Texture Mapping with Mudbox and 3ds Max

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2011

ABSTRACT

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The purpose of this study was to determine the intuitiveness of texture mapping and compressibility of files generated using Autodesk 3ds Max 2012 versus Autodesk Mudbox 2012. This will be used by anyone starting to learn how to texture map and who is comparing programs that have the capability to do so. This will save users time in researching which program is better suited for their needs.

This study investigated how Autodesk 3ds Max 2012 and Autodesk Mudbox 2012 compared in mapping textures to 3D models. A basic computer skills assessment test and an intuitive test was administered to twelve participants. They were ranked based on their computer skills assessment scores, texture map completion time with 3ds Max, and texture map completion time with Mudbox. Exported files sizes for 3D models using 3ds Max and Mudbox were also compared to determine which was smaller. Participants were not included in the file size portion of the study.

Results from twelve participants in the intuitive test showed that Mudbox proved to be more intuitive for first time users attempting to apply a texture to a 3D object. However, 3ds Max offers more control and precision in performing these tasks at the cost of a large learning curve and a less of a fluid interface. The compressiblity test showed that 3ds Max produced a smaller file size.

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Chapter I—Introduction

Interactive entertainment has evolved from playing primal sports games to role-playing a character in the virtual worlds of video games. These virtual experiences have captivated millions of players from around the world and are now multi-billion dollar industries. In almost every one of these virtual worlds, objects that populate the world are created from two main components. One component of the 3D object is the model. The model is the underlying physical shape of the object; it is the virtual physical space that the object occupies. In a virtual environment, a 3-foot by 3-foot box is an object because it occupies a definite area within that environment. The second component of a 3D object is the texture. The texture is the outermost layer that makes up the appearance of a model. In an example of a human as a 3D object, the model would be the general shape of the person, whether the person is athletically built, heavyset, or very small. It is the physical space that he or she occupies. The texture is the skin, eye color, hair color, and other attributes that represent the appearance of that person. Proper texturing is essential to creating a fully immersive and believable experience. There are many ways to texture a 3D object and there are countless software programs that have the ability to texture.

This study asks: in the texture mapping process, how do Autodesk 3ds Max and Autodesk Mudbox compare in mapping textures to 3D models? Both of these programs have the ability to map a texture onto the surface of a model, but they approach the process differently because each application was designed for different uses. Mudbox seems more geared towards texturing than 3ds Max. With this assumption, Mudbox likely has a larger variety and more developed set of tools that support texture mapping. 3ds Max seems to focus more on the creation, animation, and rendering of models.

The purpose of this study was to determine the intuitiveness of texture mapping and compressibility of files generated using Autodesk 3ds Max 2012 versus Autodesk Mudbox 2012. Ultimately, an efficient workflow would produce intended quality textures at higher speeds of production with minimal impact of file size. As a 3D enthusiast, it is essential

to knowing what each program is capable of performing before beginning to learn those programs.

Chapter II—Literature Review

The manufacturer of Mudbox and 3ds Max is Autodesk. In the official Autodesk description, Mudbox "digital sculpting and digital painting software gives [the user] freedom to create production-ready 3D digital artwork without worrying about the technical details" (Mudbox). 3ds Max "provides a comprehensive, integrated 3D modeling, animation, and rendering solution for game developers, visual effects artists, and graphic designers" (3ds Max). At this point, these descriptions may be overwhelming, but they simply point out that each program is ultimately oriented towards similar tasks through dissimilar interfaces. These descriptions also present Mudbox as the program more oriented towards dedicated texture mapping.

