Taking an Architectural Illustration Course from Traditional Rendering to 3D Computer-Based Rendering

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Abstract

The transition from traditional graphics into computer graphics over the past decade has brought about a multitude of changes that graphics educator's and other graphics professionals have had to address and incorporate. The ever evolving integration of Computer Aided Design (CAD) in architecture and engineering have revolutionized the design and documentation process. In the graphic communication area, changes from layout and design to desk-top publishing and interactive 'new media' design for CD-ROM and Web distribution are but a few of the changes graphic educators have to keep up with. One problem with new technology is computer graphics encompasses several components and areas, and some of these areas are not able to progress into technology as quickly as others. This paper will give an overview of the Shades, Shadows, and Perspective course at Purdue University and how it has evolved into an integrated 2D and 3D Digital Lighting and Rendering illustration course.

Keywords: Traditional Rendering Course, 2D illustrations, 3D Digital Rendering

1. INTRODUCTION

The Department of Computer Graphics Department at Purdue University has historically required every student to enroll in a traditional *Shade, Shadows, and Perspective* course, otherwise known as Architectural Illustration. Helms state's "the course was designed to introduce students to theories in light, shade and shadows by applying components and concepts through traditional media (pencil, marker, pen and ink, watercolor, and acrylic paint) projects [1]." It was also designed to provide a thorough coverage of perspective drawing systems by instructing the theories and procedures for creating perspective illustrations. With a thorough knowledge of perspectives, various media techniques, and the resulting effects of light on surfaces, the individual could create dazzling illustrations-provided the student was creative, artistically inclined, and had a strong work ethic.

Instead of opting to replicate traditional 2D methods and techniques via digital means, faculty within the Department decided to create a technologically progressive method of incorporating traditional content with emerging 3D modeling, lighting, and rendering techniques. Initially, this became immediately problematic due to the highly differing techniques and knowledge base required.

2. TRADITIONAL COURSE

The traditional course was designed with the concept that each student would generate several traditionally created projects in a laboratory setting. The *Shades, Shadows, and Perspective* course would start with projects with pencil illustrations in the development of perspective and shadow knowledge for the student. The next illustrations continued in the pencil domain and included the exterior perspective outline of an architectural structure. Using the pencil perspective outline of the structure, the student would then progress to an acrylic painting. The next project in the course was to develop a marker and colored pencil rendering of an interior. The course ended with a traditional pen and ink rendering of the exterior perspective of a house or commercial building. All during the creation of each project, the professor would introduce and instruct the students on various types of media to use and which color combinations would produce the best values in light, shade and shadowed surfaces.

A problem that existed with the course was that students really needed inherent artistic ability in order to effectively create the illustrations presented to them as projects. There was only one project in the course, which required little more than mechanical ability and knowledge of the construction process to generate a quality perspective drawing. Unfortunately, this project did not account for a large portion of credit. The largest portion of each student's grade was contained within the acrylic painting, the interior marker illustration and the pen & ink illustration. This was problematic for many students because some would excel in the acrylic rendering, while others would be more effective in marker or pen & ink illustration. It was incredibly hard for students to master all areas of illustration in this course sufficiently for commercial work. However, students would still come away with an understanding of how light affects surfaces and how to illustrate those planes of a structure in at least a minimum of one medium.

It was not only the knowledge and ability to apply different mediums as well as lighting values that the students were acquiring, but they were also getting a sense of what should and should not be included in the illustration. Each illustration would bring an entire laboratory class designated to structure, layout and composition. The instructor would indicate key components of the illustration, items that could be hidden, and most important, what the viewer should be focusing on while looking at the illustration. Each student would be required to provide a freehand sketch of the final illustration before even one rendered line was created. This was to provide students with a guide to creating the final illustration, and it provided the instructor the ability to ask students important questions over

what was the focus of their illustration. The underlying goal was to instruct students on the focus and composition of their illustrations. But, due to time and the nature of the media, the composition was briefly discussed and critiqued but not really emphasized or broken down into key elements. As a result of these limitations, focus and composition were not considered to be of major importance by students.

