2016-01-01

Animating Composition: 3D Computer-generated Imaging and Technical Communication Classes

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ANIMATING COMPOSITION:

3D COMPUTER-GENERATED IMAGING & TECHNICAL COMMUNICATION CLASSES

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Dedication

For Mom, Dad, and Nat,
who love, support, and encourage me

&

For Beth and Helen,
whose classes challenged me and changed my life

Thank you.

ANIMATING COMPOSITION:

3D COMPUTER-GENERATED IMAGING & TECHNICAL COMMUNICATION CLASSES

by

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DISSERTATION

Presented to the Faculty of the Graduate School of

The University of Texas at El Paso

in Partial Fulfillment

of the Requirements

for the Degree of

DOCTOR OF PHILOSOPHY

English Department

THE UNIVERSITY OF TEXAS AT EL PASO

May 2016

Acknowledgements

Many Obi Wans guided my passage through this project. I am most indebted to my dad, Douglas; my mom, Rosario; and my sister, Natalie. During the course of this project (and throughout my life) they provided loving support, wise counsel, words of encouragement, and positive energy. They embody Good and are my life Force.

I am indebted to both Dr. Beth Brunk-Chavez and Dr. Helen Foster, whose courses challenged me to think deeply and inspired me to see the world, and my place in it, very differently. Their optimism, encouragement, and mentorship will always stay with me.

Additionally, I am grateful to both Dr. Anita August and Dr. Lucia Dura for their encouragement.

Of course, I would like to thank my entire committee, Dr. Beth Brunk-Chavez, Dr. Lucia Dura, and Professor Vince Burke, for their insightful feedback. I greatly appreciate their continual support, patience, and positivity throughout this endeavor.

Many other individuals played an important role in this project's development. I am deeply grateful to Dr. Sunay Palsole, who recommended using Blender and whose final remark to me -- "Everything's possible; the impossible just takes longer" – became a personal mantra. I am deeply obliged to Saul Gutierrez, from InRadius Systems, who helped me to understand what students with no 3D experience could reasonably create in a semester. I would also like to thank Dr. James Salvador (from Chemistry), Dr. Rebecca Reed-Jones (from Kinesiology), Dr. Rodrigo Romero (from Computer Science), and Adrian Hernandez (from Ysleta high school), and Profs. Vince Burke and John Dunn (from Art) who took the time to speak to me about how they integrated 3D CGI into their classes. Additionally, I would like to thank David Espalin and Jorge

Ramirez, from the W.M. Keck Center for 3D Innovation, for allowing me to observe engineers at the center and for helping me to better understand the additive manufacturing processes.

Of course, I am further indebted to many individuals in cohorts before mine including Dr. Brian McNely, Dr. Anita August, Dr. Scott Lunsford, and Dr. Christina Ramirez, who greatly inspired me. Thank you.

Finally, I would like to thank the students in my technical communication classes. You make the world a better place, and I’m honored to have taught you.

Abstract

This project examines the rhetorical nature of 3D computer-generated imaging (CGI) and investigates how technical communication instructors can integrate it into their classrooms to foster rhetorical awareness of digital and multimodal composing practices; to foster technical communication competencies; and to teach technical communication genres. To justify 3D CGI's study and use in technical communication classes, the dissertation first overviews 3D CGI's complex, interdisciplinary history; discusses how professionals across disciplines rhetorically use it; and reviews the lack of scholarship on 3D CGI in Rhetoric and Writing Studies. 3D CGI is next conceptualized as a rhetorical information ecology with micro-, meso-, and macro-levels, and its logics and interface are rhetorically analyzed. Finally, this study reports the results of integrating 3D CGI into three sections of technical communication and offers guidance on best teaching practices.

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Introduction

Professionals across disciplines use 3D computer-generated imaging (CGI) and animation[1] as part of knowledge construction processes. For example, civil engineers use 3D CGI to visualize structures before and throughout construction. Legal teams use 3D CGI to clarify circumstantial events and to persuade jurors. Medical professionals use 3D CGI to perform virtual surgeries, to visualize post-operative results, and to make diagnoses. And marketing campaigns use 3D CGI to (re)construct consumer perceptions and attitudes about products.

Although 3D CGI is often depicted as a neutral form of visualizing information, it is a thoroughly rhetorical form of multimodal and digital composing.[2] Every stage in the 3D design process shapes what individuals know about objects, how individuals understand and perceive objects, and how individuals respond to objects. 3D CGI, thus, functions as an incredibly powerful rhetorical form: To effectively refute and create it, individuals need multiple literacies,

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[1] 3D computer-generated imaging (CGI) generally refers to using computers to create and edit three-dimensional graphics. 3D animation refers to using computers to create and edit three-dimensional graphics and to make them appear to move (Parent, 2008, p. 2). For the sake of brevity, I will use the term 3D CGI to refer to both using computers to create 3D graphics and to animate them. I will use the term CG (computer graphics) to refer to 2D and 3D images created on a computer.

[2] In the past, the terms multimodal, new media, and digital media have often been problematically conflated. More recently, however, scholars have begun to differentiate (and debate) these terms. Some scholars (e.g. Kress) use the term multimodal to refer to those compositions that use more than one mode (or resource for making meaning) to communicate. These resources include written or spoken words, static or moving images, sound, touch, taste, etc. Multimodal compositions can be distributed in multiple ways including digitally or on paper. Digital compositions, however, can also be multimodal, but the medium of distribution is screen-based. The term new media is also frequently used to describe both compositions that are multimodal and digital or paper-based. As Selfe (as cited in Lauer, 2012) asserts, however, the term new media is problematic for the field because it does not adequately describe what scholars in Rhetoric study, and it is too closely associated with the works of those outside the field. Other scholars (See Lauer, 2012) have additionally noted that the term new media is problematic because it often describes types of media that are not “new” including blogs and websites. For the purposes of this project, I will use the term “new media” only when referencing the works of scholars who have specifically used the term to refer to digital composition. Otherwise, I will use the terms *digital*, to refer to computer and screen-based compositions, and *multimodal*, to refer to those compositions that communicate meaning using multiple resources.

including scientific literacies (Zerbe, 2007, p. 98),[3] critical technological literacies (Selfe, 1999, p. 148),[4] and visual design literacies (New London Group, 1996).[5]

As Rhetoric and Writing Studies (RWS) scholars (e.g. Selfe, 1999, Yancy, 2004) assert, 21st Century writing instructors have a responsibility to integrate digital and multimodal forms of composing, such as 3D CGI, in their classrooms, and they have a responsibility to teach students to critically interrogate such forms. Otherwise, individuals lacking such literacies may accept, uncritically, the realities, truths, knowledges, and worlds created for them by others, becoming complicit in accepting and maintaining dominant social structures. While RWS scholars have investigated different types of digital and multimodal composing in undergraduate writing courses, only a few have examined the potential of composing with animation (See Ellertson, 2003; Duffelmeyer & Ellertson, 2005; Sorapure, 2006; Luckman & Potanin, 2010; Morton, 2010; Orlowicz, 2010; Thomas & Tufano, 2010).[6] These scholars, however, have not examined the rhetorical nature of 3D CGI or its use in composition classrooms.

In this research project, then, I examine the rhetorical[7] nature of 3D CGI and examine how technical communication instructors can integrate it into their classrooms. I ask two

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3 Zerbe asserts scientific literacies exist on a tripartite continuum. Autonomous scientific literacy includes a basic understanding of scientific knowledge and an understanding about how scientific disciplines construct knowledge. Critical scientific literacy includes the ability to question scientific texts and to use writing to analyze, interpret, and explain them. Ideological scientific literacy, which includes autonomous and critical scientific literacy, includes an awareness of the ways scientific literacies "operate within cultures to both dominate and empower" (p. 95).

4 To be critically technologically literate, Selfe argues individuals must not just have "basic technological skills" but they must also have a "reflective awareness" of "the complex set of socially and culturally situated values, practices, and skills involved in operating linguistically within the context of electronic environments" (p. 148).

5 The New London Group asserts "literacy pedagogy" needs to account for "the understanding and competent control of representational forms" including "visual images" such as "visual design in desktop publishing or the interface of visual and linguistic meaning in multimedia" (para. 2).

6 Ellertson (2003); Duffelmeyer & Ellertson (2005); Sorapure (2006); and Orlowicz (2010) discuss uses of *Adobe Flash.* Luckman & Potanin (2010) and Morton (2010) examine uses of Machinima. Thomas and Tufano (2010) investigate stop-motion animation.

7 My use of the term "rhetorical" changes throughout this work; however, I will attempt to define these different uses as they arise. In this first case, my use of "rhetoric" refers to situated, strategic, discourse, which is both partial and contingent in its creation of knowledge. I do not limit the term "discourse" to written or spoken language only,

questions: How is 3D CGI rhetorical? How can technical communication instructors use 3D CGI in their classes to foster a rhetorical disposition; to teach digital and multimodal composing; to teach traditional technical communication genres; and to integrate technological, scientific, and design literacies?

To address these questions, my inquiry unfolds in the following way: In **Chapter 1: Situating 3D CGI Historically, Across Disciplines, and in RWS,** I overview 3D CGI's history to provide an understanding of the field; to show its interdisciplinary development and complexity; and to emphasize its pervasiveness in our society. I then survey 3D CGI's use across disciplines, discussing how that use is also rhetorical. Finally, I survey the scholarship about 3D CGI in RWS to situate my inquiry. In **Chapter 2: Conceptualizing 3D CGI Using Ecological Models,** I briefly discuss the difficulties inherent in using existing theories of digital media as frameworks for analyzing 3D CGI and discuss the benefits and limitations of using the ecological framework as a model for structuring and analyzing 3D CGI. In **Chapter 3: Blender's Meso-Level Rhetorical Ecology and Procedural Rhetoric**, I draw from both Bogost's (2008) notion of procedural rhetoric and Burke's (1966) notion of terministic screens to analyze 3D CGI and to demonstrate the ways in which composers' design choices shape perception. In **Chapter 4: The Technical Communication Class as a Macro-Level Rhetorical Information Ecology**, I examine how 3D CGI can be adapted in the ecology of a technical communication classroom to teach traditional technical communication assignments and to foster in students a rhetorical disposition. Specifically, I report the results of an ethnographic study which integrated 3D CGI in three technical communication classes in the fall 2011 and spring

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however. The term "discourse" as I use it refers to all methods of meaning making, including gestural, aural, and visual.

2012 semesters. Finally, in **Chapter 5: Best Practices and Future Directions**, I discuss best practices for instructors who want to use 3D CGI in their courses.

Chapter 1: Situating 3D CGI Historically, Across Disciplines, and in RWS

1.1 Introduction

Three-dimensional computer-generated imaging (3D CGI) is ubiquitous. TV spokes characters such as *Mucinex's* Mr. Mucus*, Lamisil's* Digger the dermatophyte; and the *Nasonex* bee encourage consumers to purchase prescription medications for nettlesome bodily ailments. Televised children's specials, such as *Merry Madagascar* (2009), *Shrek the Halls* (2007), and *Ice Age: A Mammoth Christmas Special* (2011), air on TV every Christmas. 3D CGI special effects appear in blockbuster movies such as Steven Spielberg's (1993) *Jurassic Park,* Peter Jackson's (2002) *The Lord of the Rings: The Two Towers,* and James Cameron's (2009) *Avatar.* And we often choose 3D avatars to inhabit 3D computer games such as *World of Warcraft* and *Wii.* However, 3D CGI has not always been this pervasive. 3D technology emerged over a 70 year period as a result of the collaborative and individual inquiries of scientists, engineers, and artists, who worked at different institutions to solve different problems. As the technology was developed and became more accessible, these interdisciplinary scholars also used 3D CGI in rhetorical ways.

To demonstrate 3D CGI's complex, interdisciplinary (and often collaborative) histories and to show its wider, rhetorical use within our society, Chapter 1 provides a broad historical overview of 3D CGI, discusses its rhetorical uses in other disciplines, and examines the need for its use in composition classrooms. Chapter subsections are organized as follows: **Section 1.2, Situating 3D CGI Historically,** overviews 3D CGI's history to show its complex, interdisciplinary development and historical complexity. **Section 1.3, Situating 3D CGI Rhetorically in Research Across Disciplines,** emphasizes 3D CGI's relation to Rhetoric by surveying the ways interdisciplinary professionals have used it rhetorically. Finally, **Section 1.4,**

Situating 3D CGI in Rhetoric and Composition Studies, reviews the limited ways in which 3D CGI has been integrated in composition classes and advocates its inclusion in technical communication classes.

1.2 Situating 3D CGI Historically

Chronicling 3D CGI histories[8] is difficult because of the technology's complex, interdisciplinary development. Some scholars (e.g. Freeman, 1980; Lockheed, 1981) divide the histories into periods based on the kinds of contributions individuals made. Other scholars (e.g. Auzenne, 1994; Carlson, 2003; Sito, 2013) report histories topically to provide more detailed accounts within localized settings or to show how subareas of 3D CGI, such as scientific visualization or gaming, emerged. Because I wish to highlight the complex, interdisciplinary development of 3D CGI's hardware, software, algorithms, products, and projects, I present a broad, linear chronology, starting in the 1950s (when computers capable of supporting CGI development emerged)[9] and ending in the 1980s (when the technology was widely used and accepted).[10]

1.2.1 The 1950s

From its early beginnings, CGI development was interdisciplinary. Academic researchers, the US Military, and artists all contributed to hardware development and computer image creation. For instance, in the mid-1940s, the US Navy contracted MIT researchers[11] to develop the Whirlwind, a digital computer that displayed "real time text and graphics" (Carlson,

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[8] The term *histories* is used here to reflect the multiple locations of 3D CGI's development. I also feel that emphasizing the notion of histories aligns well with my later conceptualization of 3D CGI as made up of different ecologies.

[9] Most CGI historians start their histories in the mid-to-late 1940s, when the computer, called ENIAC (Electronic Numeric Integrator and Computer) was developed because it had similar "components and concepts" of modern computers (Carlson, 2003, Sec. 1). However, as Sito (2013) notes, ENIAC did not support computer graphics and predominately served to "solve mathematical problems" (p. 38). For this reason, I start my history in the 1950s.

[10] Organizing the history this way is also problematic. It presents CGI's history in a linear way as a "march of ideas" over time (Berlin, 1994, p. 112), and it glosses over many important contributions as well as the field's complex technological, political, economic, and ideological issues. However, presenting a chronological history also allows me to illustrate the complexity of these histories without exceeding the scope of my project.

[11] Sito (2013) credits Jim Everett and Ken Olson as conceiving of the Whirlwind (p. 38) while Carlson (2003) asserts that the Whirlwind was developed in 1945 under the direction of Jay Forrester (Sec. 2).

2013, Sec 2). The Whirlwind, completed in 1951, enabled operators to track a plane's movement using radar and to obtain aircraft information by pointing a "light pen" – a special type of input device – at the plane's image on the screen. The Whirlwind was further developed by academic researchers in 1958 for the US Air Force's Semi Automatic Ground Environment (SAGE) air defense system, which simulated "aircraft landings, takeoffs, and emergency procedures" (Auzenne, 1994, p. 38).[12]

While academic and military researchers improved computer hardware, individual artists and filmmakers also experimented with, and sometimes modified, military hardware found in junkyards to produce computer graphics (Sito, 2013, p. 21). In the early 1940s, for instance, experimental filmmaker John Whitney Sr. modified analogue devices in military equipment to produce images and sound (Carlson, 2003, Sec. 2; Sito, p. 24). His film *Five Abstract Film Exercises* (1944) presents colorful, transforming geometric shapes, accompanied by the sound of "electronic blips."[13] Other artists (e.g. Ben Laposky and Mary Ellen Bute) also experimented with computer image creation using military oscilloscopes (Sito, 2013, p. 21).[14]

1.2.2 The 1960s

In the 1960s, interdisciplinary work in CG continued as teams of researchers and individuals pioneered more developments in hardware, software, and algorithms and also experimented using the computer to create scientific visualizations, games, and art.

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[12] Advances in the Whirlwind and SAGE systems led to the development of the TX-2 computer in 1959. The TX-2 further advanced the potential for CG because, unlike the Whirlwind and SAGE computers, it had "magnetic tape storage, an on-line typewriter, the first Xerox printer, paper tape for program input, and . . . a nine inch CRT" (Carlson, 2003, Sec. 2).

[13] One of Whitney's films can be viewed here: https://www.youtube.com/watch?v=JdCjwS1OxBU .

[14] Videos of Laposky's *Oscillations* (1954) and Bute's *Abstronic* (1954), both created with oscilloscopes, are hard to find. However, sketches of Bute's film can be found here: http://www.centerforvisualmusic.org/Abstr_study.JPG or by going to the Center for Visual Music site at http://www.centerforvisualmusic.org/Bute.htm . Images of Laposky's *Oscillations* (1954) can be found at the Center of Excellence Digital Art site: http://dada.compart-bremen.de/item/agent/253 .

Interdisciplinary Developments in CGI Hardware

Both teams of corporate researchers as well as pioneering individuals contributed to developments in CGI hardware. In 1961, for instance, the Digital Equipment Corporation (DEC), contributed to CGI hardware with the PDP-1 (Carlson, 2003, Sec. 3). Considered to be the "first commercial interactive computer," the PDP-1 ran multiple operating systems and "was the first to allow multiple users to share the computer simultaneously."

Other corporations, however, also contributed to CGI hardware development. For instance, in 1964, researchers at IBM and General Motors collaborated to create the DAC-1 (Design Augmented by Computer), an early computer-aided design (CAD) system. As Carlson (2003) asserted, ". . . the first [DAC-1] system was built by IBM using specifications provided by a team of engineers from General Motors" (Sec. 3). The DAC-1 allowed users to rotate and zoom into and out of geometric objects. It also allowed users to "input drawings from other sources . . . using a computer controlled film reader" and used a light pencil (Carlson, 2003, Sec. 3).