To understand these programs better, one must understand the process they are capable of. In traditional steps, "texture mapping is usually done by either wrapping or projecting a 2D image onto a 3D object. 3D models all have a coordinate system that corresponds to the texture maps being applied" (Purdue). "UVs exist to define a two- dimensional texture coordinate system, called UV texture space. UV texture space uses the letters U and V to indicate the axes in 2D. UV texture space facilitates the placement of image texture maps on a 3D surface" (UVs). For example, on flat paper, horizontal units are measured by a factor of "X" and vertical units are measured by "Y." In texture mapping, "the coordinate system by which maps align themselves to a specific part of the model are called UV's" (Purdue). The letters U and V are placeholders for measuring the coordinate points of 3D objects, just like X and Y are for 2D planes.

File sizes play a large role in loading, also known as rendering, times for the user. A user is anyone who is loading the files needed to display an object or even an entire level of a video game. The smaller the files, the less time is needed to load them. To load objects in a reasonable amount of time, textures must be optimized in resolution and in the way they are utilized. Smaller resolutions create less pixel data at the expense of image quality. Textures that are only used once in an entire game are wasteful. An instance is composed of many

objects that make up a scene in a rendered space, such as a complete level in a video game. Since a single texture only has to be loaded once for a given instance, it can be replicated multiple times and an entire instance can be loaded much quicker.

With objects that are not flat or simple, the algorithms that attempt to automatically map a texture onto a surface are not always accurate. "This can be especially problematic... because it often causes stretching and streaking depending on the projection. It is often necessary to 'unwrap' your UV Mapping to get it to apply properly" (Purdue). Tiling is a strategy used to optimize loading times. Tiling arrays multiple objects with identical textures to give the appearance of a continuous texture. This ultimately reduces loading time for the user rendering the objects. To do this, the textures must be seamless so that the repeating process is not visibly obvious.

"Image projection mapping is a technique where an image is projected onto a 3D object. The easiest types of projections to control tend to be planar, spherical, and cylindrical projection" (Purdue). These projections attempt to more accurately describe how the texture needs to be mapped to a surface that is more like one of those shapes. "A model can consolidate many large areas into one texture map. In some cases, an entire model could use a single map. UV's do not occur naturally with polygonal generated surfaces, so they must be applied through a process called unwrapping" (Purdue). Unwrapping a UV "is the process of cutting a mesh so that you can lay its entire surface area flat" (Unwrapping). This process is not completely refined because it is still possible to have areas that show seams where one texture stops at an edge and another begins. There are ways to reduce these defects such as using plug-ins that attempt to automatically eliminate seams, but it is important to set goals for standardizing the application of textures before beginning the process in order to minimize redundant tasks and maximize visual simulation.

> One goal is to have a uniform distribution of UVs along the surface of the model. However, UV overlapping can be a problem. This occurs when one piece of 3D geometry will fall and line directly over another piece. This forces one layer of UV data to be on top of another layer, causing parts of a texture

image to be repeated. Another UV projection technique consists of taking a polygonal object and flattening it, then projecting the texture coordinates onto it with planar projection. An advantage to this is that the texture map can be painted using a 2D or 3D paint system. Because the texture coordinates occur in one continuous surface, textures can be painted without worrying about painting across different UV patch definitions or overlapping UV's. (Purdue)

There is one last element that must be mentioned when textures are being created - the element of animation. Since a texture is "glued" to a model when it is rendered, the texture must keep the shape of the model even when there is movement. On an incorrectly textured model, joint areas and pivot points will stretch a texture and make it look unnatural. Since intuitiveness and compressibility are the topics at hand, the techniques for preparing a texture for animation will not be described in depth, but understanding the many tests a texture must pass when applied to a model is important.

Looking at the workflow of applying textures, it is common to first build the model in 3ds Max and layout the UVs for Mudbox. The textures would then be painted onto the UVs and imported once again into 3ds Max for the object to be rendered. It is possible to complete these tasks entirely in 3ds Max or Mudbox, but the capabilities of 3ds Max greatly enhance modeling, and those of Mudbox provide far more capabilities for texturing.

Some of the programs capable of performing these tasks are significantly expensive. A recently graduated college student may not have the budget to support the full purchase of some of these applications. Autodesk, however, has granted most university students full educational access to the majority of their programs with a "36-month license" (FAQ). This gives students a huge advantage in gaining knowledge in programs used by the professional industries minus the corporate cost.