All aspects of this course were developed from the concept in which students would learn about properties of light while applying traditional media to their projects. With the introduction of the computer into the graphics industry, several areas within the Department of Computer Graphics Technology, (formerly Technical Graphics), adopted the computer as the sole instrument for creating their illustrations. These areas had several good reasons for change. The software adopted was just as quick as conventional drafting, revisions were much easier, and pictorial technical illustrations were easier to create. As for the traditional applications and the knowledge of shades, shadows, and lighted surfaces; initially, it was difficult to make practical computer graphic changes. In fact, it was deemed more time consuming to create architectural illustrations on the computer using a traditional approach. Therefore, the faculty decided that the *Shades, Shadows and Perspective* course did not need to convert to a computer-based illustration course.

Over time, however, with every area of the Department increasingly involved with computer graphics, instruction in architectural illustration needed to develop a strategy for going digital. The architectural illustration course went through several changes. The first of the changes was to create perspective illustrations digitally. These perspectives were generated in a traditional perspective construction process using any one of several CAD programs. Generating the traditionally constructed perspectives in CAD provided students the ability to create perspectives without the troublesome set-up and drafting equipment. One of the major reasons for the traditional 2D construction of perspectives in a CAD program was 3D modeling of architectural structures to create a perspective was not yet accepted as efficient use of time.

The next major transformation was the creation of exterior illustrations digitally instead of the acrylic paintings. This task seemed to be more of a challenge than the creation of the perspectives in CAD packages. Architectural illustrations had always been created in a traditional manner and became more of a piece of art than a commodity. The transition from the "art form" to digitally created illustrations resulted in a number of complaints, from of all people - the students. It seemed that the students actually looked forward to the traditional *Shades, Shadows and Perspective* course. Some of the reasons for the anticipation were a chance to learn how to paint, use markers, or apply ink. The overwhelming reason was to have a chance to get away from the computer and create illustrations by hand. They could not see the relationship between digital renderings being an "art form", but could only relate traditional renderings with creativity. Eventually, the logic behind this argument began to fade and the students still in the curriculum wanting some traditional rendering skills were graduating. Newer students came into the department expecting computer-based graphics and the amount of traditional graphic techniques being employed throughout the curriculum had become minimal. As a result, the quality of manual work produced by students began to decline steadily. It was time to completely change the course into a digital one. The acrylic paintings were finally retired and the color architectural illustrations were generated using raster-imaging software. Examples of traditional acrylic painting as well as pen and ink architectural illustrations are shown in figures 1 & 2.

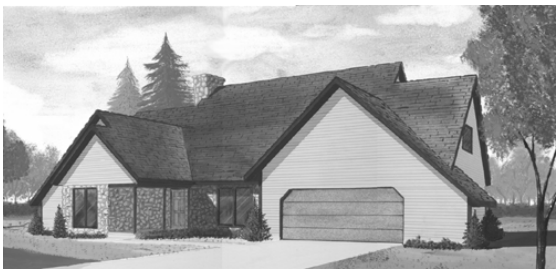

Figure 1: Acrylic Paint Illus. - Traditional

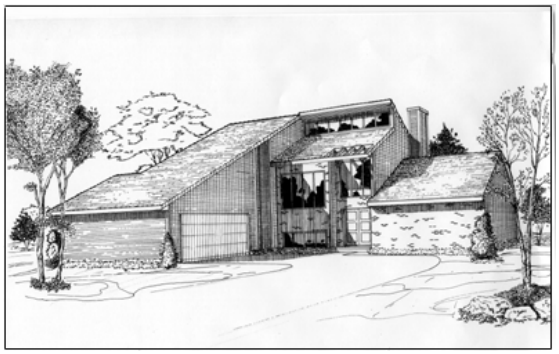

Figure 2: Pen & Ink Rendering- Traditional

The digital illustrations of the architectural perspectives were initially accomplished in Photoshop. The vector perspectives were transferred into Photoshop, placed on an outline layer, and rendered on multiple layers according to material type. The students were given information about construction materials, such as brick, vinyl siding, stucco, shingles, window types, doors, and proportional sizes to complete the illustrations. They were also given procedures for creating the materials as graphic images in Photoshop to apply to the perspective. The entire rendering of the structure was not a problem for the students. The casting of shadows was the biggest hurdle the students encountered. They did not understand the relationship between the shades & shadows worksheets they were working on and how to cast the shadows in the illustration. It was clear after two semesters that although Photoshop materials were highly useful, student knowledge and ability to create shade and shadow correctly on 2D digital illustrations was very ineffective. Students were still failing to comprehend and correctly visualize the fundamental three-dimensional relationships between building structures, sunlight, shade and shadow. Since the course had to evolve into a digital medium and forego the traditional process, it was time for a truly monumental change for the course.

