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### **3D reconstruction of ancient pottery using drawn profiles. A case study: reconstructing a Dacian fruit bowl.**

*Alexandru Berzovan\*, Claudiu Toma\*\**

\*Alexandru Ioan Cuza University, Bd. Carol I, No. 11, Iași, Romania, [berzovanalexandru@gmail.com](mailto:berzovanalexandru@gmail.com)

\*\* West University of Timisoara, Bd. V. Pârvan, No. 2-4, Timișoara, Romania, [claudiugtoma@gmail.com](mailto:claudiugtoma@gmail.com)

**Abstract:** *3D reconstruction of ancient pottery using drawn profiles. A case study: reconstructing a Dacian fruit bowl.* Without any doubt, the last years had seen an increasing deal of interest towards the Dacian culture and civilization, not just in Romania, but also in other countries. Unfortunately, most of those who are outside academia or specialized institutions do not have any sort of access to proper information about the subject. Reconstructing and bringing to life ancient artifacts could be a useful way to resolve these issues. In this paper we discuss a method for 3D reconstruction of ancient pottery using drawn profiles and we had chosen as a case study and example a reconstruction of a wheel made Dacian fruit bowl. Although the method is known, issues such as texturing are not discussed in great detail. In order to reconstruct the pot, we had used software such as Photoshop, 3ds Max and Mudbox. We processed and cleaned the original image, while importing it in 3ds Max, where, we transformed the drawing into an object and we created an UVW texture. Then, we imported our work in Mudbox, where we applied a texture. The texture was created from the photography of the original pot. We applied the texture and we obtained as a final result a pot with an authentic look. Software such as Mudbox can also be used to sculpt 3D objects in great detail, so reconstructing uneven handmade pots, painted pots, or pots with various plastic ornaments can also be possible. Reconstructing ancient pots in 3D is extremely useful especially for the larger public, as it effectively manages to "bring to life" the otherwise inert drawings that are "readable" only by the expert eye of the archaeologist.

**Keywords:** Photoshop, 3ds Max, Mudbox, Pottery reconstruction, Dacian pottery, fruit bowl.

#### **Introduction**

Without any doubt, the last years had seen an increasing deal of interest towards the Dacian culture and civilization, not just in Romania, but also in other countries. Unfortunately, most of those who are outside academia or specialized institutions do not have any sort of access to proper information about the subject - and to make the matters even worse, the few information existing on the Internet or in the mass-media are often presenting, willingly or not, an overly exaggerated and fabulous image about the Dacian culture. It is not in the purpose of this paper to discuss in detail such matters (Borangic 2008), but we strongly believe that the archaeologists studying the Late Iron Age should

do much more to promote their works and discoveries to the larger public.

Our present work attempts to come in response to these problems, by offering a relatively simple way to "give life" to the ancient pottery using the drawn profiles. In this work, we will present as a case study, a 3D reconstruction of a ceramic form specific to the Dacian Kingdom's Period (1st century BC- 1st century AD), the so-called "fruit-bowl" (Crișan 1969). The one we had chosen to reconstruct was a wheel-made one, grey colored, with an even and elegant shape. We will also describe in detail all the steps we followed in this operation.

We must say from the start that this method of pottery reconstruction is not without errors,

due to the fact that the process is based on a human-made drawing that can inherently present errors. Also, we must mention that this method of creating 3D is not a new one - it had been described already in a number of works, however accent was put mostly on shape reconstruction while very little, if any attention had been given to the texturing. We hope that the method we present in this article will be further enhanced.

### Materials and Methods

In order to make our study, we used the following software: **Photoshop CS 5.1** (any recent version or any similar software could be used with the same success), while for the 3D translation we have used **3ds Max 2012 x 64** and **Mudbox 2012**. The process of creating the 3D reconstruction can be structured in four different stages: the scanning and editing of the drawing, its translation from 2D to 3D, the fine polishing of the shape and finally, the texturing. We will describe below each of these individual steps.

The first step was, obviously, to draw the pot as correctly as possible, considering the fact that the drawing represents the 2D rendering of a 3D object (M. Kampel, R. Sablatnig, 2003). The drawing was scanned and edited in Photoshop, carefully cleaning the image. The white background color had been replaced by a grey one, for a better visibility in 3ds Max (Fig. 1). Then, the image was saved. After finishing this operation, 3ds Max was opened, and the edited image was imported into the background using the **Alt+B** command.