While teams of corporate researchers contributed to CGI hardware, so too did pioneering individuals. For instance, in 1964, Seymore Cray developed his CDC 660 computer which was "ten times faster than any other computer of the time" (Sito, p. 77). Additionally, in 1968, Douglas Engelbert and other researchers presented the mouse as an input device at a conference in San Francisco. Engelbert's mouse design, still widely used today, is a critical component in 3D CGI design creation.

Interdisciplinary Developments in CGI Software

Much like CGI hardware developments, CGI software developments emerged from the interdisciplinary efforts of pioneering individuals in academe and private labs. For instance, in

1963, MIT doctoral student Ivan Sutherland created Sketchpad, a software program that enabled users to draw precise points, lines, and arcs onto a cathode ray tube (CRT) screen using a light pen (Carlson, 2003, Sec. 3). Sketchpad also let users "zoom in and out on the display"; create "combinations of elements and shapes"; and copy, move, rotate, and resize shapes. As Carlson (2003) noted, Sutherland's "contributions moved graphics . . . to the world of engineering and design."[15] Similarly in 1963, Kenneth Knowlton at Bell Laboratories developed BEFLIX (Bell Flicks), an "animation language designed for making computer films" (Auzenne, 1994, p. 40). As Sito (2013) noted, BEFLIX enabled users to "'draw' images directly onto the cathode ray tube via a light pen, similar to Sketchpad" (p. 75).

<u>Interdisciplinary Developments in Scientific Visualization</u>

Individuals working within private labs, such as Bell and Boeing, also contributed to CG development by using the computer to create scientific visualizations. Several researchers at Bell Laboratories, for instance, created scientific visualizations. In 1963, Edward Zajac at Bell Laboratories created the first computer animated film, *Two-Gyro Gravity-Gradient Altitude Control System,* which showed a satellite rotating around the earth.[16] Similarly, in 1965, Michael Noll, also at Bell Laboratories, created three animated films including *4-Dimensional Hypercube,* [17] *4-D Hypermovie,* and *Computer-Generated Ballet.* And mathematician Frank Sinden (at Bell Laboratories) created *Force, Mass, and Motion* (1966), which depicted Newton's laws of motion (Auzenne, 1994, p. 32).[18] At Boeing, William Fetter created the first computer-

[15] A demonstration of Sketchpad can be viewed here https://www.youtube.com/watch?v=6orsmFndx_o .
[16] Zajac's animation can be viewed here https://www.youtube.com/watch?v=m8Rbl7JG4Ng
[17] Noll's film *4-Dimensional Hypercube* can be viewed here: https://www.youtube.com/watch?v=M4nql28E_AE
[18] Sinden's *Force, Mass, and Motion* can be viewed here: https://www.youtube.com/watch?v=f2hbBUWpEVo

made human model as part of his research on cockpit design and coined the term "computer graphics" in 1964 (Sito, 2013, p. 26).

Interdisciplinary Developments in Entertainment and Art

The interdisciplinary efforts of scientists, academics, and artists also led to developments in CG entertainment and art. In 1961, for instance, MIT computer programmer Steve Russell and his team created the first interactive videogame, *Spacewar* (Carlson, 2003, Sec. 3).[19] Objects in *Spacewar*, much like the scientific visualizations at the time, appeared as small, white 2D wireframes that rotated around each other.

However, artists also began independently using the computer to create art. In 1968, artist Charles Csuri created a 2D CG animation, *Hummingbird.*[20] Csuri's animation begins with a 2D black-and-white outline of a hummingbird being "drawn" on the screen. The hummingbird then moves about the screen before it deconstructs into a series of lines and dots that disperse. As Sito (2013) explained, "The film is considered one of the landmarks of CG because it is the first time someone attempted to move a living thing rather than geometric shapes" (p. 58).

1.2.3 The 1970s

In the 1970s, interdisciplinary efforts to develop CGI grew as a result of governmental and corporate funding and as a result of newly emerging computer science programs. Academic researchers innovated new algorithms, software, and hardware; researchers at national labs created more sophisticated scientific visualizations; commercial CG companies emerged to create CG for the public; and some researchers left academe to found their own game development companies.

[19] Russell's *Spacewar* can be viewed here: https://www.youtube.com/watch?v=Rmvb4Hktv7U .
[20] Csuri's *Hummingbird* (1968) animation can be viewed here: https://www.youtube.com/watch?v=awvQp1TdBqc .

CG Developments Emerging from Academic Research

University researchers profoundly advanced CG during the 1970s. At the University of Utah, researchers created algorithms for rendering[21]; texture mapping[22]; antialiasing[23]; lighting; modeling; shading; and adding solid surfaces to objects (Carlson, 2003, Sec. 4). They also developed algorithms for creating atmospheric effects, environment mapping, and facial animation. Utah researchers also developed "one of the early 'motion capture' systems called the Twinklebox. Additionally, in 1972, a collaborative effort between University of Utah researchers Ed Catmull (who later founded *Pixar*) and Fred Parke resulted in the "first 3D-renderd images . . . ever seen on film" (Sito, 2013, p. 64). Catmull and Parke's *A Computer Animated Hand* (1972) depicts a 3D hand that rotates slowly with fingers that bend. The video shows how the hand was made from a plaster cast and was then digitized into triangles for modeling. In the same video, Catmull and Parke also show a 3D model of an artificial heart valve and a human face that smiles and opens its mouth as if speaking. In one segment of the video, the face's eyes even shift from left to right. Although Catmull and Parke's video is also entirely in black and white, it differs from the 1960s scientific visualizations in that objects are surfaced and resemble more modern-looking (though still somewhat crude) 3D animations.[24]

Research at other universities also helped to move 3D CGI forward. At Cornell, researchers focused on "realistic image synthesis" and made advances in synthetic light (Carlson, 2003, Sec. 5). From 1975-1979 New York Institute of Technology (NYIT) researchers designed early animation programs such as Tween and Soft Cel, and they created a paint program, Paint.

[21] Rendering is a file conversion process in which 3D files are converted into readable 2D movie and image files.
[22] Texture mapping is a method of applying the appearance of textures to 3D objects.
[23] Antialiasing is a method of making pixelated edges of digital images look like smoother lines.
[24] Catmull and Parke's video can be viewed here: https://www.youtube.com/watch?v=Jjbax5HYHLQ .

NYIT researchers developed "image techniques involving animation, fractals, morphing, image compositing, [and] texture mapping."

Additionally, researchers at Ohio State University's Computer Graphics Research Group (CGRG) began developing animation languages and more complex modeling and animations systems. In 1972, for instance, Tom DeFanti developed an animation language for artists called Graphics Symbiosis System (GRASS), which was used to create the Death Star in *Star Wars* (Sito, 2013, p. 60). In 1973, Manfred Knemeyer developed ANIMA, an animation system that enabled computer-generated motion. Mark Gillenson also developed a system called WhatIsFace "that used techniques of keyframe animation to blend images to create facial drawings" and perform morphing (Carlson, 2003). In 1974, Rick Parent developed "geometric modeling tools for animation." Dave Zeltzer created the Skeletal Animation System, a program that "developed goal-directed motion description capabilities for skeletal and creature animation." Mark Howard's work resulted in "real-time playback of animation tests."

CG Developments Emerging from National Research Labs

While university researchers developed new CG algorithms, software, and hardware, researchers at national and private laboratories also continued to use CG for scientific visualizations. In the late 1970s, a computer graphics lab was established at the Jet Propulsion Lab primarily to create visualizations from NASA space flights (Carlson, 2003, Sec. 4). Jim Blinn produced several simulations of the space-crafts Voyager, Pioneer, and Galileo as they flew by Jupiter and Saturn.[25] Blinn's animations differ from Catmull and Parke's early hand modeling in that they are in color and have some realistic-looking texturing. Blinn also later

[25] One of Blinn's CG animated films *Voyager 2 Encounters Jupiter* (1978) can be viewed here: https://www.youtube.com/watch?v=o4xIJlEV8Kw .

created CGI for televised series such as the *The Mechanical Universe* and Carl Sagan's *Cosmos* (Carlson, 2003, Sec. 4). Similarly, at Lawrence Livermore National Laboratories, Nelson Max created several computerized scientific visualization films, including *Turning a Sphere Inside Out,* and *DNA with Ethidium,* and *Doxorubicin/DNA*. Like Blinn's animations, Max's animations appear more complex than those developed in the 1960s. In *DNA with Ethidium* (1978)*,* for example, blue and red sphere-shaped molecules are connected to a DNA strand that rotates slowly over a black background.[26]

CG Developments Emerging from Commercial Companies

While researchers in national and private laboratories were creating 3D scientific visualizations, commercial CG companies also began emerging during the 1970s to produce images for TV, advertising, and film. According to Carlson (2003), these early companies included Robert Abel & Associates (1971), Mathematical Applications Group Inc/SynthaVision (1972), Picture/Design Group (1972), Image West (1975), and Digital Effects (1978). Robert Abel & Associates developed commercials for 7-Up and Levis. MAGI/SynthaVision is believed to have developed the first CGI commercial for IBM, and Digital Effects created advertisements for both CBS and NBC. Several companies, including, Robert Abel & Associates, MAGI/SynthaVision, Information International Inc. (III), and Digital Effects were also contracted to collaborate on special effects in the movie *TRON.*

Interdisciplinary Developments in CG Gaming

As private companies began developing CG for TV, advertising, and film, entrepreneurs also began developing commercial CG games. For instance, in 1971, Nolan Bushnell and Ted

[26] Max's *DNA with Ethidium* can be viewed here: https://www.youtube.com/watch?v=TD0-2lkvfgU .

Dabney created the first computer game, *Computer Space,* which required players to shoot at flying saucers from a simulated rocket ship (Edwards, 2011). The game and its instructions, however, were too complicated for users, and so it was not considered successful (Sito, 2013, p. 108). In 1972, Bushnell and Dabney founded Atari*,* where Alan Alcorn created *Pong*, a computerized ping-pong game. *Pong* allowed users to control a 2D paddle and to play against another opponent. As Sito (2013) noted, "*Pong* is now considered one of the greatest breakthroughs in motion graphics. Before *Pong,* all computer actions were text-based. You typed in code for everything. *Pong* was the first to use real-time images to communicate a graphic idea" (p. 110).

While entrepreneurs, such as Bushnell and Dabney created computer games for the public, government researchers also experimented with computer game development. In 1974, for instance, government researchers created *MazeWar*, a network multiplayer shooter game. In *MazeWar,* "a player ran through a black-and-white vector maze while shooting it out with others online" (Sito, 2013, p. 105). However, because *MazeWar* was considered classified, it was not publically released.

By 1976, arcade games such as *Asteroids* and *Centipede* became increasingly popular, and in 1978, Taito*,* a Japanese company, manufactured *Space Invaders,* another popular game.

1.2.4 The 1980s and Beyond

During the 1980s, CGI spread throughout the commercial sector. Although many of the "first generation" production companies (e.g. Robert Abel & Associates, Digital Productions, and Omnibus) went out of business, other companies were reorganized and new ones were founded to meet demands for CGI in advertising, television, movies, gaming, and software development (Carlson, 2003, Sec. 11).

CGI Companies Focus on Advertising, TV, Movies, and Gaming

Throughout the 1980s, new (and reorganized) companies continued to push the boundaries by creating CGI for advertising, TV, movies, and gaming. For instance, Pacific Data Images (PDI) (1980) produced graphics for television shows such as *Entertainment Tonight* and for advertising for the 1984 Olympic Games on ABC (Carlson, 2003, Sec. 6). Cranston/Csuri (1981) created "opening graphics for 3 Super Bowls; the on-air sports promotions for ABC, CBC, NBC, and ESPN networks; and news open[ers] and promos for all of ABC's news shows" (Sec. 6). The company also made ads for "Sony, Proctor and Gamble, AEP, GE, and DOW" and provided graphics for *Twisted Sister's* and *Chaka Khan's* music videos (Sec.6). Wavefront Technologies (1984), similarly, created CGI for programs such as *Showtime, Bravo,* and *National Geographic Explorer.*

Other production studios made important contributions in television and film. For example, deGraf/Wahrman (1987) developed the "first virtual character for television" (Carlson, 2003, Sec. 11). Kleiser Walczak Construction Company (1987) "experimented with CG actors which they call Synthespians . . . . a new brand of animated three-dimensional characters with a high degree of life-like motion" (Carlson, 2003, Sec. 11). Lamb & Company (1980) experimented with motion capture in 1989 to assist with keyframe animation, and Xaos "was an early pioneer in developing particle animation engines." Meanwhile, Blue Sky Studios (1987) became known for its "realistic lighting" software.

During the 1980s, production houses also increasingly created CGI for movies and for fully-animated cartoons. The 1982 movie *TRON* first drew attention to CGI's use in the movie industry (Carlson, 2003). However, it did not immediately gain popularity among Hollywood producers for several reasons: *TRON* required "four major production companies to produce over

20 minutes of full 3D graphics," so it was also not cost-efficient, and the movie was unsuccessful with movie-goers. However, in 1984, *The Last Star Fighter* renewed interest in CGI, and it began to be used in many popular 1980s films, including *GhostBusters* (1984), *Who Framed Roger Rabbit* (1988), *Indiana Jones and the Last Crusade* (1989), and *The Abyss* (1989) among others.

3D CGI was also increasingly used for producing fully-animated cartoons. During the 1980s, Pixar Animation Studios produced several widely acclaimed shorts (Carlson, 2003, Sec. 11). These shorts included *Luxo Jr.* (1986)[27] – about a miniature hopping desk lamp that wants to play with a ball; *Red's Dream* (1987)[28] – about an unsold unicycle's dreams of stardom; and *Tin Toy* (1988)[29] – about a toy tin marching band drummer who meets the drooling baby it belongs to. These animations differ greatly from those produced in the 1970s in that 3D objects, colors and textures, and animation look more realistic.

While CGI began to be used in both the movie and TV industries, it also became popular in the video game industry. For instance, during the 1980s, Japanese designer Toru Iwatami – wanting to create a video game that "appeal[ed] to women" developed *Pac-Man,* a "little [pizza-shaped] character [that] eats things rather than killing them" (Sito, 2013, p. 113). As Sito (2013) suggested, "*Pac-Man* became one of the most successful video games in history" (p. 114). Other games using CGI also gained popularity. Japanese designer Shigeru Miyamoto at Nintendo created *Donkey Kong*, which resulted in many "spinoffs" such as *Donkey Kong Jr., Mario,* and *Supermario Bros.* Sito (2013) noted, however, that by 1982, the arcade market "reached saturation" (p. 116) and American game makers turned to other endeavors. However, Japanese companies, such as Nintendo and Sega – identifying a market for home consoles and games –

[27] The 3D flick can be viewed here: https://www.youtube.com/watch?v=D4NPQ8mfKU0 .
[28] The flick can be viewed here: https://www.youtube.com/watch?v=X6ybsfTbAgA .
[29] The flick can be viewed here: https://www.youtube.com/watch?v=wtFYP4t9TG0 .

began manufacturing systems and games for home entertainment, and they continued to do so throughout the 1990s.

CGI Software Development

During the 1980s and the decades that followed, seminal software companies also emerged. Autodesk (1982) developed the first animation package, *AutoFlix*, in 1986 for the PC (Carlson, 2003, Sec. 8). In 1985, Alias developed Alias/1, a software package that "was based on cardinal splines, producing much smoother and realistic lines or surfaces than polygonal lines" (Sec. 8). The company also produced Alias/2 in 1986, which "led to the creation of the term CAID (computer-aided industrial design)." As Carlson (2003) suggested, the software was used by companies such as Timex, Reebok, BMW, GM, Honda, Apple, Sony, and Industrial Light and Magic (Sec. 8). In 1989, Honda also began using Alias' 3D software to design its cars, as did BMW and Volvo. Wavefront Technologies (1984) developed its own software, including Personal Visualizer (1988), which "gave CAD users a point and click interface to high-end photorealistic rendering" (Sec. 8). It also sold Data Visualizer to researchers in scientific communities for use in industrial design. Wavefront Technologies also developed widely-used software in the 1990s, including *Composer*, which Carlson (2003) stated "would become a standard for professional 2D and 3D compositing and special effects in the feature film and broadcast/video arenas" (Sec. 8). Other software developed by Wavefront in the 1990s included Kinemation (1992), "a complete 3D character animation system for creating synthetic actors with natural motion and muscle behavior" and Dynamation (1992), "a powerful 3D animation tool for interactively creating and modifying realistic natural images of dynamic events" (Carlson, 2003, Sec. 8). Additionally, like many of these companies, Pixar Animation Studios created its own software, including REYES, a rendering program, and *Marionette*, an animation

software that integrated modeling, animating, and lighting (Sec. 11). With these newer CGI products, and their increasing use, CGI had come of age. By 2002, the Blender Foundation released the 3D CGI program Blender (discussed in Chapter 3 and used in Chapter 4) under a GNU General Public License which meant that 3D CGI could be created by anyone who owned a computer (Blender Foundation, "History," n.d.).

1.2.5 In Conclusion

The interdisciplinary trends begun in the 1980s continued into the next two decades: Researchers made (and continue to make) advances in CG algorithms, hardware, and software; companies continued to make CGI for television advertisements, gaming, and movies; and software companies continued to make programs that were increasingly user-friendly. These interdisciplinary advances also resulted in CGI's increased rhetorical use. The next section selectively discusses how researchers across academic fields rhetorically used 3D CGI since the mid-to-late 1980s and early 1990s to facilitate their work.