3. DIGITAL COURSE- EMBRACING 3D

The development of the *Digital Lighting and Rendering* course was structured around the use of 3D models. Giambruno claims "The implementation and utilization of models, especially architectural, had become significantly easier and more efficient to construct and therefore essential to use in the new course [2]." The Department was also driving the instructors to increase the theory base in each course on both the fundamental and technological levels. With interactive 3D computer programs, the course was now free to take an analytical and artistic look at the fundamentals of lighting, surfaces, and composition within a scene. Principles of perspective could now begin to blend with cameras, intensity, color, and other vision related mechanics [Deleeuw [3]. This course would merge art and technology with knowledge of lighting design and architectural illustration as logical by-products. Though not a course purely in art, to ignore lighting design and composition would not only isolate the students from a discipline that is fundamental to creation of almost any imagery, but would also make the instruction obsolete within the next life cycle of the current software. [Meador [4]

Lee Watson's statement that "Technology is an important tool, and design is the creative use of that tool, but the progress of the artistic mastery of light as a design element has sometimes been almost lost in the welter of developing technology and craft skills" was the cornerstone of the development of *Digital Lighting and Rendering* [5]. It was the goal of the course to keep the creative skills in the design process while utilizing a digital means to achieve a final illustration.

Initial topics in the revised course deal with camera position and composition. Most students have a good background in computer graphics technology when they enroll in the course, but are lacking in a 3D composition understanding. In the first two weeks of the semester, the students are exposed to several aspects of traditional compositional elements and how the use of those elements in a 3D space can open up many new opportunities for composing imagery.

After the introduction of cameras and composition, the course discusses material creating, rendering technology, and color. In material creation, the students are required to use the knowledge and procedures developed in an earlier 2D raster imaging course as well as learning the processes needed in 3D material setup. For the architectural component of material creation, the students are introduced to construction materials and not only their colors, but also their tactile qualities, how they react to light like whether they are glossy or diffuse, and their relative scale. Scale, color, and texture were some of the most valuable lessons learned from our previous developmental efforts in teaching 2D digital illustration. Several material examples are brought in and discussed while students are instructed to look critically at their surroundings, interior and exterior, for inspiration while creating materials for their illustrations. The introduction and use of texture mapping within the 3D programs gives the students the ability to generate realistic materials within the scene by mapping their 2D raster images onto 3D surfaces in the scene. Without the experience of applying various types of images to a model in a scene through diffuse, bump, reflection or refraction maps; digital illustrations would again be reduced to just flat, and lifeless illustrations.

Along with material creation, the students are also introduced to the technology behind computer-based rendering. First, history is discussed to put 3D rendering in context with computer graphics and traditional graphics. Then, different types of shaders are discussed. These shaders offer the students more options when defining the many different types of surfaces found in an illustration. File formats, compositing, and anti-aliasing algorithms finish up this section of the course. By getting a strong foundation of the technology early on, the students exhibit the ability to use it as a tool for illustration rather than becoming constrained by it throughout the semester.

After rendering, the course covers the complex field of lighting both from an aesthetic and technological point of view. From a lighting terminology standpoint, one of the issues that students had to overcome was the inconsistency that exists in the vocabulary and methodologies within lighting design literature. This is a problem due to the lack of good digital lighting texts that are written from a lighting design point of view rather than a computer graphics point of view. It was a struggle throughout the initial design of the course to develop content that could bridge the different information sources of conventional and digital lighting. The course was structured such that students could compare the different methodologies and eventually create their own method.

Another complication was variation in the implementations of lighting and rendering technologies in 3D software rendering applications. For every lighting and rendering application used, there were just as many commands and terms defined for the same basic type of light or rendering algorithm used to give that piece of software a unique rendering look. It is essential to introduce the student to as many of the differences as possible to give them an understanding of the entire computer graphics process instead of only a one-method approach. Introducing the students to as many methods, software programs and terminologies as possible will better prepare them for their professional career by allowing them to adapt more quickly to whatever the industry supplies them. To keep from overwhelming them, the course focused on one 3D application and then as different methods were used, it was related to other popular applications.