Chapter III—Research Methods and Procedures

The purpose of this study is to determine the intuitiveness of texture mapping and compressibility of object (OBJ) files using Autodesk 3ds Max versus Autodesk Mudbox. Both of these programs have the ability to map a texture onto the surface of a model, but they approach the process from opposite ends of the spectrum. 3ds Max relies on taking coordinate points on the model and spreading them out over a flat surface. An example of this would be trying to draw the earth on the piece of paper. The earth is a sphere, therefore the appearance would be different if it were projected onto a flat sheet. Mudbox relies more heavily on painting, which allows the user to paint the 3D model when it is still in 3D form without having to "unwrap" it.

The scientific method was solely used to compare and contrast 3ds Max and Mudbox and determine which program was initially more intuitive in trying to texture a 3D model. The scientific method is "the process by which scientists, collectively and over time, endeavor to construct an accurate (that is, reliable, consistent and non-arbitrary) representation of the world" (Wolfs). In this case, the representation pertains specifically to 3ds Max and Mudbox only. The question being asked is which program is more intuitive between 3ds Max and Mudbox. The hypothesis states that Mudbox is ultimately more intuitive. Data was gathered from a case study group and conclusions were formulated to address the final outcome.

The case study group consisted of 12 other users between the age of 18 and 24 with varying computer knowledge in the San Luis Obispo area. The age and location are pertinent because exposure to progressive technology is high in that sample demographic due to the surrounding university. To qualify for the overall test, the subject must never have used neither 3ds Max nor Mudbox. Without ever having used either of these programs, the subjects were not able to consult online resources for additional instruction or the test became invalid for that individual.

The research was divided up into sections of operations. Measurable characteristics included intuitiveness and compressibility of files. The sample group of students took only the intuitive test using both 3ds Max and Mudbox. The compressibility test did not require a case study group.

The first test was the "intuitive test" on the sample group. Each individual's general computer skill level was determined with a program developed by the Board of Studies of the New South Wales Government (BOS). The test was measured on a 20 point scale with 20 questions and a time limit of 15 minutes. It determined the subject's basic technical knowledge of "computer operations [and] graphics and multimedia skills" (BOS). Subjects with similar skill levels were grouped in order to prevent skewed data. A group was created for every 5 points on the 20 point scale for a total of 4 groups as shown in **Table 3.1**.

Group	Skill Test Score
1	0-5
2	6-10
3	11-15
4	16-20

Table 3.1

The intuitive portion of the test determined how much progress could be made in a 5 minute period to texture a 3D model for each program. The texture had to be custom or a preset, not simply a solid fill color. A preset would be a pattern such as rock or marble texture already loaded in a program library. The subjects were told to apply a texture to the model using only the tools granted by the program. The user was not able to make a query for the answer whether that be via an internal help menu or an outside resource such as a search engine. The model, a simple cube, was be provided. The individuals were timed in 1 minute intervals and progress was noted after each interval. Intuitiveness was measured on a 1-6 scale in minute:second timing, as shown in **Table 3.2** with the lower score implying a more intuitive program. To qualify for a successful texture being applied, the model needed to show an applied texture on the surface of the 3D model.

Application Score	Texture Application Time Frame
1	Between 0:00 and 1:00
2	Between 1:01 and 2:00
3	Between 2:01 and 3:00
4	Between 3:01 and 4:00
5	Between 4:01 and 5:00
6	Not applied in the time frame

Table 3.2

The sum of all test subjects' scores was compared for each program. Whichever program had the lowest overall score would be more intuitive.