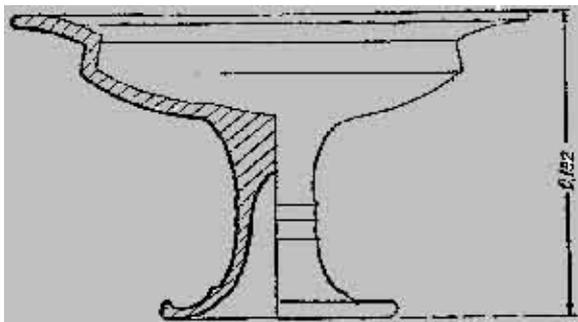


Fig. 1 - Dacian fruit bowl. Drawing.

After selecting the imported image, we selected the options **Match Bitmap**, **Display Background** and **Lock/Zoom/Pan**, then the **OK** button. For enlarging the viewport, the **Alt+W**

command we used. From the menu located to the right we selected **Shapes**, followed by **Rectangle**, after which we begin to mark on the image a square, with one of its sides located in the center of the image and with the other one located on the opposite side, more precisely on the exterior part of the drawn vessel. We made right click on the square and then we selected from the list of options the **Convert To: Convert to Editable Spline** button. Then again we made right click and selected **Refine**, in order to create as much details as possible to the object. The points need to be aligned in such a way in which to respect the drawing's line in order that the lines they support might imitate as much as possible the original shape of the vessel (Fig. 2). The last stage before obtaining a 3D model was to click on the **Modifier List** button and select the **Lathe** option. Depending on the used settings, we can obtain various results such as a section of a vessel or an entire vessel, depending on how much degrees had been selected (Fig. 3). The number of segments represents the quality of the rendering; usually this can be adjusted to about 30 segments. The final result of this stage gave us a conventional rendering of the pot (Fig. 4).

The next stage we followed was the creation of a **UVW** type texture (**UVW** mapping). This is not a texture in itself, but rather a mathematical technique to coordinate the textures in computerized graphic, being the most used method in order to transfer a 2D texture on a 3D object (M. Lo Turco, M. Sanna, 2009). We clicked the **Modifier List** button and we selected the **Unwrap UVW** option. Then we clicked on the **Open UV Editor**. We selected all the polygons and we used the **Mapping** and **Flatten Mapping** commands, after which we clicked the **Ok** button. The unwrapping process can sometimes be rather complicated and time-consuming, but, if given enough attention, the quality of the resulting texture can be very good. In order to better understand this process, we recommend also the reading of the numerous tutorials freely available on the Internet, such as the „The Brian White Method of Unwrap UVW mapping”, „Tutorial: Unwrap UVW” and others more.

In this stage of editing (Fig. 5), there are a few simple rules that need to be respected - for example, the **UVW** needs to be compacted as carefully as possible, taking into account the