1.3 Situating 3D CGI Rhetorically in Research Across Disciplines

While the last section situated 3D CGI historically and emphasized its interdisciplinary development, this section demonstrates the ways in which interdisciplinary professionals use 3D CGI rhetorically (with or without an awareness of doing so). For instance, some professionals (e.g. in law, advertising, education) use 3D CGI primarily to visually persuade and inform. Other professionals (e.g. in engineering and architecture) use 3D CGI as a visual invention strategy within a larger rhetorical design process. And still others (e.g. in medicine) use 3D CGI as visual data that must be analyzed and interpreted to create new knowledge. This section overviews how 3D CGI has been used by professionals across disciplines and discusses how these uses clearly fit within the realm of rhetoric.

1.3.1 Persuasive and Informative Uses of 3D CGI

The most obvious persuasive and informative uses of 3D CGI appear in the fields of law, advertising, and education. In the legal field, for instance, Dunn (2002) asserted that lawyers often used computer animations not just to visualize scenarios or to clarify physical evidence, but to persuade jurors (p. 2). According to Dunn's (2002) two case studies, the persuasiveness of computer animations on juries depended upon the trial type and the kinds of evidence presented by the prosecuting and defending attorneys. Her study found, for instance, that when the prosecutor used computer animation to present evidence and the defense attorney used only diagrams, the jury tended to believe the prosecutor. However, when the defense used computer animations and the prosecutor used visual diagrams, the jury tended to favor the defense. Additionally, computer animations persuaded jurors more when they depicted unfamiliar scenarios, such as evidence of a plane crash, rather than more familiar scenarios, such as evidence of a car crash. Kassin and Dunn (1997) suggested that juries might be persuaded more

by computer animations because they lack knowledge of physics; because they are "highly influenced by information that is vivid, easy to imagine, and readily available in memory" (p. 270); and because it is easier for juries to make decisions when presented with a series of temporal events that they can link together via common sense. Kassin and Dunn (1997) concluded, then, that while computer animated displays assisted juries in decision making, they could also be used to mislead jurors, particularly when animations did not support physical evidence.

Like lawyers, advertisers also use 3D CGI to persuade consumers to purchase their products. According to Phillips (1996), companies used animated spokes-characters because they effectively persuade and aid in recall. Animated spokes-characters help consumers cognitively link products with packaging and advertising. By personifying the product, animated spokes-characters increase the brand's meaningfulness and emotional appeal, which may result in a preference for a specific brand. Callcott and Phillips (1986) further suggested that to be most effective, animated spokes-characters had to have a distinct personality and a physical appearance that consumers like. Interestingly, Pashupati (2009) noted that while traditional animated advertisements targeted children and were associated with low-involvement products like cereal, cleaning supplies, and children's products (p. 375), companies increasingly have used animated spokes-characters to persuade adults to purchase other products. In Pashupati's (2009) study on direct-to-consumer (DTC) prescription drug advertising, seven out of 56 brands used animated spokes-characters including Lunesta, Lamisil, Imitrex, Nasonez, Rozerem, Tamiflu, and Zoloft. These prescription drugs (excluding Imitrex and Tamiflu) ranked among the top ten DTC drug advertising campaigns for brand recall and brand association. Pashupati (2009)

concluded, therefore, that consumers have better brand recall and association when companies use animated spokes-characters.

More recently, marketers and advertisers have focused their research on how animated features of web advertisements affect consumers. Traditionally, researchers have found animation in web advertisements psychologically superior in gaining individuals' attention than static visuals (Sundar and Kalyanaraman, 2004, p. 7). Animated advertisements resulted in stronger orienting responses, stronger arousal, and better ad recall as well as in more positive attitudes toward the advertisements. However, Sundar and Kalyanaraman (2004) also found that animation speeds affected perceptions of advertisements. While faster animations initially attracted more attention, slower animations better engaged consumers, who reported they found slower animations more vivid and more emotionally interesting and appealing. The authors advise companies to experiment with animation speeds to create the most psychologically appealing ads.

While the legal and advertising fields primarily use 3D CGI to persuade, professionals in education have embraced 3D CGI as a way to engage students in meaningful learning. O'Day (2008) suggested animation had the potential to enhance learning, especially in the sciences because it communicates complex information in meaningful ways and incorporates principles recognized as important in acquiring knowledge. For instance, animation conveys information in multiple modes, especially visually and aurally, and it encourages interactivity as learners engage with images, animations, sound, narratives, and text. This interactivity, O'Day (2008) argued, fosters active thinking and may aid learners with long-term retention. Perhaps for this reason, 3D CGI has been integrated into many educational contexts.

For instance, Barab et al (2000) used 3D animation and VR technologies in undergraduate Astronomy courses as an alternative to the large lecture-style course. Unlike the lecture-style format, 3D and VR technologies create a "technology-rich, inquiry-based, participatory learning environment" (p. 9) for students. In Barab et al's (2000) pilot study, groups of students created 3D models of either the Earth-Moon-Sun systems, or they modeled the entire solar system, ensuring they portrayed the correct orbits, sizes, colors, rotations, distances, and internal structures. Instructors provided heuristic questions for students to answer and required students to write a joint paper, which they presented to other groups in a VR environment called CAVE. Students further presented their 3D animations to the entire class, wrote individual papers about their research, and took an exam. Students in the pilot study scored higher on items testing conceptual knowledge than students enrolled in the large, lecture-style courses. Students in the pilot study were also more actively engaged and asked content-specific questions to complete their projects.

3D CGI has also been used to inform and engage individuals in educational environments outside of the classroom, however. For instance, Bates et al (2009) found 3D CGI useful in educating the public about their paleontology research. Using 3D CGI, the authors reconstructed the body mass, volume, outlines, respiratory structures, and internal organs of dinosaurs from fossilized remains (p. 135). By creating 3D CGI models of these fossil specimens and integrating them into interactive museum displays for the public, the paleontologists not only preserved rare fossils and conserved museum space, but they also generated public interest in their research.

These uses of 3D CGI are, of course, obviously rhetorical. Rhetoricans, in each case, could analyze the ways 3D CGI informs and persuades the public or students in educational settings using Aristotle's appeals to logos, ethos, and pathos, for example.

1.3.2 Uses of 3D CGI as an Inventional Strategy in Design Processes

Other disciplines, such as engineering and architecture, use 3D CGI rhetorically in more subtle ways – as an inventional strategy within a larger rhetorical and compositional design process – to create real-world objects and structures. Ma, Shen, and Zhang (2004) noted that 4D animation software programs, which incorporate 3D animation and time, enabled civil engineers to visualize sites, simulate construction scenarios, communicate designs, schedule data, and view potential problems before construction begins.

For this reason, perhaps, 3D CGI is often used to train engineering and architecture students. Sampaio, Ferreira, Rosario, and Martins (2010) used CAD technologies to help students conceptualize construction planning and techniques. Students followed specifications and configuration details to virtually construct a bridge and a lighting system. The authors indicated that using 3D and 4D animation technologies, paired with VR, taught students not only about construction and design, but it also supported decision making. Additionally, Clayton, Warden, and Parker (2002) used 3D and 4D CGI technologies in architecture courses to teach students about drafting conventions, construction materials, and the importance of precision and collaboration.

Although these uses of 3D CGI do not at first appear rhetorical, Buchanan (1985) and Roxburgh (1999) suggest they are. Buchanan (1985), drawing on Aristotle's logical, ethical, and emotional appeals, asserted that communication (and thus rhetoric) is an inherent feature of all design processes. Designers, including engineers and architects, always make logical, ethical, and emotional arguments in their designs. Designers must use logic (i.e. technological reasoning) to "manipulat[e] materials and processes to solve practical problems of human activity" (p. 9). Logically designed products, he asserted, persuade when they "addres[s] real needs . . . [and] meet those needs in a reasonably expedient way." Use logic, then, is always built into designed

object – whether they are bridges, buildings, or electrical systems – and those objects that are most persuasive to users are those that clearly communicate (and make tacit arguments regarding) what the object is used for; where and when it can be used; how it is used; whether it meets a need for use; and whether it has use value. Designers must also persuade users, through their designs, "that a product has credibility in their lives" (p. 12). Buchanan (1985) argued "Designers fashion objects to speak in particular voices, imbuing them with personal qualities they think will give confidence to users, whether or not the technological reasoning is actually sound" (p. 14). In addition, designers must "put an audience of users into a frame of mind so that when they use a product, they are persuaded that it is emotionally desirable and valuable" (p. 16).

Roxburgh (1999) further argueed that design processes, including those of architects and engineers, are also rhetorical because they are always products of larger social, cultural, economic, and political discussions among clients and designers, who negotiate and often contest designs. Thus, these design processes – often viewed as removed from the field of rhetoric – are very much part of it.

1.3.3 3D CGI's Use as Visual Data

Perhaps the least obvious rhetorical use of 3D CGI across disciplines is as visual data that is manipulated, analyzed, and interpreted to create new knowledge. 3D CGI's use in various fields of medicine provides a good example. For instance, oral and maxillofacial surgeons S. Girod, Keeve, and B. Girod (1995) used 2D computer tomography (CT) data to make 3D graphics, which were then used to plan preoperative surgery on patients with cranial deformities and to visualize postoperative results in bones and soft-tissues (p. 120-125). Similarly, Xia et al (2000) used 2D CT data to reconstruct 3D models of patients' skulls, mandibles, necks and skin

surfaces. The team then "immersed" the 3D models into a virtual surgical simulation system, enabling them to plan and perform virtual osteotomies before conducting the actual surgeries.

Biomedical engineers have also used 3D CGI to help surgeons analyze data and diagnose disease. Taratorin and Sideman (1995) argued that 3D imaging technologies could be used to diagnose some kinds of heart disease (e.g. aneurysms) because they allowed surgeons to "globally examine" the changing shape of heart tissue. The authors used Cine-CT data to construct a 3D model of the left ventricles of four patients, two with healthy hearts and two with aneurisms. They then mapped the "form-time structure" of the actual hearts onto 3D models and showed that aneurismal hearts differed from healthy hearts in tissue thickness and contraction/relaxation times.

Neurologists, have similarly used 3D CGI to understand complex relationships among brain structures that 2D imaging captures less well. Toga and Payne (1991), for instance, argued animating static 3D neuroimages of small brain structures helped them to better understand static "complex displays" (p. 290). Using 3D animations, they virtually "[flew] through a scene" or zoomed "into a display," which helped "establish the context and spatial relationships" of smaller brain structures (p. 290).

Although we often associate these uses of 3D CGI with more objective, scientific methods, they are also highly rhetorical because they involve subjective decision-making processes. As Vannier (2000) suggested, evaluations of 3D medical images typically require "a human operator or interpreter" (p. 168). Additionally, human interpretations of visual 3D images are contingent upon numerous contextual factors: the type of imaging technology used; its accuracy, precision, and reliability in scanning digital images (p. 171); the experience of equipment operators; the experience of image readers (p. 173); the quality of the images (p. 175);

and an individual's body size/shape. Interpretations of such images, are furthermore rhetorical because they often generate debate and discussion among medical experts.

Emig (1982) also suggested that what constitutes knowledge and evidence and how we "value/judge" it depends upon the inquiry paradigms of the given fields we belong to. These inquiry paradigms – within fields such as medicine and rhetoric – teach us to see and understand our realities in different ways. As she suggested, "Perceiving is a process of immensely complex activity and selectivity. We see what we elect to see" (p. 65). She further asserted, "Our gaze is determined by our expectations, which are in turn governed by our experiences, and what we have decided to cognitively make of them: by, that is, our hypotheses, schemes, and constructs" (p. 65). Emig also asserted that what we view as evidence and how we value/judge/interpret it depends upon the "sets of assumptions" (p. 69) we carry. These assumptions often result from a field's theories, traditions, authorities, methodologies, and logics (p. 72). For this reason, then, interpretations of 3D CGI used as data are also highly rhetorical.

1.3.4 In Conclusion

As these multiple and varied uses suggest, 3D CGI is highly rhetorical. RWS scholars, then, must recognize its rhetorical and compositional potential and incorporate it as an object of study in their courses. In the next section, I briefly survey scholarship on animation in Rhetoric and Composition Studies and argue that more scholarship is needed in our field.

1.4 Situating 3D CGI in Rhetoric and Composition Studies

Despite 3D CGI's broad interdisciplinary history and its rhetorical use across professional disciplines, Rhetoric and Composition Studies has produced very little scholarship on the topic. While scholars have investigated the rhetoricity of many kinds of digital media -- including sound (McKee, 2006; Selfe, 2009; Rickert, 2013); visual images (Kress, 2003; Stroup, 2000; Blair, 1996); gaming (Bogost, 2007); video (Arroyo, 2013), hypertext (Bolter, 1993), etc. –fewer scholars have examined composing with 2D animation (e.g. Ellertson, 2003; Duffelmeyer & Ellertson, 2005; Sorapure, 2006; Luckman & Potanin, 2010). Still fewer scholars have examined composing with 3D CGI (e.g. Morton, 2010; Orlowicz, 2010; Thomas & Tufano, 2010; Sherman, 2012). This section briefly reviews scholarship on 3D CGI and animation.

1.4.1 Scholarship on 3D CGI and Animation in Writing Classes

In RWS journals, inquiry into animation results in a plethora of articles on new media, electronic literacy, web authoring, gaming, and virtual reality. These articles, however, often list animation as one of many multimodal design elements rather than discussing, in any depth, animation's rhetorical or pedagogical potential in writing classrooms.

The few articles devoted entirely to animation typically focus on Adobe Flash (formerly Macromedia Flash), a software used by graphic designers and novices to animate text and images and to save interactive digital projects to small files. Scholars writing about Flash emphasize both its pedagogical and its theoretical importance. Duffelmeyer and Ellertson (2005), for example, discussed using Flash in first-year composition (FYC) courses as an alternative to teaching website design and hypertext, which do not provide enough structure for first-year composition (FYC) students, who need help focusing, developing, and organizing arguments as well as articulating and analyzing texts. Dufflemeyer and Ellertson (2005) also identified three

critical technological literacies Flash enables: an understanding of the constructed nature of texts; an awareness of students as composers and readers of texts; and a sense of agency. Ellertson (2003) also advocated using Flash in FYC because it helps students develop an increased awareness of multimedia techniques, an awareness of multimodal rhetoric, and an increased awareness of audience. It also allows students to speak back to dominant cultural discourses. However, Ellertson (2003) also took a more critical approach to using *Flash,* acknowledging arguments of theorists with more deterministic views of technology. Drawing from Baudrillard's notion of simulation, Ellertson (2003) called Flash a "simulacra machine" because it enables the endless remixing and repurposing of digital media. Using Althusser's notion of interpellation, and drawing on ideas from Feenberg, Ellertson (2003) acknowledged that we cannot neutrally separate ourselves from technologies like Flash*,* which shape our ways of thinking and being, and which discipline users by forcing them to work within software frameworks. These criticisms, however, ultimately function to support Ellertson's (2003) argument for using Flash to teach students critical literacies.

Sorapure (2006) took a thoroughly theoretical approach to examining Flash*,* and her article attempted to answer the question Kathleen Blake Yancey (2004) posed in her CCCC chair's address: "What do our references to writing mean?" Sorapure's analysis suggested writing in the 21^{st} century means, in part, composing in multiple modes: in text, in images, in codes, and in code comments. Writing takes many forms and serves different functions; as a result, writing in the 21^{st} century is "dynamic . . ., interactive, and social" (p. 427).

Orlowicz's (2010) article, geared toward do-it-yourself (DIY) media users, provided a brief history of animation before offering an introductory tutorial to Flash. She argued animation's pedagogical value lies in helping students consider the "end user/viewer" during the

design and production process. In addition, she suggested that exposing students to the design process helps students develop numerous competencies, including media literacy; communication competence; critical thinking and systems thinking skills; problem identification and solution skills; creativity and intellectual curiosity; interpersonal and collaborative skills; social responsibility; self-direction; and accountability and adaptability (p. 202).

Other scholars (Morton, 2010; Luckman & Potanin, 2010) examined using machinima in composition classrooms. Luckman and Potanin defined machinima as "animated filmmaking which uses 3D game engines as the source of the video material" (p. 136). In their article, Luckman and Potanin, like Orlowicz, provided a brief history of the new media form, discuss its strengths and weaknesses, provided a basic "how to" guide for beginning machinima projects, and provided various activities DIY users might try. Morton, unlike Luckman & Potanin, discussed machinima's epistemic nature.

Finally, Thomas and Tufano (2010), like Orlowicz and Luckman & Potanin, geared their article toward DIY users. They similarly provided a brief history of stop-motion animation, and provided a tutorial for making stop-motion animation.

1.4.2 In Conclusion

While these scholars address different ways animation can (and should) be integrated into writing classes, they do not address using 3D CGI in technical communication classes or the rhetorical choices users must make when using such software. For this reason, the next chapter situates my project's inquiry and methods.

Chapter 2: Conceptualizing 3D CGI Using Ecological Models

2.1 Introduction

Theories of digital media in the field of Rhetoric vary widely, and there is no singular, unifying theory to analyze digital scholarship.[30] Generally, rhetorical theories of digital media do not provide an adequate methodology for rhetorically conceptualizing or analyzing 3D CGI. These theories often create highly structured frameworks particular to one form of digital media; they discuss broad characteristics that do not account for 3D CGI's complexity; or they re-theorize the rhetorical canons in ways that greatly limit how one thinks about 3D CGI.[31] Additionally, these theories don't always account for the larger environments in which technologies are used, and they often minimize the importance of creativity, innovation,

[30]Eyman (2015) asserted that digital rhetoric, much like visual rhetoric, should be seen as a large field with many different theoretical frameworks, and he noted that theories of digital rhetoric fall under three categories: 1) those that apply classical (i.e. Greek or Roman) or contemporary (e.g. Barthes, Burke, Foucault) rhetorical theory to analyze or inform the digital; 2) those that revise classical rhetorical theory to analyze and inform the digital; and 3) those that go outside the discipline of rhetoric to create new theories of digital media (p. 61). Scholars who have chosen to go outside the discipline to theorize digital rhetoric have drawn from theories of networks, ecologies and ecosystems, and economies of circulation, among others. In this project, I use both contemporary theories as well as the ecological framework to theorize 3D CGI.

