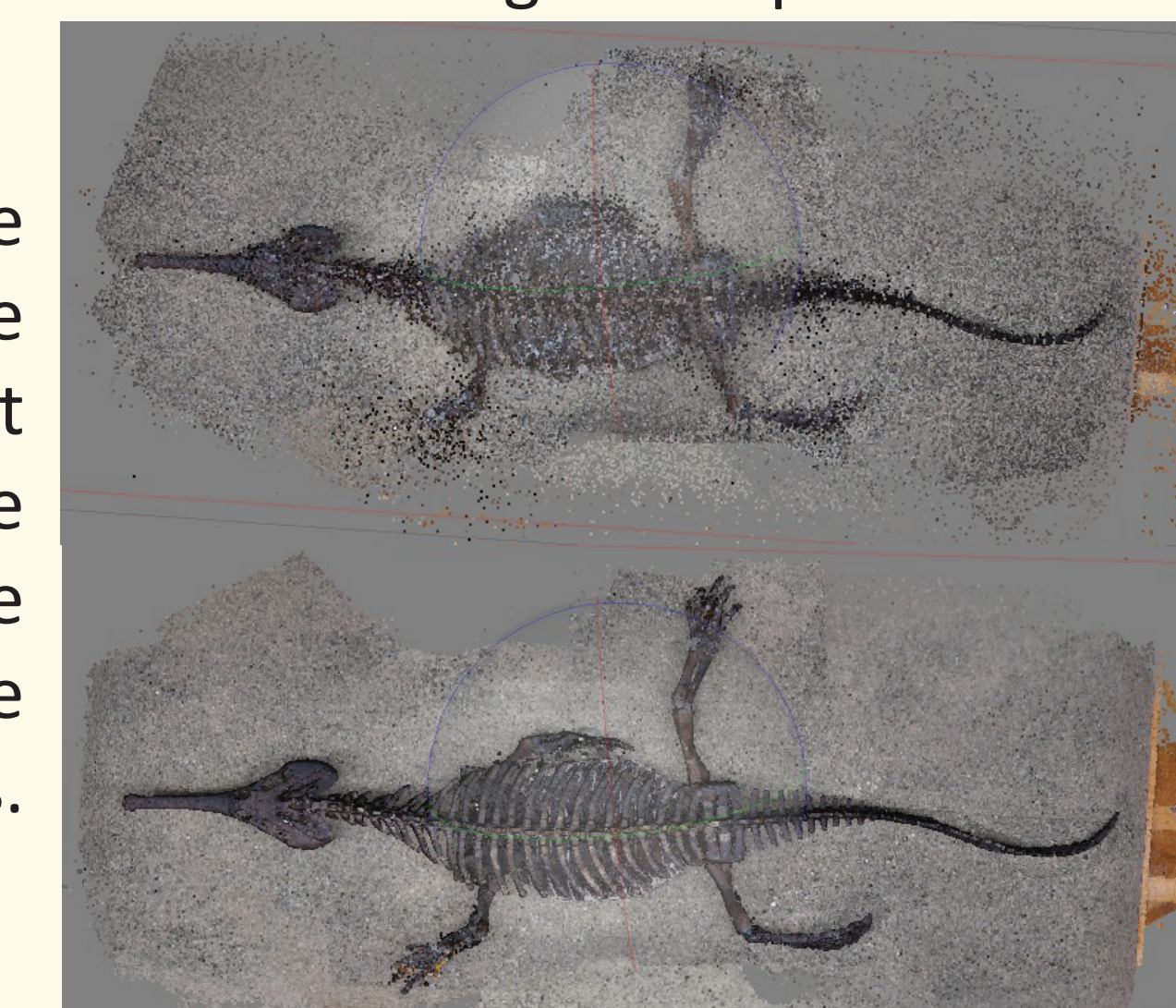


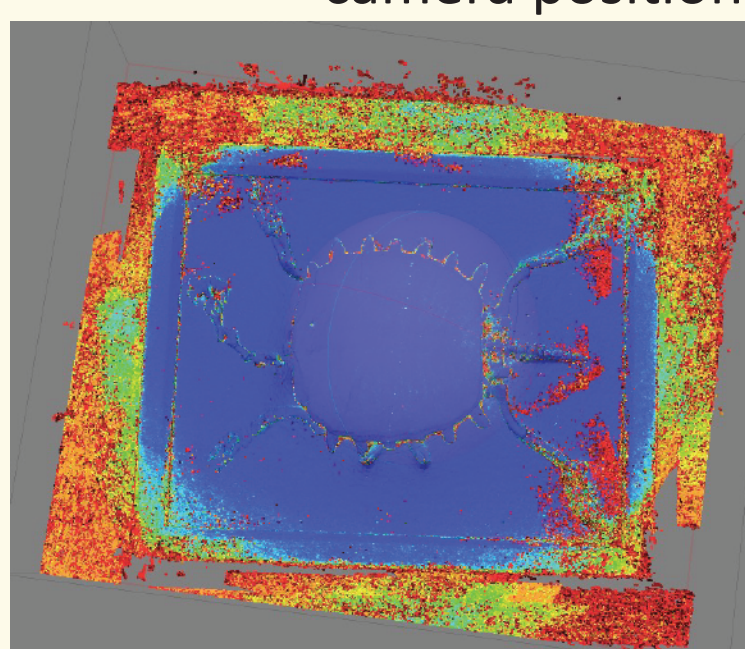
Figure 2- Sauronitholestes sparse cloud with camera positions shown