"Learning how to plan the use of light in any field whether in computer graphics, theatre, film, or architecture involves the understanding of the principles of light, designing with light, and the technology used to employ the light." (Meador [4]) Consistent with this point, in depth discussions of how light rays are affected by changes in media, such as air, water or glass were included. Additionally, color properties of light in the mixing of different colors of lights on objects in a scene became important. Finally, how these properties work together to affect all objects in the scene allows student's to achieve an increasingly higher level of understanding and photo-realism in their illustrations.

Lighting design was introduced before technology, but after the principles of light itself. Design was first described based on a theatrical, or studio-based paradigm, then Day lighting was covered, and lastly, interior lighting design was discussed in great detail. By covering the design of light the students were

empowered to create strong imagery based on aesthetics and well-developed practices as well as get a fundamental understanding of the vocabulary of the lighting designer.

On the technological side of digital lighting, the students were given a thorough explanation of the properties of shadows, decay of light, and the ability to project patterns or images on the scene. In nature, the qualities of shadows are defined by the quality of the source of light, and the distance from the objects casting the shadows to the objects receiving the shadows. In the 3D applications, the shadows must be enabled, and then the different parameters involved in the algorithms must be changed to achieve appropriate looks. Digital lights do not have to decay over distance like real lights, so this must be taken into account when setting up a rendering. Some theatrical and architectural lighting fixtures can project patterns to infer shadows of objects outside of the image frame. 3D lights also have projection capabilities and they are controlled by the same means as creating materials for surfaces.

The students complete four projects throughout the semester. These projects include a still life that must be composed and surfaced, but lighting is given; an exterior scene that requires complex materials and simple lighting; either an exterior architectural rendering, or a still life that requires all materials and lighting; and last, an architectural interior. The main goal of these projects parallels Smith and Bertolone's opinion that there is a need to generate an understanding of the observer's perspective of objects, materials and lighting within the scene [Smith [6]. The closer the camera, the more detailed the illustration. In the last two projects, the students are given several scenes to choose from, then after selecting one, they create a camera, create and apply materials, and then apply a lighting scheme to produce a digital illustration. Figures 3 and 4 show examples of exterior and interior architectural illustrations composed and rendered by students from 3D models.

Figure 3. Exterior 3D Rendering by Student

Figure 4. Interior 3D Rendering by Student

Figure 5, 6, and 7 show illustrations from other areas of the course. It was deemed important for the students to have an understanding of other areas of digital illustration and not just focus on Architectural renderings.

Figure 5: Digital Rendering- Final Project

Figure 6: Digital Rendering- Just Getting Started in Digital Rendering Course

4. CONCLUSION

The original traditional course was designed to advance the students understanding of Light, Shades and Shadows through the generation of traditional perspective illustrations in a variety of media. To an extent, the course developed an understanding within the student of a single light source, the location of the observer, and the resulting affect of this on all elements in an architectural illustration.

The new 3D digital course takes student understanding of light, shade and shadows to a different level of experience. In the traditional course, composition was a bi-product of the course whereas in the 3D digital course, composition is one of major focus through arrangement and camera placement. Not only does composition play an important role in the course, but also the introduction of lighting design dictates key components within the sixteen-week curriculum. The artistic components that were taken for granted in the traditional course are now driving course content in the digital one.

Figure 7: Digital Rendering- Final Project

It is evident now that the focus of the original course was more on artistic ability of the student than interactively understanding the components behind the illustrations created. Once the students were introduced and understood the merging of art, lighting, and rendering with 3D technology, most were able to produce amazing illustrations. That was the intended goal, but the course is extremely hands-on and intense. There is virtually no way to be a passive by-stander in the new course. *Digital Lighting and Rendering* within the Department of Computer Graphics at Purdue University has developed into an art, light, color, physics, and technological course- all delivered in one semester. To get all components delivered successfully, the course has focused on the basics and is stresses the ability of students to utilize practically any 3D modeling and rendering software package very quickly. The emphasis of the course is not on software, but about the knowledge of composition, lighting, and developing a creative process.

5. REFERENCES

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