[31]For instance, Bolter & Grusin's (1999) *Remediation: Understanding New Media* theorized that new media remediates (i.e. incorporates and builds upon) older technologies to satisfy our desire for immediacy and hypermediacy. While 3D CGI programs do remediate technologies such as cinema, photography, sculpture, and animation (among others) to create a sense of immediacy and hypermediacy, remediation is only one of 3D CGI's features. Similarly, Rice's (2007) *The Rhetoric of Cool: Composition Studies and New Media* broadly discussed six characteristics of new media composing: chora, appropriation, juxtaposition, commutation, nonlinearity, and imagery. But, like remediation, these characteristics only partially characterize 3D CGI. For instance, users can appropriate (i.e. "rip") such things as models, textures, and backgrounds from various online sources, but they also very often build them from scratch using program algorithms and operations. Similarly, although 3D CGI often juxtaposes objects, the objects, themselves, can still require hierarchy. For example, rigs (3D skeletons) must be parented (assigned) to skins (3D human models) in order for a 3D character to move, but for a character to move in realistic ways, specific bones within a rig must be hierarchically parented to other bones. Additionally, animation, itself, requires linearity, relying on keyframes (specific locations for movement in space), which are set along a timeline specifying *when* movements will occur. Thus, while Rice's (2007) characteristics are important, they are too broad to use to analyze 3D CGI. Similarly, Brooke's (2009) *Lingua Fracta* presented a rhetoric of new media that emphasized the interface as a "unit of analysis," and Brooke (2009) retheorized the classical canons in terms of ecologies of practices (p. 25). He reframed invention as proairesis; arrangement as pattern; style as perspective; memory as persistence; and delivery as performance. However, Brooke's (2009) reframing is similarly problematic in two ways: First, like Rice's (2007) theorization, it presents very broad categories that do not always fit 3D CGI, and second, Brooke's (2009) reliance on the classical rhetorical canons is problematic because it greatly restricts the lens by which we view and can rhetorically theorize digital rhetoric.

problem-solving, revision, and collaboration needed to compose and produce 3D CGI. For this reason, in this project, I use both contemporary rhetorical theories as well as an ecological framework to theorize 3D CGI. More specifically, I borrow from ecological models of other rhetorical scholars to conceptualize 3D CGI as a rhetorical ecology with micro-, meso-, and macro- levels. This chapter discusses the frameworks I draw upon to conceptualize 3D CGI ecologically and rhetorically. This chapter includes the following subsections: In **Section 2.2 "The Ecological Framework: Usefulness & Limitations as a Research Method,"** I overview the ecological model, discuss its use as *a research method* as described by Fleckenstein, Spinuzzi, Rickly, & Clark Papper (2008), and discuss its usefulness and limitations in this study. In **Section 2.3 "Information Ecologies: Considering the Larger 3D CGI Ecology"** I discuss the ways Nardi & O'Day (1999) appropriated the ecological model to conceptualize human's use of technology as part of a larger ecology of people, practices, and values, and I discuss why this model is useful for conceptualizing 3D CGI. In **Section 2.4 "Rhetorical Ecologies and 3D CGI,"** I overview Edbauer's (2005) notion of rhetorical ecologies, discuss why it is useful in conceptualizing 3D CGI rhetorically, and discuss how this notion influences my understanding of 3D CGI as rhetorical. In **Section 2.5 "3D CGI's Rhetorical Information Ecology,"** I briefly overview the elements constituting Blender's 3D CGI Rhetorical Information Ecologies. Finally, in **Section 2.6 "Demarcating My Scope,"** I discuss my research scope to answer these questions posed by later chapters:

- How is 3D CGI rhetorical? (e.g. Chapter 3)
- How can technical communication instructors use 3D CGI in their classes? (e.g. Chapter 4)
- What are "best practices" for integrating 3D CGI? (e.g. Chapter 5)

2.2 The Ecological Framework: Usefulness and Limitations as a Research Method

Ecological research models, often used in anthropology and sociology, take the concept of a biological ecosystem and use it as a metaphor to study how individuals engage in activities in their environments (LeCompte & Schensul, 2010, p. 72). Scholars using the ecological framework theorize that individuals – much like organisms in an ecosystem – exist in complex and interdependent social, technological, and environmental systems, and they examine how individuals, their activities, their tools, and their environments continually adapt to and change each other.

However, rhetorical scholars Fleckenstein, Spinuzzi, Rickly, & Clark Papper (2008) have argued that the ecological model works well as a framework for researching 21st century conventional and digital writing. They asserted – perhaps most importantly – that the model works well as a research framework because it is metaphorically "congruent" with ecological models of writing (See Cooper, 1986; Dobrin, 2001, Syverson, 1999).[32] For example, both ecological writing and research models require interdependence among elements. Just as ecological writing models require scholars to study writing in terms of interdependent relationships among writers, texts, language, tools, and environments to better understand how those relationships coevolve (p. 393), an ecological research model requires scholars to conceptualize research elements – (e.g. the researcher; the research methodologies, methods, techniques; and the phenomenon being studied) – as interrelated, interdependent "symbiotic clusters" that "inform each other" (p. 394). The researcher's first task, then, is to study the interdependent relationships among research elements (including her own relationship in "a web

[32] Ecological writing models theorize writers as existing in complex systems that include other writers, texts, technologies, and environments in addition to a "'complex web of ideas, purposes, interpersonal interactions, cultural norms, and textual forms'" (Cooper cited in Flecknstein et al, p. 393). These theories of writing further assert that to understand how individuals learn to write, scholars cannot simply study the individual elements of writing (e.g. writer, strategies, error) alone but rather must investigate the interactions among the interdependent and diverse components in the writing ecology.

of social-material practices") in the ecology to better understand the phenomenon (p. 395) and to identify timely research questions that emerge from the researcher's situatedness within the ecology.

Additionally, both ecological writing and research models emphasize the importance of feedback (i.e. a "flow of information between organisms and their environment") in continually shaping the ecologies (p. 396). In ecological writing models, for example, feedback at the "social, material, and semiotic levels" influences a writer's purpose as well as her content, style, structure, and identity etc. (p. 396). Similarly, in an ecological research model, feedback "provides . . . the guidelines necessary to demarcate the scope, or the limits, of a research project within which the researcher is immersed" (p. 396). By identifying the key feedback "pathways" – including "the relationships, constraints, sustainability, and behaviors" (p. 398) of the research phenomenon, the researcher determines (using decorum of audience and occasion) the aspects of the ecology that are most relevant to her research project, and she, thus, selects which area(s) of the ecology to study. Because researchers demarcate the scope of their research – understanding that a study is always limited to one partial view of the ecology over others – they must also become cognizant that their research scope is always "mutable and permeable" as well as flexible (p. 399).

Finally, both ecological writing and research models require diversity. For instance, just as writers benefit from reading multiple texts that shape their perspectives and from getting feedback from numerous peer reviewers, diversity is also essential for good research. Fleckenstein et al (2008) emphasized that good research requires researchers to integrate "multiple sites of immersion, multiple perspectives, and multiple methodologies" – including different kinds of qualitative and quantitative research (p. 401). In an ecological research model,

then, the methodologies and methods researchers use are diverse and emerge from "the demands of the phenomena" (p. 410). This flexibility in using multiple methodologies also enables researchers to create (i.e. "evolve") their own unique methodologies for studying research phenomena.

While an ecological research model is congruent with ecological models of composing and thus creates a kind of harmony between the researcher, the research, and the phenomenon being studied (i.e. print or digital writing), Fleckenstein et al (2008) argued that an ecological research model is useful for studying writing for additional reasons. For instance, because ecologies are themselves complex, an ecological model "privileges the complexity and messiness of twenty-first century meaning making" and as a result also accounts for "the complexity and messiness" of 21st century writing (p. 389). Ecological models also "privilege[e] flexibility" (p. 399) since researchers can choose what aspects of the ecology to emphasize and de-emphasize. Finally, the ecological model allows scholars to take a rhetorical approach to research. As Fleckenstein et al (2008) suggested, "rhetoric is immersed in feedback loops that link the timeliness of the situation, the constraints of the situation, the push-pull of actuality and possibility, and the vagaries of audience to the research ecosystem . . . . rhetoric puts ecological thinking into action by providing answers to the why, what, when, how, and how much of research" (p. 405). Additionally, the authors suggested that rhetoric is inherent in the model because researchers must "devise and argue for a systematic account of reality in ways that others find persuasive, useful, and widely applicable while remaining sensitive to the incompleteness – the distortions of a single account" (p. 389). Interestingly, the authors suggested that enacting ecological research rhetorically allows researchers to make a difference in the world because by considering where to intervene in an ecology as well as what questions

are important to ask, they can identify places within the ecology that need further research and can contribute new knowledge.

However, the ecological model, as a research framework, also has limitations. For instance, it does not provide step-by-step methods to follow for creating knowledge as many methodologies do. Fleckenstein et al (2008) asserted, for instance, that enacting ecological research *rhetorically* will alone guide researchers in their data collection and evaluation methods as they carefully reflect on rhetorical notions of possibility, *kairos*, decorum (audience and context), and rigor (i.e. the number and density of interconnections etc.). Additionally, the research model Fleckenstein et al present provides no framework for analyzing or interpreting data. Rather, it requires researchers to either integrate multiple methods or to create their own.

Despite these limitations, the ecological research model provides an acceptable framework for my study. The open-endedness of the model allows me to delineate the scope of my research and methods. It offers the flexibility to combine theoretical scholarship as well as methods of data collection and analysis while accepting that the knowledge created will always be limited, partial, and contingent since ecologies are complex and dynamic. The model further is useful for my study because it is congruent with ecological models that other rhetorical scholars have used to theorize technology use (Nardi & O'Day, 1999, p. 49) and rhetoric (Rice, 2015). These models and their relevance to my conceptualization of 3D CGI are discussed in Sections 2.3 and 2.4 below.

2.3 Information Ecologies: Considering the Larger 3D CGI Ecologies

In their book, *Information Ecologies: Using Technology with Heart,* Nardi & O'Day (1999) applied the notion of ecologies to study how "human activities . . . are served by technology" (p. 50). The authors used the term *information ecology* to describe the complex "system of people, practices, values, and technologies in a particular local environment" (p. 49). The authors theorized information ecologies as having five key characteristics. First, information ecologies are conceived as systems "marked by strong interrelationships and dependencies" (p. 51). Therefore, if one part of the information ecology changes, other areas of the ecology are also affected. Second, information ecologies are marked by a diversity of people and tools– each of which serves different functions within the ecology and which enhances the sustainability of the ecology. A third characteristic is coevolution between the social and technological aspects of the ecology. For instance, as technologies change, individuals must adapt to those changes, and at the same time, technologies must continually be adapted to meet individuals' needs within the environment. Information ecologies also are marked by *keystone species* – "skilled people whose presence is necessary to support the effective use of technology" (p. 53). And finally, information ecologies are characterized by *locality.* A technology's use within an ecology and its perception by users will differ depending upon each localized setting, the people in that setting, their values etc.

Nardi & O'Day's (1999) model is useful in conceptualizing 3D CGI for two primary reasons: First, the model helps to account for the complex social, technological, and environmental systems that influence 3D CGI's development and use.[33] The social systems affecting 3D CGI, for instance, can be quite diverse. As just one example, careers advertised on

[33] The model, however, does not account for economic and political systems. (I view ideological systems as part of the social.) While these are very important – especially to 3D CGI -- they go beyond the scope of the current project.

Pixar's website include animators, artists, editorial/sound producers, story developers, production managers, software/research developers, post production, security officers, lawyers, and finance teams, among others (Pixar, 2015, "Career Opportunities"). These social roles are highly interdependent and affect the 3D CGI produced. Animators, artists, story developers etc. must collaborate to complete a 3D CGI movie, with each team modifying and transforming a 3D object. However, these experts also rely heavily on software/research developers to complete their work as well as security officers to ensure their work is not released to the public early or compromised. Additionally, Pixar fans (who support the organization through their pocket books) and Pixar competitors are part of the 3D CGI social ecology since they, too, affect 3D CGI products produced.

Similarly, the technological tools used to produce 3D CGI are diverse. There are numerous 3D CGI software programs (e.g. Blender, Maya, Rhinoceros, Tinkercad, Google SketchUp, SolidWorks etc.) with differing interfaces, internal logics, and operations. These programs – which themselves create very different epistemological and atmospheric "environments" for users – can also be thought of as "ecologies" worthy of exploring. However, 3D CGI software programs are also often used with other types of programs (e.g. GIMP, Photoshop, iMovie, GarageBand etc.) to assist in the creation of 3D CGI. Special programs (e.g. Re-Face! Facial Mocap Retargeting Tools, Make Human etc.) are available to do such things as animate character faces or create and animate ready-made human models. 3D technologies as well as add-ons are always in a state of flux, with versions being continually updated (or created) to meet the needs of designers. As Nardi & O'Day (1999) suggested, these technologies and their users continually coevolve.

Additionally, ecological environments profoundly affect not just the social and technological ecology but also the 3D CGI objects produced. For instance, at Pixar architectural design & furnishings foster social values of creativity, collaboration, and fun, and these values encourage practices and behaviors that further affect the kinds of 3D objects produced. Pixar Studios features a large center atrium with a café, mailroom, and game tables to encourage togetherness and collaboration (*Inside Pixar Animation Studios: Part I*). To foster creativity, employees are encouraged to transform their offices into themed immersive environments (e.g. "Tikiland"). Air vents are transformed into crawl spaces that are themed and decorated (e.g. "Love Lounge"). To further foster creativity, Pixar has scooters employees ride from office to office and spaces for miniature golf. Additionally, the company holds various contests (e.g. airplane throwing, ugliest make-up and dress etc.) to encourage fun. John Lasseter, the chief creative officer at Pixar, noted the importance environment has on the 3D CGI movies produced, saying, "I always believe that if you're having fun making the movie, it's going to appear on the screen" (*Inside: Part I*). Of course, as Nardi & O'Day (1999) asserted, locality greatly affects how individuals view the technology and its use, and not all 3D CGI environments embrace the atmosphere or technologies used at Pixar.

While Nardi & O'Day's (1999) model allows me to account for the larger social, technological, and environmental ecologies, the model is also useful to this project for a second reason: It provides a way to structure discussion about 3D CGI in terms of key elements (i.e. people, their practices, their technologies, their values, and their environments). This further allows me to demarcate my research scope. In Section 2.4 below, I discuss a second important element in my understanding of the 3D CGI ecology: the way I conceptualize rhetoric as ecological.

2.4 Rhetorical Ecologies & 3D CGI

In "Unframing Models of Public Distribution: From Rhetorical Situation to Rhetorical Ecologies," Edbauer (2005) applies the ecological model to rhetoric. She asserted that traditional models for describing (specifically) public rhetorics, such as the rhetorical situation, are problematic because they present rhetorical elements (e.g. speaker/writer, audience/reader, message) as "fixed," overly simplistic, and discrete. They, thus, do not account for multiplicity of exigencies, audiences, and messages that are part of public rhetorics. As she states,

> A given rhetoric is not *contained* by the elements that comprise its rhetorical situation (exigence, rhetor, audience, constraints). Rather, a rhetoric emerges already infected by the viral intensities that are circulating in the social field. Moreover, this same rhetoric will go on to evolve in *aparallel* ways . . . . (p. 14)

As she suggested, even more problematically, rhetorical situation models do not account for the ways that rhetoric circulates and transforms as it moves through social networks. Edbauer (2005) argued that "rhetorical communication is always in a state of flux" (p. 8), is fluid (p. 20), and is always "an amalgamation of processes and encounters" (p. 8) that "bleed into wider social processes" (p. 9). As a result, Edbauer (2005) asserted that scholars ought to conceptualize public rhetorics ecologically. According to Edbauer (2005), a rhetorical ecology includes multiple actors, "actions, events, and encounters that form 'small events loosely joined'" (p. 20). Rhetorical ecologies also include "co-ordinating processes, moving across the same social field and within shared structures of feeling."

To provide an example of the ways in which rhetoric moves, transforms, and is distributed throughout publics, Edbauer (2005) cited the use of the slogan "Keep Austin Weird" during the 1990s. The slogan was initially created by Austin's small business owners as an attempt to get the public to support locally-owned business that were being forced to close

because they could not compete with the large number of national franchises popping up around the city. The slogan was quickly embraced by the public. However, as it circulated throughout the city, other groups adapted the slogan and distributed it to suit their own needs. The slogan was used and was often changed, for instance, by a local radio station, the city council, local libraries, large franchises like Cingular, and the University of Texas at Austin's Liberal Arts' college for very different purposes, audiences, exigencies, etc.

Edbauer's (2005) notion of ecological rhetoric is also useful for conceptualizing 3D CGI as rhetorical. Her theorization of rhetoric as shaped by multiple actors, events, exigencies, constraints, etc. – as opposed to a singular situation with only three fixed elements of rhetor/audience/message – aligns more closely with the ways in which 3D CGI is designed, composed, and produced. As Section 2.3 discussed, 3D CGI, in many environments, is collaboratively created by multiple designers (e.g. modelers, animators, story development teams, videographers, editors, etc.), using multiple processes and technologies for multiple audiences and purposes (e.g. parents' and children's entertainment; education; and more simply, developers' desire to create increasingly realistic animations).