The compressibility test determined how large the resulting file sizes were for a given textured model in formats exportable from both 3ds Max and Mudbox. This is an important factor in optimizing for rendering times. If an environment has hundreds of objects in a scene, each object must be exported to the smallest size possible to reduce loading. A simple, textured cube generated in each program was used to conduct the test. The object was exported as an OBJ file format in all default settings and directly compared to the corresponding object generated in the other program. Whichever object had the smaller file size, measured in bytes, was ultimately more compressible.

Intuitiveness was measured only on a scale of time. In whichever program the texture was consistently applied quicker was ultimately more intuitive in texture mapping. The compressibility test was used only to compare file sizes of the exported object formats. Whichever exported object was smaller was ultimately more compressible.

Intuitiveness is most practical for individuals beginning to create and model textures and who need guidance on which program to use. Compressibility is an important factor to all steps of creating 3D models. Both of these tests will serve as resources for those interested in how 3ds Max and Mudbox compare.

Chapter IV—Results

Table 4.1 shows the results of the intuitive test, in ascending chronological order of when the test was taken by each subject.

Name	Age	Skill Test Score (out of 20)	Skill Test Group	3ds Max Completion Time (5 minute deadline)	Mudbox Completion Time	3ds Max Application Score	Mudbox Application Score
Craig	22	14	3	DNF	0:57	6	1
Josh	22	18	4	2:00	0:30	2	1
Amber	18	13	3	DNF	DNF	6	6
Carly	20	13	3	DNF	1:35	6	2
Mark	22	18	4	4:50	0:16	5	1
Aaron	22	16	4	DNF	1:03	6	2
Rick	22	17	4	DNF	0:46	6	1
Max	22	17	4	DNF	1:35	6	2
Tim	23	16	4	DNF	DNF	6	6
Amy	21	13	3	DNF	1:11	6	2
Kyle	24	20	4	DNF	2:51	6	3
Julia	19	15	3	DNF	4:48	6	5

Table 4.1

There was a total of 12 participants for the intuitive portion of the 3ds Max and Mudbox test. With the overall average age of subjects at 21, the group sits over the college student demographic, all residents to the San Luis Obispo area in California, USA. Based on each individual's skill level, five subjects belonged to Group 3, a test result between 11-15 points. The other seven subjects belonged to Group 4 with test results between 16-20 points. The average skill test score was 4. No subjects received a skill test score under 13/20. Two subjects completed the 3ds Max test in the alloted time. Two subjects did not complete the Mudbox test in the alloted time. The four lowest overall program completion times belonged to the two youngest and two oldest subjects.

Table 4.2 shows the results of the compressibility test.

| 3ds Max Exported File Size (bytes)	Mudbox Exported File Size (bytes)
927	313

<div align="right">**Table 4.2**</div>

Mudbox exported a smaller main object file size in bytes. The exported object for 3ds Max released two other files required to utilize it when it was exported, whereas the Mudbox object only released one other file. This is standard procedure since texture maps are often interchangeable if those files are separate from the main object file. The 3ds Max object released an MTL file, which stands for the material, at 361 bytes in size. The MTL contains the material, also known as texture, definitions that describe what settings the texture has. The second file 3ds Max released for the object was the texture itself, exported automatically as a TARGA file type at 729 kilobytes or 729,000 bytes. TARGA stands for Truevision Advanced Raster Graphics Adapter, a raster graphics file format created by Truevision Inc. The only file Mudbox released was the texture map, and since both objects use the exact same texture, the size is the same at 729,000 bytes for the Mudbox TARGA. Comparatively, the image sizes are much larger than the actual model file sizes. This is only true because the models themselves are very small. With larger objects, sizes vary according to the design, but a cube is simple, widely used in many games and can be easily arrayed. **Table 4.3** shows the sizes for each released file associated with the corresponding model.