- Step 2: Import the photos and align the cameras, which creates the sparse cloud. The sparse cloud is the computers first draft of the 3D model. Camera alignment positions seen in Figure 1.

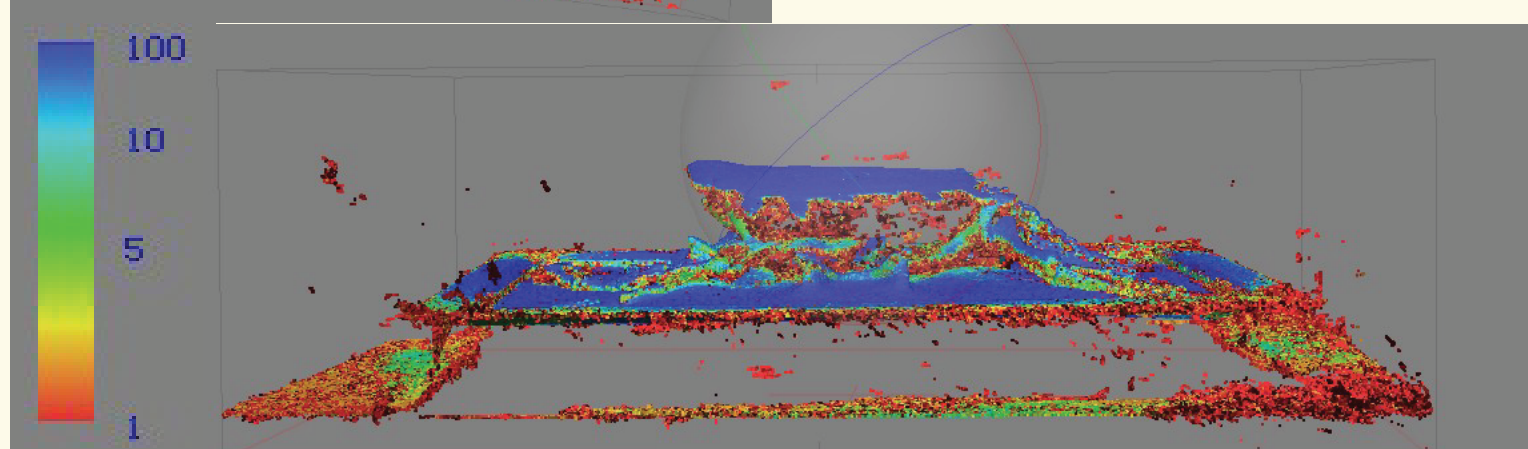
- Step 3: Generate a dense cloud. This is what the computer bases the rest of the model and the texture off of. This step is extremely important. It also gives the user a very good picture of what the finished model will look like. To the right is the dense cloud alongside the sparse cloud of the Champsosaurus.



Figures 3A(top) and 3B(bottom)- Champsosaurus sparse cloud (3A) and dense cloud (3B) shown side by side. Note the detail.