However, Edbauer's (2005) theorization is also helpful because it accounts for the movement of rhetorical objects and the ways an object's meaning transforms as it moves throughout an ecology. This notion, too, aligns well with the ways in which 3D CGI is created as well as distributed. The rhetoricity of a 3D CGI object, for instance, changes throughout creation processes (which are always, themselves, in flux) as it moves through different stages of production and as different technologies are used to create it. The *form* of a 3D CGI object, for example, shapes its meaning, but that meaning transforms as colors, textures, movements, lighting, camera angles, dialogue, music, sound effects, etc. are applied and as that object moves

from creator to creator, from software operation to software operation, from department to department. Additionally, the meaning of a 3D CGI object transforms as it circulates throughout the larger ecology of people, values, practices, and environment etc. As an example, the character Nemo (from the film *Finding Nemo*) in the larger ecology rhetorically transforms into a commercialized object that can be owned and played with or used to decorate one's home environment via bed sheets, pillows, and aquarium equipment (as well as oneself via clothing). Importantly, the larger ecology and its social values also greatly influences the creation of the 3D CGI object. For instance, Barnes (2013) noted in her *New York Times* article, "Finding Nemo Sequel is Altered in Response to Orcas Documentary," that Pixar changed the ending to its movie *Finding Dory* (2016) because of the negative public reaction to Gabriela Cowperthwaite's (2013) documentary *Blackfish,* which critiques SeaWorld's confinement and treatment of orca whales. According to Barnes (2013), *Finding Dory* (2016) initially ended with characters being taken to a theme park similar to SeaWorld. However, the script was later changed so that "the fish and mammals taken to its aquatic center have the option to leave" ("Finding Nemo Sequel is Altered," 2013). Thus, the negative rhetoric circulating in the larger ecology about animal captivity and treatment influenced the storyline of the 3D CGI movie, and *perhaps* even the way 3D CGI objects themselves were designed.

Edbauer's (2005) ecological notion of rhetoric is further useful to my study because it aligns well with Fleckenstein et al's (2008) ecological research model as well as Nardi and O'Day's (1999) information ecologies model. In both, rhetoric might be viewed as "the feedback loop" holding elements (e.g. research, researcher, object of study; people, practices, values, technologies; writer, writing, subject etc.) together and continually co-evolving with, transforming, and being transformed by them.

However, rhetoric functions on levels beyond just "the feedback loop." Rhetoric is deeply imbricated in algorithms designed to allow or disallow operations in software programs; it is imbricated in interface design and user experience; it is imbricated in users' moment-by-moment strategic choices to make 3D CGI objects mean at every stage in the object's development. Rhetoric is deeply entangled, too, in the institutions and environments in which 3D CGI is used, as well as within the values and ideologies of people working within those environments. And rhetoric manifests itself in multiple forms: spatial design, silence, language, gesture, visual image, haptics, etc. at every level of the information ecology. As Rickert (2013), too, asserted, the ambient environment (and other complex systems) enacts its own rhetorical agency and 3D CGI objects created can enact an agency of their own beyond their creators' intentions.

Therefore, in conceptualizing 3D CGI as rhetorical, I envision rhetoric as imbued in every aspect of the 3D CGI ecology and in all of its processes. For this reason, I combine Nardi and O'Day's (1999) and Edbauer's (2005) models into one concept: i.e. rhetorical information ecologies. Section 2.5 describes elements within 3D CGI rhetorical information ecologies and delineates the scope of my study within that larger 3D CGI ecology.

2.5 Blender's Rhetorical Information Ecologies

All 3D CGI ecologies are not the same; they differ depending upon the people, practices, software, environments, and rhetorics comprising a local ecology. Even users of the same software program, for instance, may engage in different practices, for different purposes, within different environments, and this in turn affects the ecology's atmosphere and the 3D CGI objects produced. It is beyond the scope of this project, however, to describe every 3D CGI rhetorical information ecology. Instead, I generally describe characteristics comprising Blender's rhetorical information ecology. This section begins by describing the technology and then the users, practices, environment, and rhetoric in Blender's rhetorical information ecology. Although I discuss the Blender software separately (and then discuss users, practices, environment, and rhetoric together), these elements are interdependent.

2.5.1 Blender's Technological Rhetorical Ecology

Blender is a free, open-source 3D CGI and animation software suite created primarily for artists and small teams. However, the software is available to all users through a GNU General Public License.[34] The software offers users the ability to develop and complete 3D animation projects (including short films) from start to finish by incorporating into its design many different 3D design technologies, including modeling, texturing, animating, simulating, rendering, compositing, video editing, and game creation. While Blender software constitutes one part of the rhetorical information ecology, it is also thoroughly rhetorical and can be

[34] Under its Copyleft license, individuals can use, distribute, study and change, and "distribute changed versions" of *Blender* software, provided that users first contact "module owners" (who oversee various software systems) and that users document the changes they make on the *Blender* wiki (License, https://www.blender.org/about/license/).

conceptualized as a kind of complex, multi-faceted ecology with micro-, meso-, and macro-levels.[35]

2.5.2 Blender's Micro-Rhetorical Level

Blender's micro-rhetorical level consists of the more "hidden" ways programmers make meaning and influence users' experience at the level of computer codes and algorithms.[36] Rhetorical scholars (e.g. Cummings, 2006; Ingram, 2014) have generally theorized the ways in which both computer codes and algorithms, such as those used to create Blender, function rhetorically. For instance, Cummings (2006), who uses the rhetorical triangle as the basis of his analysis, drew parallels between composing processes of writers/texts/audiences and programmers/codes/machines, users. He asserted that just as writers seek to "reach an audience through texts," programmers use computer code (a kind of hidden, less publically accessible text) to develop tools for "audiences" of machines (which process the code) and users (who benefit from and manipulate software created from the code) (p. 434). Similarly, Cummings (2006) drew on the work of Fortune and Kalambach (1999), who noted that much like writers use syntax and logic to organize and structure text, programmers use computer codes to organize "'the internal structure of individual statements and the interaction among statements to create an effect'" (cited in Cummings, 2006, p. 438). Cummings (2006) further noted that just as writers draw on invoked audiences in their writing, programmers must invoke previous successful and

[35] Both Spinuzzi (2003) and Ingram (2014) use the notion of micro-, meso-, and macro- structures to theorize genre ecologies and algorithms. This three-part framework is also helpful in conceptualizing Blender software because it helps to account for "hidden" rhetorical choices that users make and are aware of as they use the software as well as the larger scale rhetoric that occurs more publically and that goes beyond user control.
[36] It is beyond the scope of this project to completely describe a rhetoric of Blender software. Here, then, I draw on research from rhetorical scholars (i.e. Ingram, 2014; Cummings, 2006) who have already theorized the ways in which such things as computer code and algorithms are rhetorical.
.

unsuccessful coding experiences to guide their knowledge of how to create code to both achieve certain output effects for machines and users.

Of course, Cummings' (2006) use of the rhetorical triangle is problematic given Edbauer's (2005) theorization of rhetorical ecologies. Cummings' (2006) focus on the singular writer, audience, and text as well as the singular programmer, machine/user, and code is particularly problematic considering Blender's open-source status. Blender has numerous programmers, who are located in different countries (and speak different languages); who use more than one computer language (including C, C++, and Python); and who create code for multiple operating system platforms (Mac, PC, Linux). Additionally, because of Blender's open-source status, a large community of users share in the role of programming, and thus, audiences also function as programmers shaping the software. However, Cummings' (2006) notion is useful to this study because it emphasizes that software creation, itself, is neither neutral nor disinterested and that processes of writing text and programming code may share similar rhetorical considerations.

Ingram's (2014) scholarship on algorithms furthers the notion that software creation is not neutral. According to Ingram (2014), algorithms are rhetorical because they "function by making certain rules matter in certain ways, and the influence of these choices results in making other things matter in the world" (p. 68) including "how people come to understand, communicate, and negotiate the complex realities of global communities" (p. 63). Ingram (2014) conceptualized algorithms as consisting of "three tiers of rhetorical action": the macro-, meso-, and micro- levels. According to Ingram (2014), the micro-rhetorical level concerns "a specific algorithm's strategies, biases, and assumptions to reveal the values it promogulates and the practical effect these values have" (p. 75). Ingram (2014) drew on the five rhetorical canons (i.e.

invention, arrangement, style, memory, delivery) to theorize how algorithms function rhetorically. For instance, he asserted that algorithms follow the rhetorical canon of arrangement because they order information in certain ways. That arrangement, upon output, is manifested and displayed in different ways – which he suggested constitutes a kind of style or delivery. The algorithm must also “know and remember” certain “inputs” to reach a desired end, which constitutes a kind of memory. He gave the example of when visitors come to a site and are asked if it helped them. Visitors must enter data that “the algorithm [must] remember, tabulate, and consider among many other factors in ranking a reviewer with a particular status.” And Ingram (2014) suggested that the canon of invention occurs as algorithms decide how to rank reviewers’ comments based upon such things as “the length of a review, its documented helpfulness, the amount of products a reviewer has written” etc. (p. 75).

While the micro-rhetorical level deals with individual algorithms, Ingram (2014) asserted that meso-rhetorical level concerns how algorithms, themselves, generally operate. Ingram (2014) compared algorithms’ operation to Plato’s dialectic. As in dialectic, algorithms tend to ask a strategic set of questions that lead to specific answers, which result in a desired end. The difference between dialectic and algorithms, he noted, however, is that algorithms are “automated and repeated through digital processes” (p. 73). Ingram (2014) asserted that at this level, algorithms function rhetorically because in asking strategic questions, they also “bring a set of assumptions to bear on the input they receive in response” and thus function in imperceptible ways (p. 73).

Finally, Ingram (2014) asserted that the macro-rhetorical level deals with the way discourse about algorithms and their value circulates in the public sphere. He suggested that such discourse makes arguments regarding which algorithms are “the best, most efficient, appropriate/

consistent/ reliable/ disinterested/ precise/ and accurate *means* for reaching the various ends to which their automation might be directed" (p. 71) and these arguments ultimately involve rhetorical arguments that influence the cultural, political, economic, and ideological spheres. As he asserted, this level of rhetoric is important because it structures "a particular way of conceiving what counts as truth and what counts as mere manipulation of belief. It means thinking about why algorithms are . . . being granted the status of truth-makers as they are implemented, extolled, and faithfully trusted to mediate so many parts of global experience" (p. 72).

Ingram's (2014) work is also valuable to this study because it suggests that small, strategic choices at the algorithmic level – which users often can't see – have an incredible impact upon what users can do and what they can see and understand, etc. The value placed upon such things also takes on greater rhetorical implications in the larger social sphere politically, ideologically, economically, legally etc. For these reasons, then, in considering Blender's rhetorical nature, it is important to at least mention this micro-rhetorical level even though my focus (in Chapter 3) is on Blender's meso-rhetorical level, discussed briefly below.

2.5.3 Blender's Meso-Rhetorical Level

Blender's meso-rhetorical level includes those parts of the software that are generally visible to its novice users, including its interface and operations. Of course, the user interface has been widely theorized by RWS scholars – perhaps most notably by C. Selfe's and R. Selfe's (1994) "The Politics of the Interface: Power and its Exercise in Electronic Contact Zones." Selfe and Self (1994) contended that the interface is not a site of democratization but rather one that maintains "ideological and material legacies of racism, sexism, and colonialism" (p. 484). They asserted that interfaces represent a typically white, male, middle-class reality, which reflects the

world of office culture and metaphorical objects, such as desktop and file-folders, reflecting that culture. They similarly asserted that interfaces often present a very racialised view of the world – citing as examples Macintosh's white pointer finger and numerous photographs of white workers found in system photographs and clip art. However, while these characteristics may predominate on computer system interfaces, 3D software interfaces present an even more specialized, technical discourse, which reflects the worlds of artists, computer scientists, cinematographers, and others. These specialized discourses used on 3D interfaces are even less accessible to the most privileged middle-class office worker that Selfe and Selfe (1994) describe and, thus, 3D interfaces have even greater ramifications for disprivileged classes and racial groups. For this reason, it is useful to rhetorically examine Blender's 3D interface and the ways in which it locates users differently.

Blender's meso-level rhetorical level, however, also includes users' moment-by-moment processes required to construct, produce, and disseminate 3D CGI artifacts. To do so, users must not only quickly assimilate the technical discourse of the interface, which situates them differently than most interfaces, but they must also first negotiate the rhetorics of navigating while secondly composing with various coded processes. For this reason, then, Chapter 3 investigates the moment-by-moment rhetorical processes composers make as they navigate in Blender.

2.5.4 Blender's Macro-Level Rhetoric

Blender's macro-level rhetoricconsists of the ways in which the software or discourse about it circulates in the wider ecology. For instance, the macro-rhetorical level would include Blender's interaction with other compatible technologies or add-ons, as well as its use at the local levels to achieve specific organizational tasks. The macro-rhetorical level would also

consider the larger discourse about Blender software as manifested on the Blender.org website as well as on blogs or community user sites. For the most part, this study will consider the macro-rhetorical level only in a very limited way and in terms of Blender's use within an educational setting in Chapter 4, since the larger purpose of the project is to examine the ways in which moment-by-moment procedural choices strategically affect rhetorical understanding.

2.5.5 Blender's Social Ecologies, Environments, and Rhetorical Practices

The social component of Blender's rhetorical information ecology is comprised of clusters of social groups that fill different rhetorical niches. These groups are not always necessarily discrete entities since individuals can (and do) simultaneously belong to multiple social clusters with different the rhetorical practices, missions, and values.

Blender's core social cluster is the Blender Foundation, a non-profit public benefit company, started by foundation Chairman Ton Roosendaal in 2002 and located in Amsterdam, Netherlands ("Blender Foundation," n.d). The foundation's primary rhetorical mission is four-fold: to create, "maintain[,] and improve" free 3D software for users; to create revenue for the organization; to support documentation and training; and to plan both *Blender* and *SIGGRAPH* conferences, among other activities ("Organization," n.d.).

The Blender Foundation, however, also relies on a global community of professionals and volunteers to engage in a variety of other rhetorical practices, including developing, scripting, translating, and designing software as well as documenting changes to the Blender wiki ("Blender's Module Owners," n.d.). These groups are organized hierarchically according to the "benevolent dictator for life" model, which allows founder Ton Roosendaal to "[delegate] design decisions to a group of module owners" while retaining the right to veto development decisions. Module owners (i.e. "active developers who frequently contribute to parts of

Blender") are approved by Roosendaal and are responsible for maintaining Blender's many platforms, including operating and build systems; user interface; core; game engine; render, video, and audio; file formats; editing; and libraries, among others. Module owners also have "the freedom to work on the modules, decide on implementation and design issues . . . and approve or reject patches and feature requests" ("Module Owners," n.d.). Additionally, module owners maintain the computer code, fix bugs, test modules before releasing new software versions, and oversee teams of developer members and user members. Developer members – classified as those who have the time, inclination, and availability – are approved by module owners and help to fix bugs, review modules, and document changes to the Blender wiki. User members – classified as non-developers who "act in the stakeholder role – typically work on small features of the software that interest them and that are easy to fix.

Despite the global nature and number of these online teams,[37] communication among the groups is frequent and fairly well structured. For instance, developer meetings are held via internet relay chats three times a month on Sundays with alternating times zones. During these meetings, global team members are required to follow good netiquette: i.e. they must stay on topic, agree not to spam, and must not use html posts. Meeting decisions are also documented in archives, and organizational procedures (e.g. for joining a team, editing documents, contacting module owners, making "quick fixes" etc.) are laid out in the Blender wiki.

While the Blender Foundation relies on both professionals and volunteers, Blender's social ecology is also minimally comprised of the 78 global, online support forums, websites, and blogs listed on the Blender.org website (although other groups who are not registered on the

[37] According to "Module Owners" section of the *Blender* wiki, there are currently 29 module owners, who often also serve as developer members.

site also exist). These sites, in 21 different languages,[38] provide video and written tutorials; links to blog sites; 3D models and movies; education and training; online manuals, question-and-answer forums, "latest SVN builds" and IRC chat rooms ("Support: User Community," n.d.). These community support groups, additionally, often target more local, but also somewhat different social clusters – i.e. both novice, intermediate, and advanced enthusiasts as well as expert artists working in small production studios – and they also have different requirements regarding site registration and use. Finally, while most sites provide free tutorials, some do charge for more advanced ones.

[38] Support communities listed on the *Blender* site, alone, were translated into English (26 groups), French (9 groups), Spanish (10 groups), Bangladesh (1 group), German (5 groups), Greek (1 group), Turkish (2 groups), Finnish (3 groups), Indonesian (1 group), Portuguese (5 groups), Polish (3 groups), Dutch (1 group), Hebrew (1 group), Bulgarian (1 group), Italian (3 groups), Thai (1 group), Chinese (1 group), Russian (2 groups), Japanese (1 group), and Hindi (1 group).

2.6 Demarcating My Scope

This project focuses on Blender's meso-level rhetoric – i.e. the interface design and genre ecologies – accessible to the novice user. More specifically, I am not only concerned with the logics inherent in the interface (which locate the user in specific ways), but I am also interested in the moment-by-moment rhetorical processes used compose in Blender. In the next chapter I draw on both Bogost's (2008) notion of procedural rhetoric and Burke's (1966) notion of terministic screens to analyze Blender's interface.