	3ds Max File Sizes (bytes)	Mudbox File Sizes (bytes)
Object File	927	313
MTL File	361	0
TARGA File	729,000	729,000

<div align="right">**Table 4.3**</div>

Chapter V—Conclusions

A total of 12 test subjects participated in the intuitive test. There was enough variation in recorded scores to produce definitive results. Whichever program had the lowest overall application score would be more intuitive. The average application score for subjects using 3ds Max was 5.583. The average score for Mudbox users was 2.667. The texture had to be custom or a preset, not simply a solid fill color, and many users found an applicator called "Hair and Fur" which gave the appearance of being an applied texture on the object. This application was simply a render modifier that didn't qualify as a true texture because it couldn't be reapplied as an image map. The visual differences are shown in **Figure 5.1**
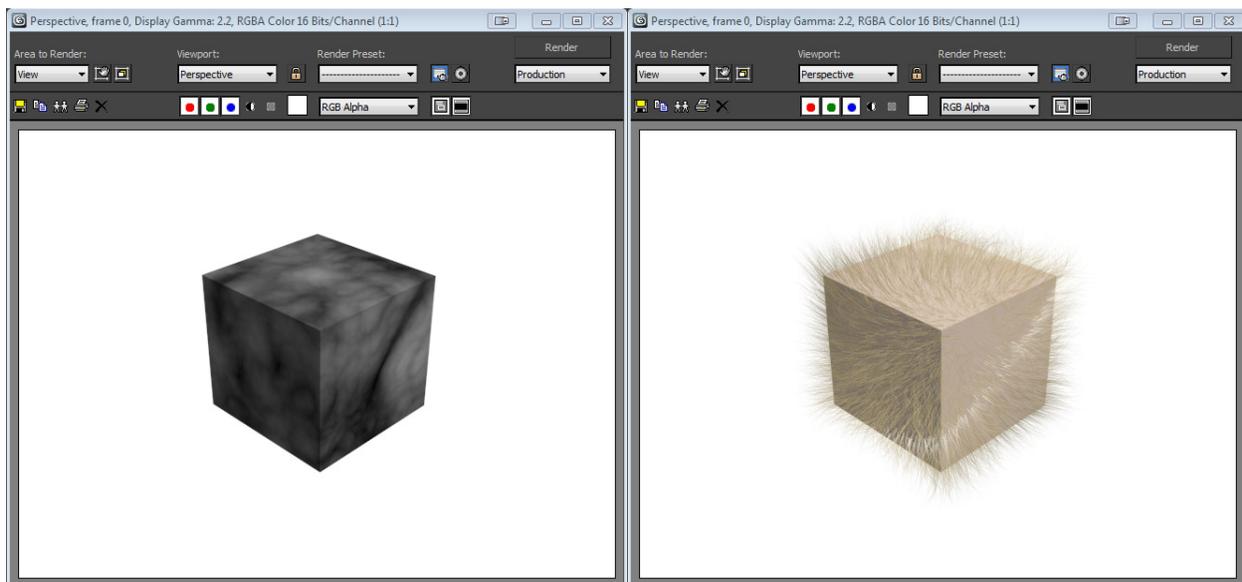
Figure 5.1

The box on the left is a normally applied texture. The box on the right shows an application of the Fur and Hair modifier.

Mudbox proved to be more intuitive for first time users attempting to apply a texture to a 3D object. For individuals beginning to create and model textures, Mudbox is a better decision for those wanting to quickly gain 3D texturing skills and experience without a large learning curve. However, 3ds Max offers more control and precision in performing

these tasks at the cost of a large learning curve and less of a fluid interface. While 3ds Max was originally developed by Autodesk for making 3D animations, further research has shown that Mudbox was originally created by a company called Skymatter and acquired by Autodesk to expand "[their] offering for the film, television and game market segments, while providing additional growth opportunities for other design disciplines, such as 3D automotive and industrial design" (Autodesk).

The total size of the 3ds Max object, including the released files, was 730,288 bytes. The total size of the Mudbox object, including the released files, was 729,313 bytes. While the differences in size appear to be minute, when used many times in an instance, the overall loading time would be shorter. This is why, at default settings, Mudbox objects are more compressible than 3ds Max objects.

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