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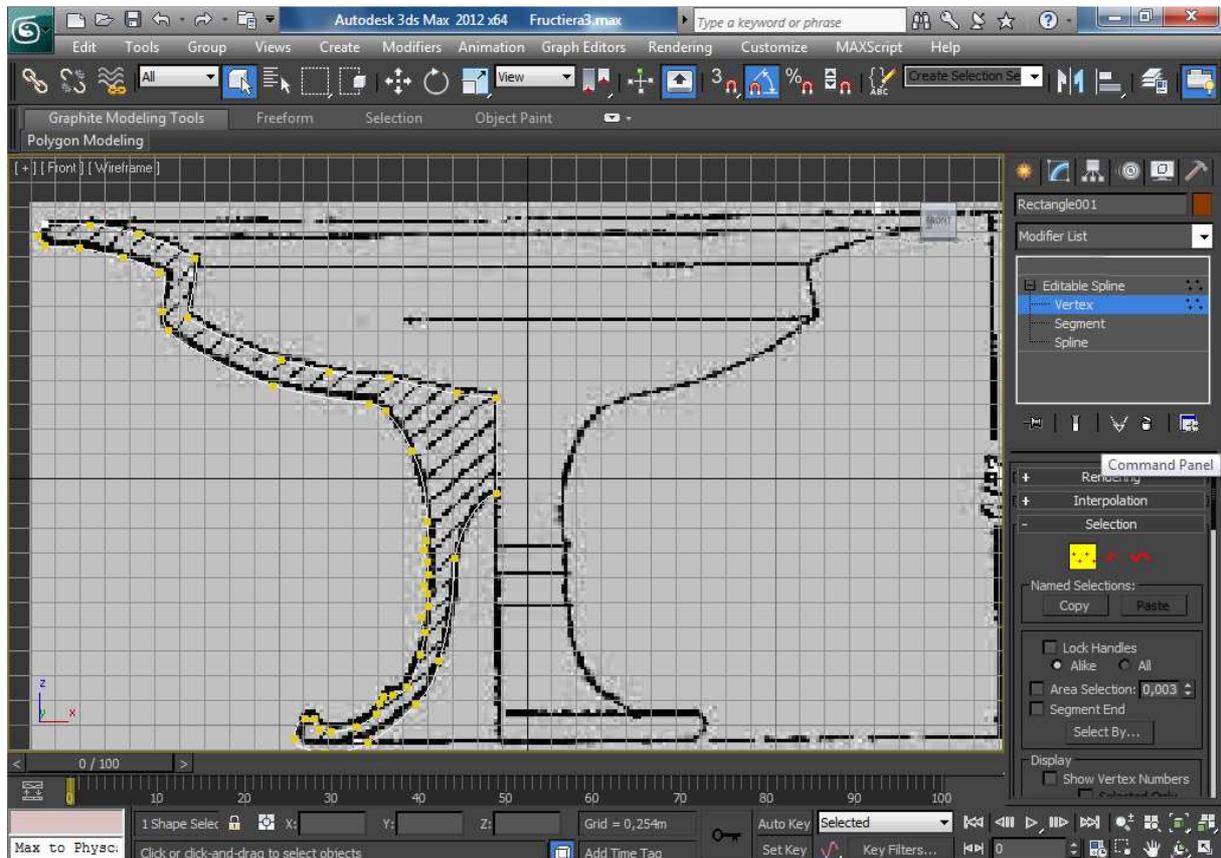


Fig. 2 - Editing the drawing with 3ds Max.

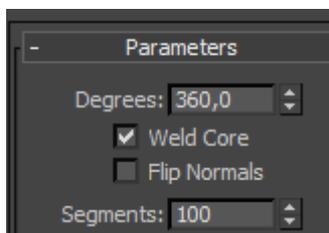


Fig. 3 - The Lathe control panel.

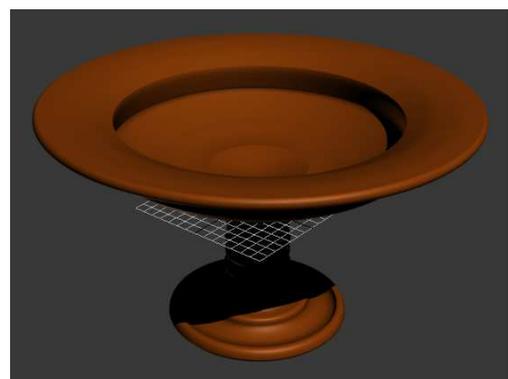


Fig. 4 - The 3D pot.

necessary texture, as well as its impact on the final look of the 3D object. Care is needed in the moment in which the polygons are cut, as interruptions in texture might appear. After we finished the **UVW** editing, we clicked on the **Tools** and **Pack UVs** buttons, choosing subsequently the **Ok** option. These options are used to wrap as effectively as possible the **UVW**'s. Then, we right clicked on the object and we selected the option **Convert to: Editable Poly**. We saved our work so far and we exported it into **.obj** format. If the **UVW** processing was

well made, importing the work into **Mudbox** presents no problems. **Mudbox** is software that permits the user to effectively sculpt details on the object - such capabilities can prove extremely useful in operations such as correctly shaping uneven hand-made vessels, or in reconstructing plastic ornaments such as girdles, etc. However, these procedures are rather complicated and require advanced knowledge in 3D modeling, so we shall not discuss them here (M. de la Flor, B. Mongeon, 2010).