Chapter 3: Blender's Meso-Level Rhetorical Ecology & Procedural Rhetoric

3.1 Introduction

The previous chapter briefly overviewed Blender's rhetorical nature at both the micro-level of the software's algorithms and at the macro-level of people, practices, and environments of use. This chapter analyzes Blender's rhetorical nature at the meso-level – the level of the interface and user action. To rhetorically analyze Blender at the meso-level, I draw upon Ian Bogost's (2008) notion of procedural rhetoric and Kenneth Burke's (1966) notion of terministic screens. I argue that procedural rhetoric is used in 3D CGI to shape viewer perception and to persuade viewers. This persuasive creation process literally creates terministic screens – ways of seeing reality based upon what is selected and represented as well as upon what is not seen and what remains hidden. I begin the chapter, then, by briefly overviewing the logics built into Blender's interface and the ways in which these logics are also rhetorical. I then discuss, in more detail, 3D CGI's procedural rhetoric and the symbol systems (i.e. the codes, the rules of behavior) required to manipulate processes that enable 3D CGI object creation. Finally, I demonstrate the ways in which composers manipulate rules of behavior in 3D CGI programs to create terministic screens. To do this, I create a 3D CGI virus (following BlenderWiz's[39] tutorial) to show how decisions made at each part of the creation process enable composers – who often work in teams – to shape our perceptions of the object and to persuade viewers to identify with a particular representation of the world. This chapter is divided into the following sections: **Section 3.2 Blender's Interface: An Ecology of Technologies, Modes, and Logics,** discusses the "hidden" logics inherent in Blender's interface and **Section 3.3 Blender's Procedural**

[39] This tutorial may be viewed by following this link: https://www.youtube.com/watch?v=M_MjkVVZh54 . For the purposes of this project I follow the first 12 minutes of the tutorial but do not apply the compositing as BlenderWiz does.

Rhetoric: Making Models through Processes discusses the ways Bogost's (2008) notion of procedural rhetoric is applied to analyze 3D CGI.

3.2 Blender's Interface: An Ecology of Technologies, Modes, and Logics

Understanding the different logics inherent in Blender's interface is important, not only because composers must acclimate themselves to them in order to create 3D CGI objects, but also because as Manovich (2001) asserted, an interface is not neutral (p. 64). It "acts as a code that carries cultural messages," and it "affects the messages transmitted" – often by "[providing] its own model of the world, its own logical system, or ideology" (p. 64). Furthermore, these models, systems, and ideologies affect "how users think of any media object accessed via a computer" (p. 65). In other words, these logics, to a great extent shape our perception of objects and they do so through a variety of processes. This section, then, attempts to both describe Blender's interface and to make explicit four of its logics.

To begin, Blender's interface is an ecology of remediated[40] technologies (e.g. cameras, photo-editing programs, animation, 3D simulation, video editing etc.). Each remediated technology uses different tools, methods, and processes to shape meaning, and each requires composers to design and create in non-linguistic modes[41] (e.g. form, color, texture, movement, light, space, etc.). As a result, Blender users must acclimate themselves not just to multiple technologies, modes, tools, and methods, but also to composing non-linguistically according to visual, spatial, computer, mathematical, and artistic logics.[42] These logics, of course, are very intricately entwined, and they all affect how objects are seen – they all affect the screens created for us.

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[40] Bolter and Grusin (1999) argued that one characteristic of new media is remediation – which they definde in two ways as the "process by which new media technologies improve upon or remedy prior technologies" and as "the formal logic by which new media refashion prior media forms" (p. 273).

[41] Kress and Van Leeuwen (2001) discussed *mode* as a resource for making meaning.

[42] Users who compose 3D animations must also consider logics of performance, sound, and narrative if they intend their animations to include spoken dialogue or music.

3.2.1 Visual Logics of Blender's Interface

Blender's default interface (See Figure 1) relies heavily on visual logics.

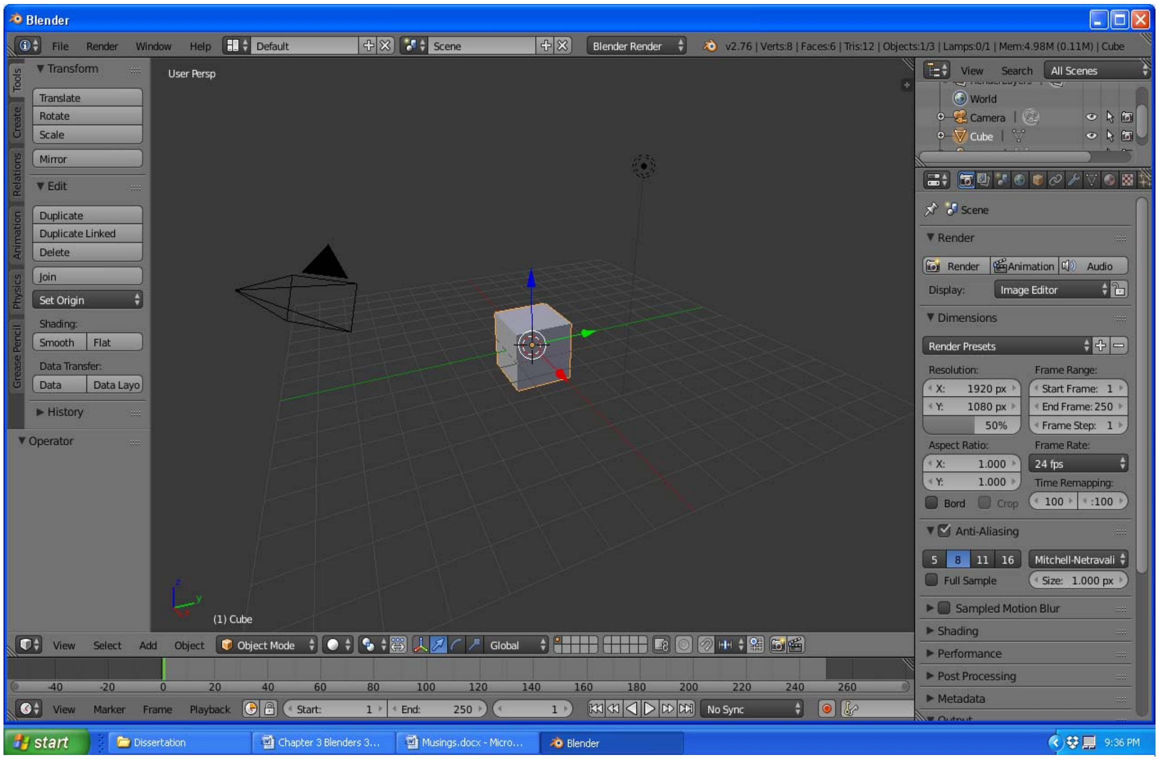

Figure 1. Blender's default interface.

The largest part of the interface, the 3D Viewport, is predominately visual, and it is the window "into" the 3D computerized world. The 3D Viewport's default objects are a 3D cube, a built-in simulated camera, and a light source. These default elements not only allow users to create anything within the 3D computerized world, but they also function as a kind of terministic screen, allowing users at least two ways of seeing objects. For instance, in *Render* mode, the built-in 3D camera enables users to view 3D objects "objectively" as they appear in their finalized form. The simulated camera, then, positions users as *reviewers* and *gazers,* whose primarily role is to critique and comment. This role empowers users. As pre-screeners, they also become gatekeepers, determining not only how objects look to non-experts, but also what visually counts (and is released) as "truth" or "knowledge."

The 3D Viewport, however, gives users a second way of seeing. By simulating a 3D environment, it allows users to see the entire construction space (as it is represented through the frame of the interface) and to manipulate objects within the space. Thus, in Blender's *Object* and *Edit* modes, the 3D Viewport positions users as *doers, creators,* and *persuaders* whose primary mission is to shape representations – and by extension, our tacit understanding of reality. As doers, creators, and persuaders, users additionally take on multiple (and very specific types) of subject positions: They become sculptors, who manipulate object form; cinematic directors, who manipulate lighting, cameras, and objects; painters and photo editors, who manipulate colors and textures; animators, who manipulate the movement and timing of objects; and video editors and compositors, who fine tune the process. Very often, these positions are embodied by teams of highly trained specialists working together to shape how others see and understand the world

around them.[43] Importantly, then, our "common" visual understanding of the world depends heavily on the representations crafted by many technical experts, who present their version of the visual world – and their way of seeing it – to us.

3.2.2 Spatial/Navigational Logics of Blender's Interface

Seeing in Blender is important, additionally, because it is intricately bound up with spatial navigation. To have complete control over what viewers see, creators must be able to "see beyond the surface" of the 3D Viewport – they must be able to navigate through the "flatter" 2D section of the interface and through the "deeper" 3D space of the 3D Viewport.

Navigating through the 2D space of Blender's interface to enhance one's vision (and to thus have more control over what others see) is fairly simple: It requires only an understanding of computer interfaces, and, more specifically, menu tabs and mouse movement. For instance, an easy way to see alternate angles of a 3D object in the 3D Viewport is to move the mouse cursor and to click on the "View" tab in Blender's 3D Window Header[44] (See Figure 2).

[43] While the technology "democratizes" the ability to create these complex 3D visual images, having artistic talent greatly affects what one can produce on his or her own without the guidance of tutorials, which are often created by computer artists or enthusiasts with artistic talent.
[44] Ironically, in Blender, the 3D Window Header appears at the bottom, not the top of the screen.

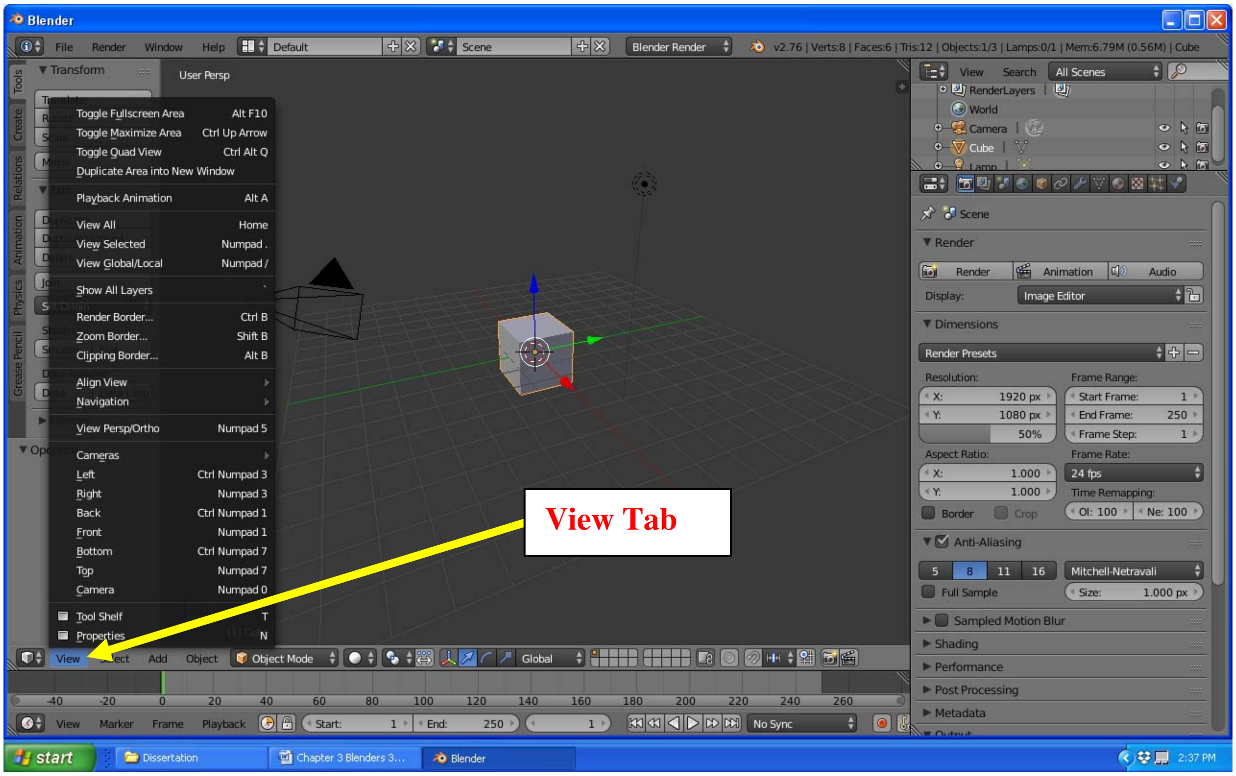

Figure 2. Blender’s View tab.

As Figure 2 shows, the “View” tab enables users to see objects in the 3D Viewport from multiple angles (e.g. top, bottom, right, left, front, back) and from multiple perspectives (e.g. from orthographic perspective, from camera perspective, from certain layers).[45] Additionally, by clicking on the sub-tab “Toggle Quad View,” users can also see (as well as work on) objects from multiple angles, as Figure 3 shows.

[45] Blender provides a second means of navigating via coded numbers on the computer key pad as a kind of shorthand navigational technique. Thus, rather than clicking on “View>Left”, users can simply type “3” on the computer’s number keypad to see an object’s left side.

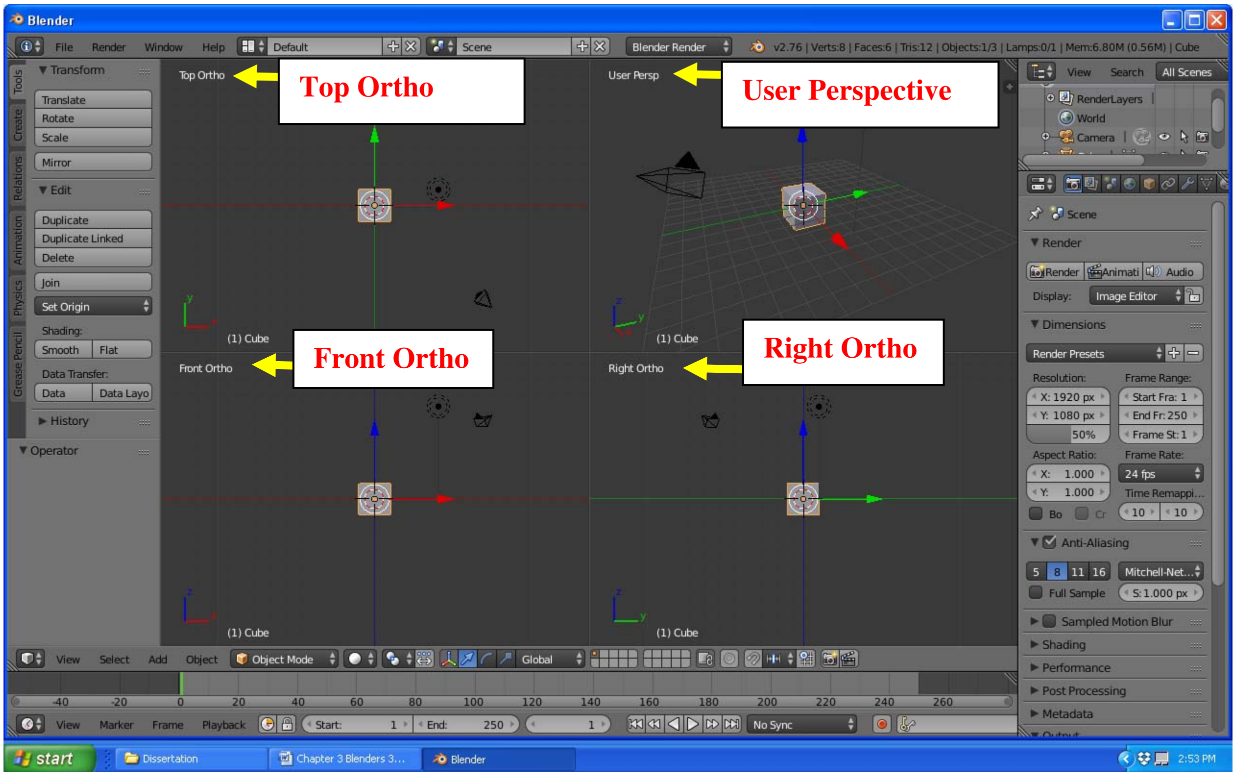

Figure 3. Toggle quad view.

However, 2D navigation gives creators only limited control over what users see because it provides only flat “snapshots” of objects from different angles. Therefore, creators who want to “see deeply” – to see around and behind objects – must understand how to navigate in the space of the 3D Viewport.[46] Navigating in the 3D Viewport requires creators to use computer-coded symbol systems that pair keys on the computer keypad with buttons on a 3 button mouse. For instance, to orbit around objects in the 3D Viewport, Blender creators must hold down the middle mouse button (mmb) and move the mouse right, left, up, or down. To pan up, down, right, or left (i.e. so that the object is moved to some other part of the interface), users must hold down the “Shift” key on the computer keypad while simultaneously holding down the middle mouse button and moving the mouse. To zoom into or out of an object, users must use the scroll

[46] As will be discussed in another section, Blender also pairs spatial logic with mathematical logic, for users during movement are sometimes called upon to consider whether they need to move along the *x, y,* or *z* axes.

wheel on the computer mouse, or (in the absence of a scroll wheel on the mouse) they must use the computer keypad's up and down arrow keys.[47]

Navigation, thus, is thoroughly rhetorical according to Bogost's (2008) notion of procedural rhetoric. For, to enhance their vision of objects, users must understand and must use a coded system (i.e. they must "follow rules of behavior" in order to move). They must also engage in a process of using these coded systems efficiently and strategically (e.g. They must know when they need to zoom to see an object closer or farther; they must pan to enhance their vision of objects; and they must orbit to see around and behind objects) to successfully create objects in 3D. Composers who cannot use these "symbol systems" efficiently or strategically cannot control how others see because their own vision (and movement) is limited.

Navigation and spatial logic, then, play an incredibly important role in persuasion. They essentially position creators relative to the 3D object, and this positioning influences what and how creators see an object. For instance, it determines the angle at which they see objects, the level of detail (e.g. by zooming in or out) etc. Composers' sight and movement, thus, affects their ability to persuade – to manipulate what others see by strategically showing or hiding certain angles or perspectives.