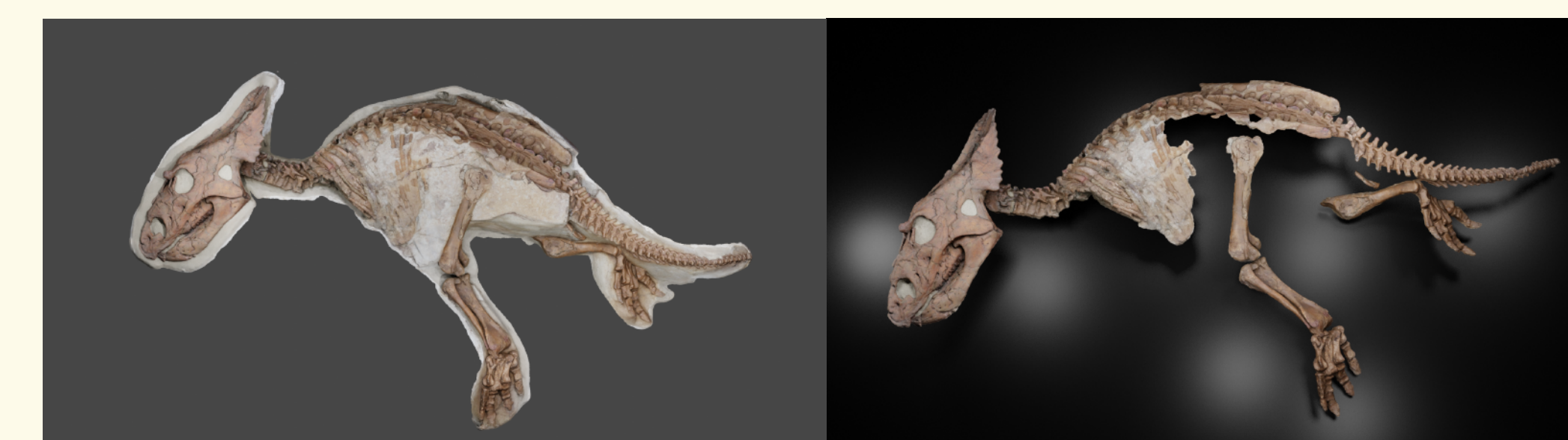
- Step 4: Use cloud confidence to help reduce wrong points. Figure 3 shows the "point cloud confidence" setting, in which Metashape™ shows how sure the computer is that it is right. Red is not confident, blue is very confident. Using this feature, it is possible to delete unnecessary points and noise caused by computer error.



Figures 4A(top), 4B(bottom right), and 4C (bottom left)- Trionychoidea dense cloud confidence (4C is the legend). Note the decreased confidence on the underside of the model

Program Two: Blender™

- Step 5: Import into Blender™ and remove the matrix (surrounding rock). See Figure 5 (below) for the difference between the raw model and the finished one.



Figures 5A(Left) and 5B(Right)- Baby Model as it was when it was imported from Metashape™(5A) and then in it finished form (5B), complete with a background on the right



Figure 6- A close-up of the Champsosaurus model's ribs. Note the difference in texture between the recreation and the original model

- Step 6 (if necessary): Reconstruct missing/ misrendered bones. See Figure 6 (right) for an example. The Champsosaurus's ribs did not render properly, so they had to be recreated digitally.

- Step 7: Final render! This step involves creating a background and adding lighting to prevent shadows from interfering with the viewing of the model. This is also the step where any additions are recoloured to blend in with the final model more. See Figure 7.

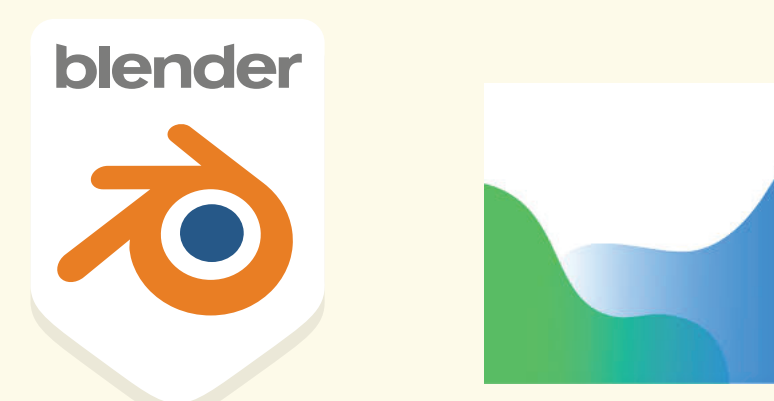


Figure 7- Champsosaurus Final Model. Note the recreated ribs and skull.

Real World

- These 3D models have a variety of uses to other paleontologists:
 - They can be used as teaching tools. This was very common during COVID-19 lockdowns
 - Individual bones can be scanned and then can be assembled into an entire skeleton. This is particularly useful when the specimens are large and heavy, or when the true orientation of the bones is unknown.
 - These models can be sent to other institutions instead of their real-world, fragile counterparts. It also allows more than one institution to study the same specimen at once.
 - The models can be 3D printed, allowing for scaling of really small and really large specimens.
 - They preserve specimens in case of breakage or theft.
 - 3D models of skeletons can be animated to investigate how joints would have interacted with each other.

Software



- Agisoft Metashape™
 - The software that produced the original rough model using photogrammetry. Figures 2-4 were all taken in Metashape™. Some rough clean up using point confidence was also done in this program.
- Blender™
 - The program where the bulk of the clean up was done i.e. the background was removed, stray points that do not make up the model removed. This was also the program where any reconstruction happened, mainly on the Chapsosaurus model and the Trionychoidea model. Figures 5-7 were in Blender™.

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