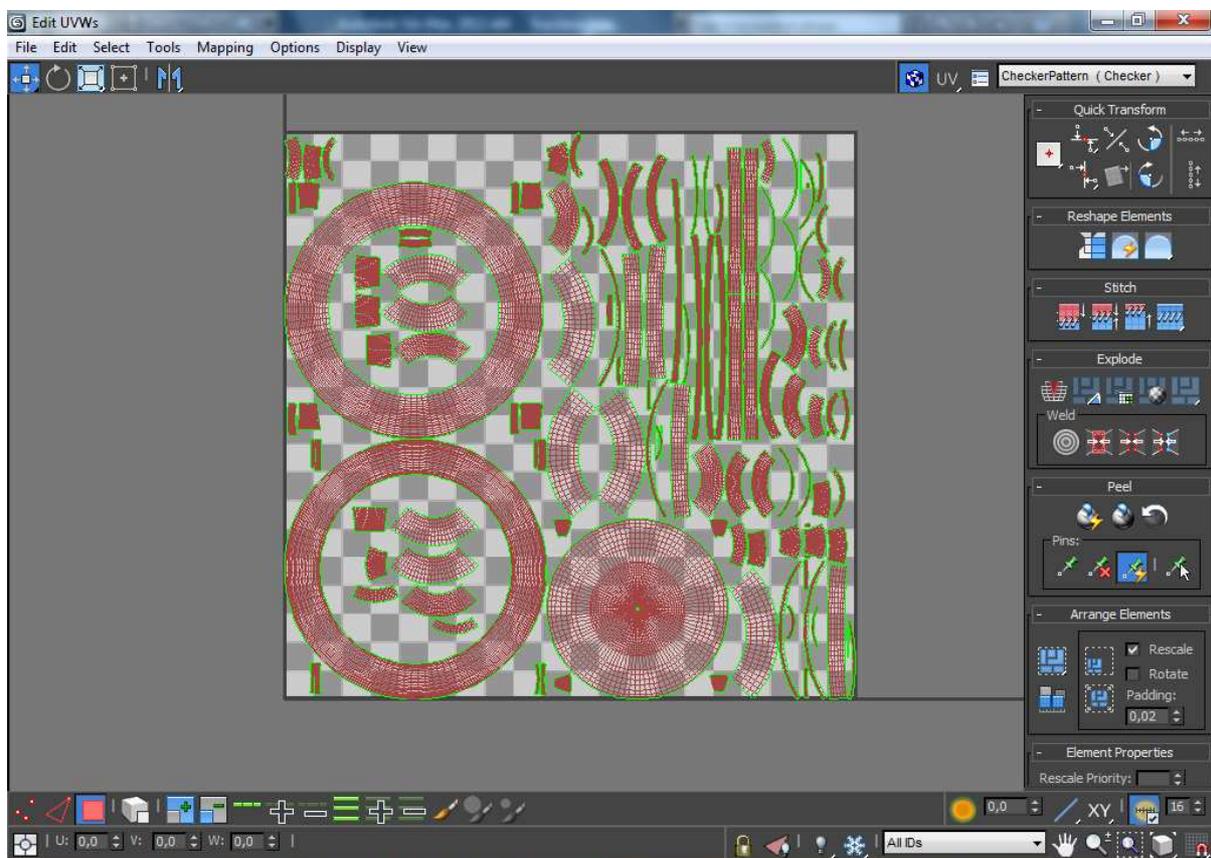


Figure 5. Editing UVW.

The texture of the model was made by extracting it from the photography of the vessel (Fig. 6). In **Mudbox**, we selected the **Paint Tools** and **Projection** buttons, and then we left clicked the object. A new window appeared, in which we had to select the size of the texture, its saving format and its type (**Channel**). For our study, in order to have a higher quality, texture we selected size to be 2048, for format we used **targa (.tga)**

and for the type we used **Diffuse**. From the Image Browser we selected the correct texture and we selected the button marked with an **S** from the right, which is called **Set Stencil**. We used a technique similar to that used for sculpting, which consisted in rotating the object and projecting its texture on the mesh in such a way as the resulted texture of the object would look as closely as possible to reality.

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Fig. 6. Texture taken from a photography of the model pot.

### Results and discussions

The final results (Fig 7 and Fig. 8) show as a 3D projection of a pot that is looking quite authentic and real. It is certain that recreating more complex situations such as painted pottery, handmade vessels with uneven shapes or with plastic ornaments the process is considerably more difficult and certainly, more time-consuming.



Fig. 7 - The reconstructed pot. View from above.



Fig. 8 - The reconstructed pot. Sideview.

However, compared to other methods used in the virtual reconstruction of pottery, the one we presented in this paper have the advantage of being more easy to learn and thus much more affordable for archaeologists and computer artists. Reconstructing ancient pots in 3D is extremely useful especially for the larger public, as it effectively manages to "bring to life" the otherwise inert drawings that are "readable" only by the expert eye of an archaeologist.

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