3.2.3 Computer Logics of Blender's Interface

While visual and spatial logics are inherent in seeing objects (and thus shaping others' sight), so too are computer logics. For, users who do not understand how to use Blender's windows, menus, and buttons will be unable to create objects. However, developing a general understanding of each window and menu is difficult since Blender has five windows that appear

[47]Interestingly, Blender also allows users without a 3 button mouse to simulate a 3 button mouse on their computer keypad by pairing numbers on the keypad with orbiting and panning. Additionally, readers will also likely note that navigation in the 3D Viewport draws on cinematic logics (e.g. zoom, pan, orbit etc.)

in the default interface and 15 other hidden windows,[48] which can be accessed by clicking on the 3D Window icon in the lower left corner of the 3D Window Header.

Blender's five default windows serve different functions in shaping viewers' visions. The 3D Viewport, for instance, enables users to construct and manipulate an object's form. The 3D Tool Shelf (considered part of the 3D Viewport) provides basic primitives (i.e. geometric shapes) to shape an object, as well as shortcuts for transforming (i.e. manipulating) objects. The 3D Window Header (also considered part of the 3D Viewport) also allows users to change the viewing perspective and to add objects such as additional lamps, primitives, cameras, etc. In addition to these windows, the Outliner window outlines all objects in the 3D window to help creators visualize objects' relations to each other. The properties panel allows users to apply additional settings (e.g. materials, textures, modifiers, world settings, light settings, etc.) to manipulate the appearance of objects in the 3D Viewport. The Timeline window, further, allows users to create key frames to animate objects – thus, giving objects the appearance of movement.

While these windows each contribute to the shaping of vision, they are rhetorical in another way. They are highly context dependent. The contents of the windows (and the choices available to users) change depending upon what the user is working on and the "mode" being used. Thus, the tools available to users working in "Sculpt" mode will be very different from those available to users working in "Edit" mode, as Figures 4 and 5 show.

[48] According to Blain (2012), these 15 windows include the Timeline, Graph Editor, DopeSheet, NLA Editor, UV/Image Editor, Video Sequence Editor, Text Editor, Node Editor, Logic Editor, Properties, Outliner, User Preferences, Information, File Browser, and Console (p. 20).

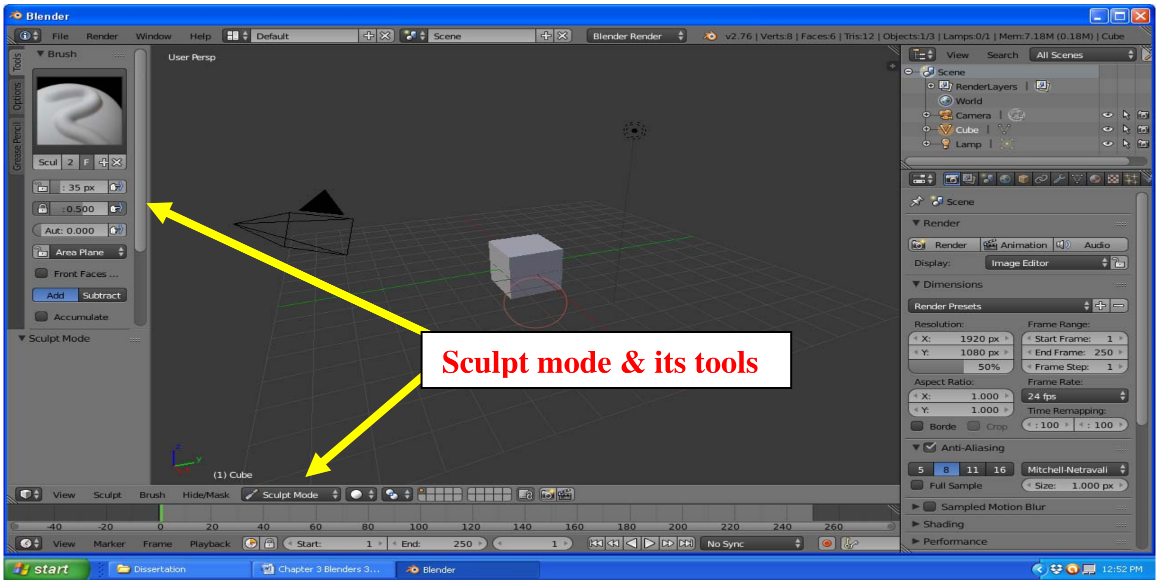

Figure 4. Sculpt mode.

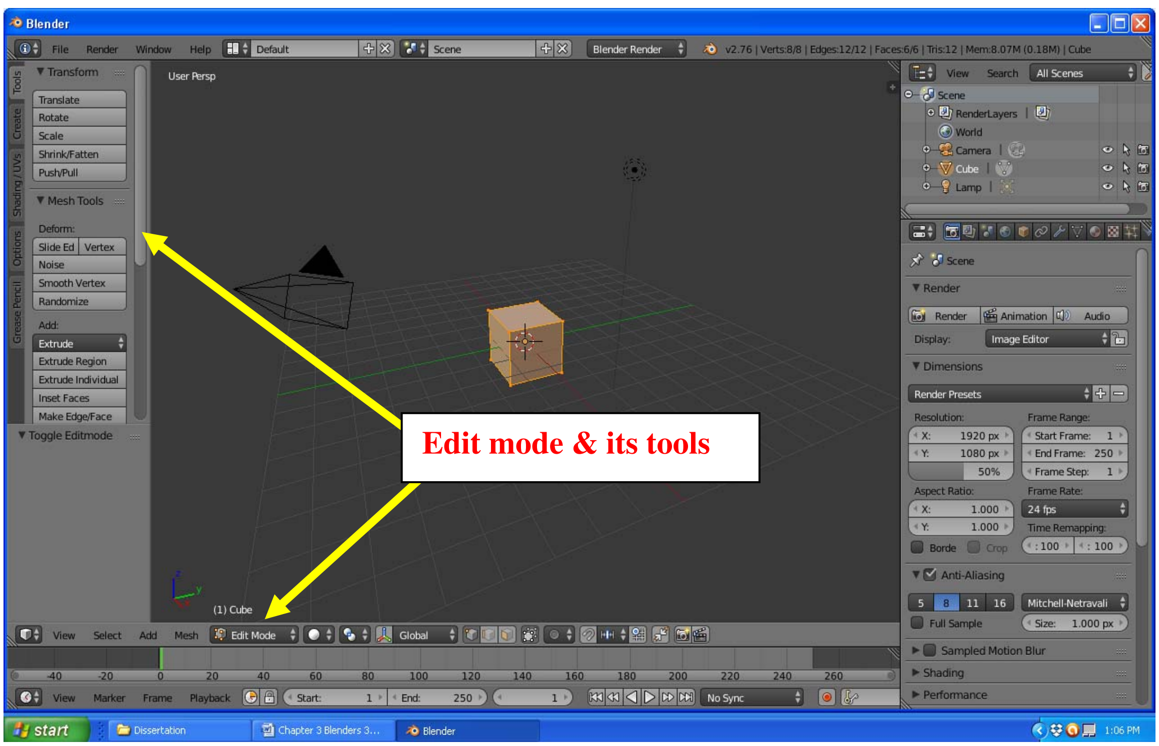

Figure 5. Edit mode.

Additionally, Blender's menu panels can create confusion for users since there are often many tabs that are not intuitive. For instance, the Render menu panel (in the Properties Window) contains 10 submenus with approximately 74 tabs, slider bars, or tick-boxes that users can manipulate to affect the output of the final rendered object. For instance, the Render menu panel

allows users not just the ability to render and animate objects, but it allows them to choose such things as frame rate, resolution, and aspect ratio among other options. Many of these tabs and sliders also require users to employ mathematical logic.

3.2.4 Mathematical Logics of Blender's Interface

Mathematical logic, too, is important in shaping vision. On the one hand, it is used to create objects. For instance, Blender incorporates "primitives" – i.e. geometric shapes – that designers can start with to create 3D objects. The standard primitives in Blender include the plane, cube, circle, UV sphere, icosphere, cylinder, cone, torus, and grid.[49] Blender also incorporates a variety of mathematically-based curves, used to create more realistic curved items such as logos, wires, and coils. These line-based, mathematical curves include Bezier and NURBS curves, among others. However, mathematical logic is also used to manipulate the properties of objects – often via slider bars. For instance, as Figure 6 shows, when a material (i.e. a color) is applied to an object, slider bars can increase or decrease the intensity of the color. Slider bars can also increase or decrease such things as specular intensity (i.e. the intensity of light shining on the object); the appearance of the object's "hardness or softness"; and its level of transparency.

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[49] Blender also includes under its primitives a monkey head instead of the teapot used in many 3D CGI programs as a kind of "test" object.

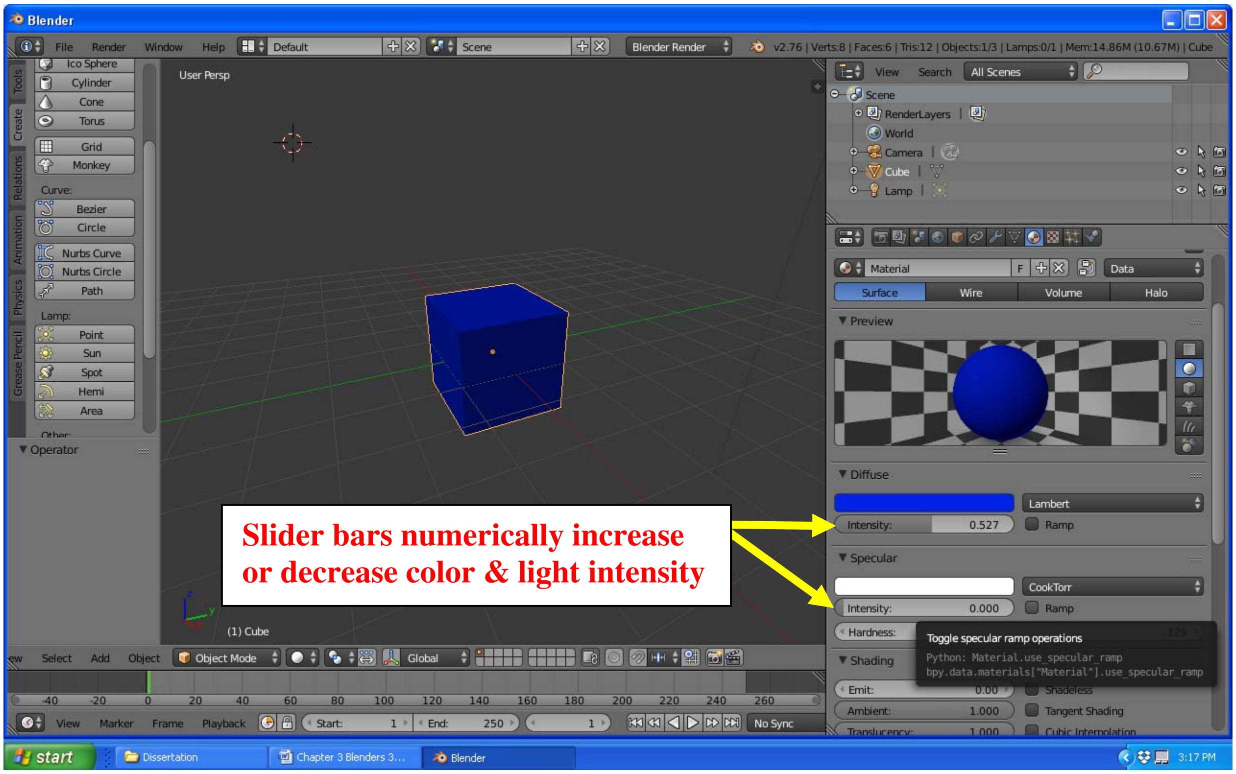

Figure 6. Mathematical logic in Blender.

Furthermore, mathematical logic is used in navigation and object manipulation. For instance, an icon for the *x, y,* and *z* axes appears in the lower left corner of the 3D Viewport to help orient users of the object's location in 3D space. Additionally, slider bars in an extended part of the Properties Panel allow users to manipulate objects along *x, y,* and *z* axes. As Figure 7 shows, users can manipulate an object's location, rotation, scale, and dimensions by mathematically adjusting the associated slider bar, and this in turn affects both what users can see and their manipulation of spatial objects.

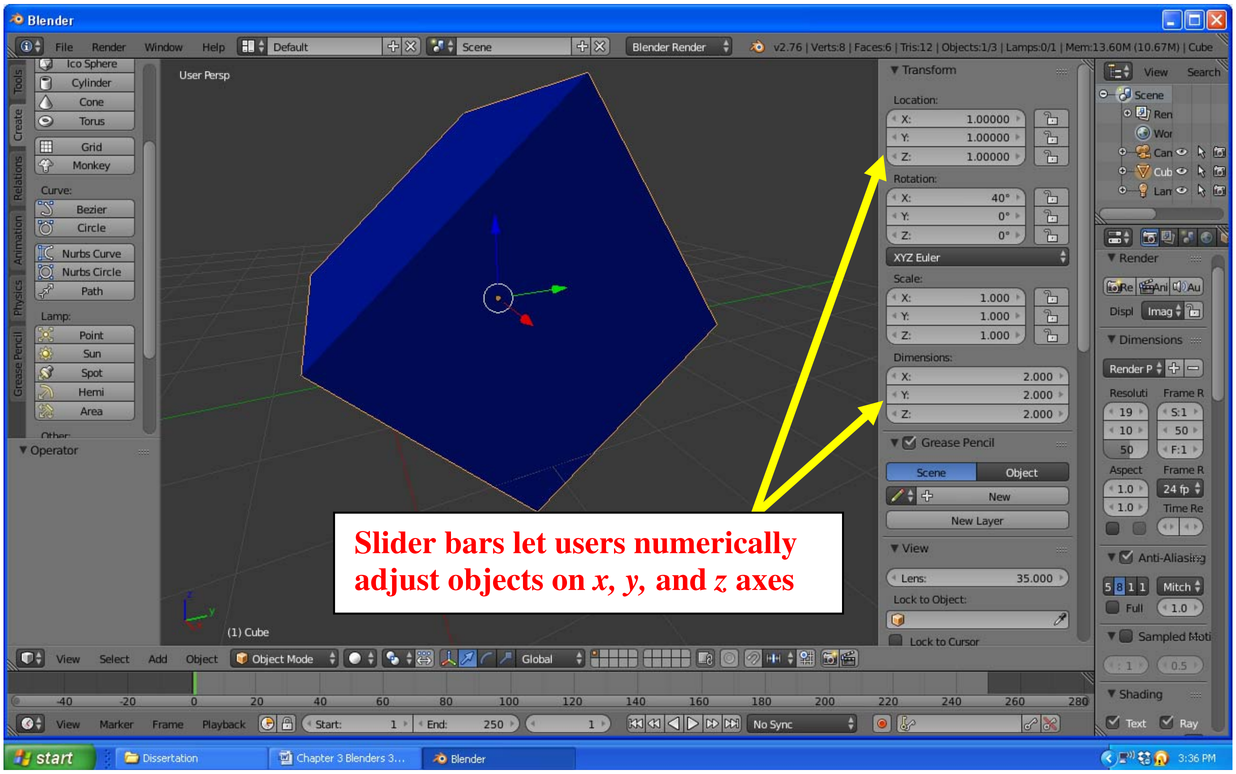

Figure 7. Properties Panel.

3.2.5 In Conclusion

The logics of Blender's interface are not those that the common computer user encounters at the office. Blender's logics are those of technical experts, who ultimately shape what our visual realities look like. Because the technical knowledge and processes used in 3D creation processes are absent entirely from the finished products – from the objects we see daily on TV or at the movies – technical knowledge and processes stay hidden and the authority of those images (as well as the ideologies of those creating them) remains unexamined. The next section, then, discusses these technical, but also very rhetorical processes using Bogost's (2008) notion of procedural rhetoric.

3.3 Blender's Procedural Rhetoric: Making Models through Processes

Bogost's (2008) notion of procedural rhetoric helps to demonstrate the complex, strategic, rhetorical choices that 3D CGI composers must make to shape viewer perceptions. Bogost (2008) defined procedural[50] rhetoric in two ways: 1) as "the practice of using processes persuasively" and 2) as "the practice of authoring arguments through processes" (p. 125).[51] According to Bogost (2008), procedural rhetoric does not use words or images to create representations. Rather, it uses "rules of behavior" that are "authored in code" (p. 125) to create persuasive or expressive representations of the world and to make tacit claims "about the cultural, social, or material aspects of human experience" (p. 123). Bogost (2008) suggested procedural rhetoric is most evident in video games, where gamers discover designers' arguments via play as they make decisions, face the consequences of those decisions, maneuver through different possibilities and constraints, and are rewarded or punished for doing so.[52] However, procedural rhetoric is also inherent in 3D CGI creation, where composers, similarly, use coded symbol systems and follow "rules of behavior" that are "authored in code" (p. 125) to develop persuasive visual representations of the world. These representations help to create what Kenneth

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[50] Bogost (2008) asserted that while the term "procedure" often connotes negative reactions and suggests "a static course of action" (p. 122), he uses the term differently. For Bogost (2008), a procedure, or process, is a"[set] of constraints that create[s] possibility spaces," which gamers in particular investigate via play. For Bogost (2008) the rules and constraints imposed by procedures/processes enable spaces where play, exploration, and creativity occur. Bogost (2008) further suggested that computer software is a primary example of procedurality. Software designers must author algorithms – or rules – that enable users to do things.

[51] While Bogost (2007) demonstrates both definitions in his book *Persuasive Games: The Expressive Power of Videogames,* my focus in this chapter is on the first definition, and my aim is simply to show the way 3D CGI creation processes shape persuasion.

[52] Bogost (2008) gave the example of the highly ideologically-based antiadver game *The McDonald's Videogame,* which critiques McDonald's business practices (p. 126). In the game, players are put in charge of four areas of "the McDonald's production environment" including "the third-world pasture where cattle are raised. . . ; the slaughterhouse where cattle are fattened for slaughter; the restaurant where burgers are sold; and the corporate offices where lobbying, PR, and marketing are managed" (p. 126). Players must make difficult choices in each area of the production environment – such as whether or not to bribe officials to gain more land to graze cattle or to slaughter and sell diseased cattle for meat. To succeed in the game, players often must make unethical choices, and as a result, Bogost (2008) argued, they become aware of the argument game designers are making – that the fast-food industry's production environment is highly corrupt.

Burke (1966) calls our "terministic screens" – our ideological ways of seeing (and not seeing), understanding (and not understanding), knowing (and not knowing). In the sections that follow, I'll discuss the codes and symbol systems that create rules of behavior in 3D CGI, and I'll then demonstrate how rhetorical processes throughout various modal ecologies in Blender shape our understanding of material visual representations.[53]

3.3.1 Blender's Procedural Rhetoric

Object creation and manipulation in Blender occurs via computer-coded *symbol systems* – i.e. "rules of behavior" – that composers must learn, apply, and combine with navigational and other processes. In Blender, the most common type of computer-coded *symbol system* requires composers to use computer keypad "hot keys" with navigational mouse movements to transform objects. To transform any object, Blender users must know the basic codes: To select objects or deselect them, users must either type *A* or *right click* on the mouse. To scale objects up or down (i.e. to make them larger or smaller), users must type *S* and move the mouse (e.g. typically right or left). To rotate objects, users must type *R* and move the mouse (e.g. right, left, up, or down). To move objects, users must type *G* and move the mouse to the desired point on the screen. To extrude (i.e. to extend or pull out) object faces, vertices, or edges, users must type *E* and move the mouse. With these basic object transformation and navigation codes, users begin a process of creation as they move back and forth among the different codes, creating very complex objects in Blender. These same codes also allow users to manipulate and adjust Blender's built-in camera and light source, among other things. However, many other codes exist (e.g. box selection, loop cut, etc.) that composers learn as they gain more experience with the program. Importantly, these codes – these "rules of behavior" – are not obvious or intuitive. There is no one-to-one

[53] The tutorial I follow to demonstrate this process I BlenderWiz's (27 May 2012) Virus Tutorial, which can be accessed in its entirety here: https://www.youtube.com/watch?v=M_MjkVVZh54 .

correspondence, for instance, between the hotkeys on the computer keypad and the corresponding action they allow users to take. This use of coded symbols as part of a larger process to create meaningful representations is itself rhetorical because users make strategic decisions about how to apply these codes to develop meaningful and persuasive visual representations.

However, a second kind of computer-coded process can also be used to persuasively manipulate 3D objects. This occurs by experimenting with setting combinations on the Blender interface to achieve more realistic outcomes. This secondary process is, of course, much more difficult because it requires a thorough understanding of each of Blender's windows, tabs, and features. The next section, however, will demonstrate both processes to show how 3D CGI creation processes, themselves, use procedural rhetoric to shape knowledge.

3.4 Modeling (i.e. Object Creation)

The object creation process, called modeling, is highly rhetorical. Composers must not only consider the larger ecology in terms of considering institutional audiences, purpose, and contexts of use, but they must also consider the modeling method that best depicts, in a believable, persuasive way, the form they are trying to create.[54] For instance, composers can import a reference image and then use a method called box modeling to build an object. In box modeling, composers begin with a single cube, which they manipulate to build the object. This type of modeling works well for objects like cars or human bodies which are dense but also very detailed. However, composers can also model objects by manipulating planar surfaces. This type of modeling works well for highly contoured or very delicate looking objects such as human faces and flowers. Composers who need to model highly curved surfaces (such as logos), on the other hand, may opt to use modeling via curves (e.g. NURBS, etc.).

Once composers decide on a method of modeling, they must engage in procedural rhetoric – a process of object manipulation using coded letter keys on the computer keypad, the 3 button mouse, and numeric and other modifiers to transform the object. For instance, in "Virus Tutorial,"[55] BlenderWiz's (2012) showed users how to create a virus first by adding an icosphere, applying various modifiers, and then manipulating the faces of the icosphere to

[54]As Richard Buchanan (1985) argued, form is rhetorical in that designers must consider technological use, emotional affect, and ethics of use and build this into designs. And as Joni Edelman's (2015) critique of Pixar's Sadness character from *Inside Out* demonstrated, representations of form are also highly rhetorical, reflecting the dominant cultural and social values. Edelman's (2015) primary criticism of *Inside Out* was that Sadness is depicted as "a short, chunky, sad-and-blue . . . person . . . with an emo haircut" and glasses. The character Joy, meanwhile is represented as a whitish, "tall, lithe, human-looking girl with a pixie cut". For Edelman (2015) the movie reinforced notions of fatness being associated with sadness and undesirable emotions while joyousness was represented by the dominant value of being white, thin, bubbly, and pretty. Hess (2010) further noted in his Blender book that object believability is created through subtlety (p. 240).

[55] Accessed here: https://www.youtube.com/watch?v=M_MjkVVZh54 .

simulate a microscopic virus.[56] This complex rhetorical process is depicted via the figures below:[57]

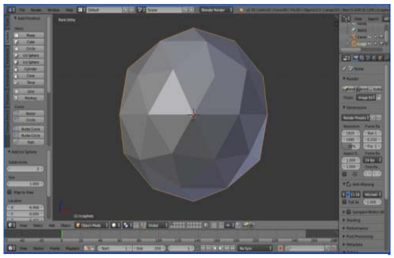

Figure 8. An Icosphere is added in Object mode.

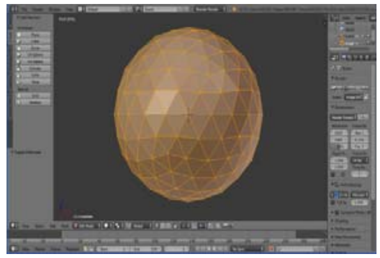

Figure 9. Subdivisions are added to increase the number of vertices on the mesh to it a smoother look.

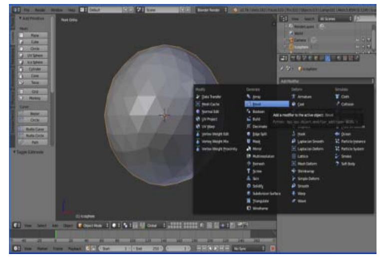

Figure 10. A bevel modifier is selected to make the edges of the icosphere flatter.

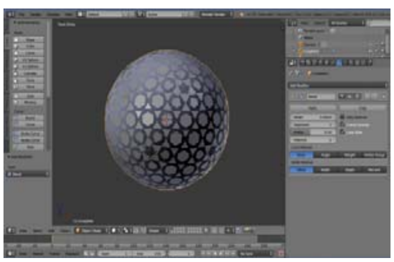

Figure 11. The numerical width of the bevel modifier is adjusted and then applied.

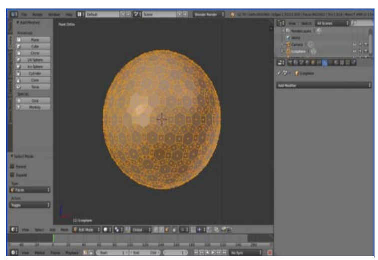

Figure 12. In Edit mode, all faces are selected.

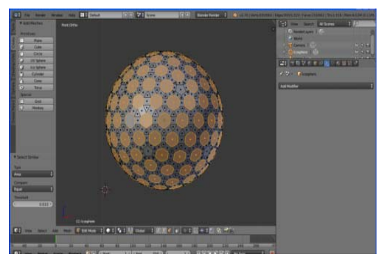

Figure 13. In Edit mode, all of the icosphere's pentads are selected by using the code *Shift G* and then selecting *Material* from the pop up menu.

[56] In this project, I used BlenderWiz's (2012) tutorial to create the figures depicted in this chapter. It should be noted that the figures I made do not look as beautiful as those in BlenderWiz's tutorial; additionally, since I did not follow the guidance he gave for compositing (due to time constraints), my figures are much rougher.

[57] Several things should be noted here: First, in presenting the procedural rhetoric used in 3D CGI, I have left out some steps, focusing on the very major ones. Second, it should also be noted that while I present this process as fairly linear and straight forward, it is not. Rather, it requires experimentation, creativity, and problem solving on both the part of the computer graphics artist as well as on the part of the tutorial user. As just one example, during the first virus tutorial I followed by another computer graphics artist, I was unable to get the icosphere's faces to scale to points. This resulted in a secondary process of conducting web research. During the modeling process, additionally, the composer manipulates not only the object but must go into and out of the Object and Edit modes of the program to work.

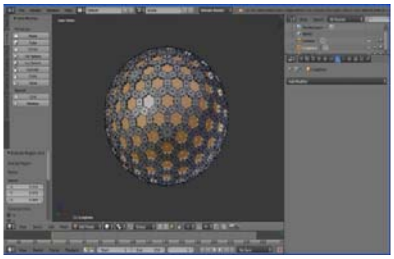

Figure 14. Faces are extruded into the model by typing the code *E* and then the faces are scaled inward via the code *S*.

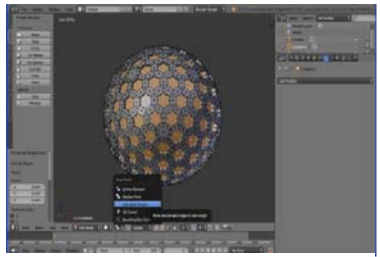

Figure 15. The pivot point of the faces is changed to a setting called *Individual Origins.*

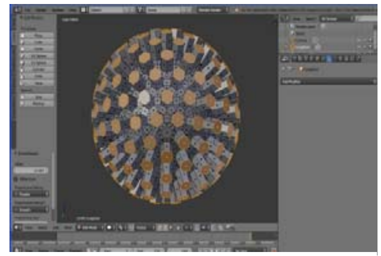

Figure 16. The code *Alt* + *S* is entered change the size of the faces. Users then type *E* to extrude faces outward and *S* to scale them down.

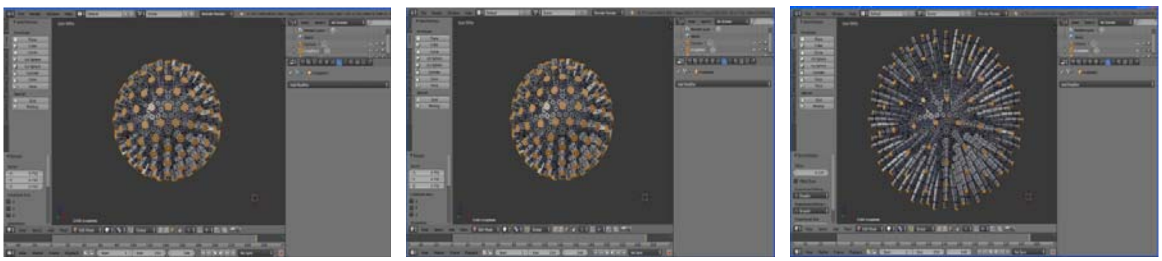

Figure 17. The repetitive application of typing *E* to extrude, *S* to scale, *Alt* + *S* to make the mesh smaller results in the appearance of many spikes along the surface of the icosphere.

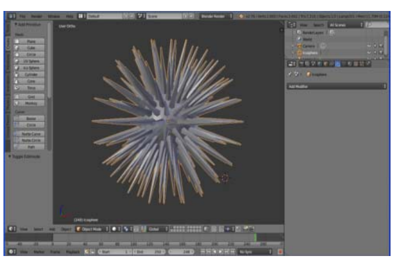

Figure 18. The results of the manipulation as they appear in Object mode.

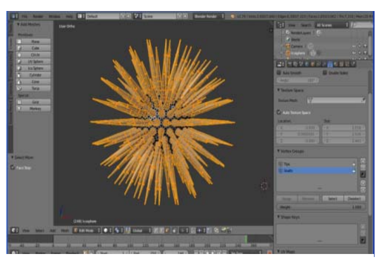

Figure 19. In Edit mode, the tips, shafts, and base of the spikes are assigned into different "groups" so that the user can manipulate these parts of the model separately.

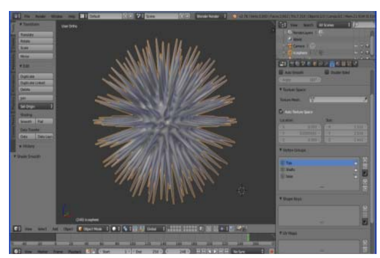

Figure 20. In Object mode, the surfaces of the icosphere are smoothed before another modifier is applied.

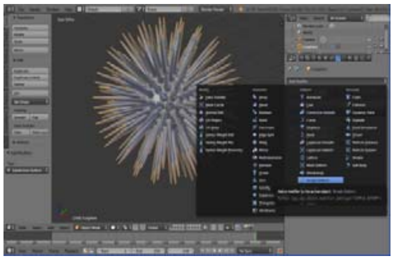

Figure 21. A *Simple Deform* modifier is applied to the tips so that the user can make the tips appear to twist.

Figure 22. Because the deform modifier provides only minimal “twist,” an “empty object” (black lines) is added and inserted into the virus object. The “empty” affects the icosphere mesh, giving users more control to twist virus spikes.

Figure 23. When the model is rendered, it appears dark and clay-like. A second rhetorical process – adding lighting and adjusting the camera – is needed to alter perceptions.

As Figures 8 through 23 show, composers use procedural rhetoric to create the virus. That is, they repeatedly and strategically use a series of codes (i.e. rules of behavior) – predominately *E* to extrude, *S* to scale, and *Alt* + *S* to scale along the normals – to shape the object as well as our perception of what a virus looks like. The rhetorical choice to repeatedly and strategically extrude and scale pentads on the icosphere results in numerous, geometrical, symmetrical spikes that cover the virus. As a result, viewers are made to understand that viruses are not only round but also have pointed spikes that twist slightly. However, different strategic choices would yield different rhetorical results. For instance, the result (and our perception of viruses) would greatly differ if, rather than using the repeated codes *E* to extrude and *S* to scale, BlenderWiz had employed other paired codes – like *E* to extrude, and *R* to rotate. In such a case, the spikes would appear as extended pentads that had flat (and not pointed) tips that rotated out from the source. Thus, small strategic decisions made throughout the process of modeling – including the series of codes used, the modifiers applied, the primitive selected – all affect our perception of objects and also affect their authority and persuasiveness. However, although coded modeling processes shape our perception of form, they are not enough to persuade viewers

that the final image in Figure 23 is a real virus. For this reason, another rhetorical process – that of manipulating both the lighting and camera – is needed. The manipulation of lights and cameras is discussed in the next section.

3.5 Cinema (Lighting and Camera)

Both lighting and camera angles create very different effects, and they also shape our perceptions of objects. In Blender, composers can choose from five different kinds of lamps to light scenes: Point, Sun, Spot, Hemi, and Area. Of these lighting types, Sun and Hemi apply lighting more broadly while Point, Spot, and Area apply lighting to localized areas. For each lighting type, however, composers can manipulate such things as lighting color, energy, distance, shadow etc. to manipulate viewer perceptions.

To create a more realistic-looking virus model, BlenderWiz's (2012) video tutorial shows composers how to manipulate the lighting and camera angles. Again, this manipulation requires composers to employ many of the same procedural rhetoric techniques used during modeling – coded computer keypad letters combined with mouse movements as well as numeric manipulation of slider and modifier values. Again, this rhetorical process is depicted in the Figures 24-32 below:

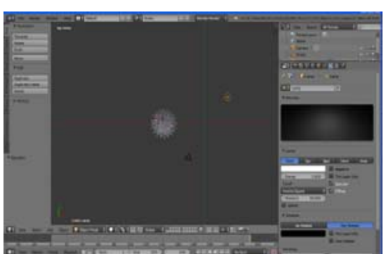

Figure 24. A Point lamp is the default setting in Blender. In this image it is depicted as an orange point. Because the lamp beam is not directed at the virus, the virus appears dark and clay-like.

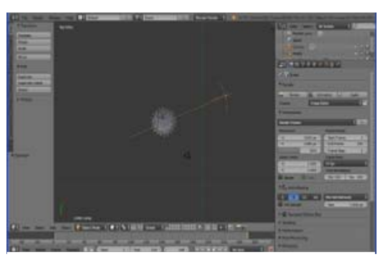

Figure 25. The default point lamp is changed to a Hemi lamp, and the beam is directed at the virus.

Figure 26. The Hemi lamp, however, makes the virus now too white – like plastic.

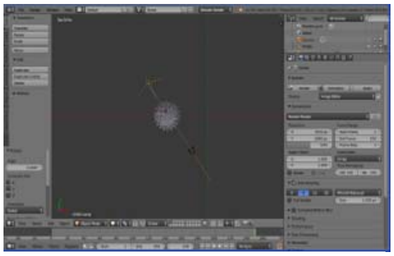

Figure 27. The Hemi lamp is using the code *G* (i.e. grab, move) and positioned behind the virus, with the light directed across from the camera.

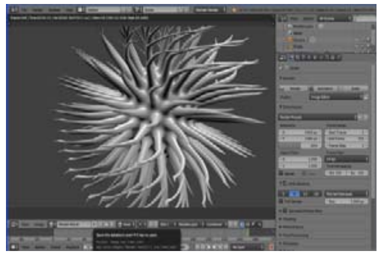

Figure 28. The result is more realistic, because shadows are now apparent, giving the model depth. However, the virus does not look as it might under a microscope.

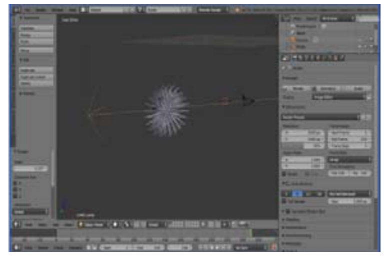

Figure 29. The lighting is adjusted again in 3D space using the code *G* so that from all views (right, left, top, bottom) it.

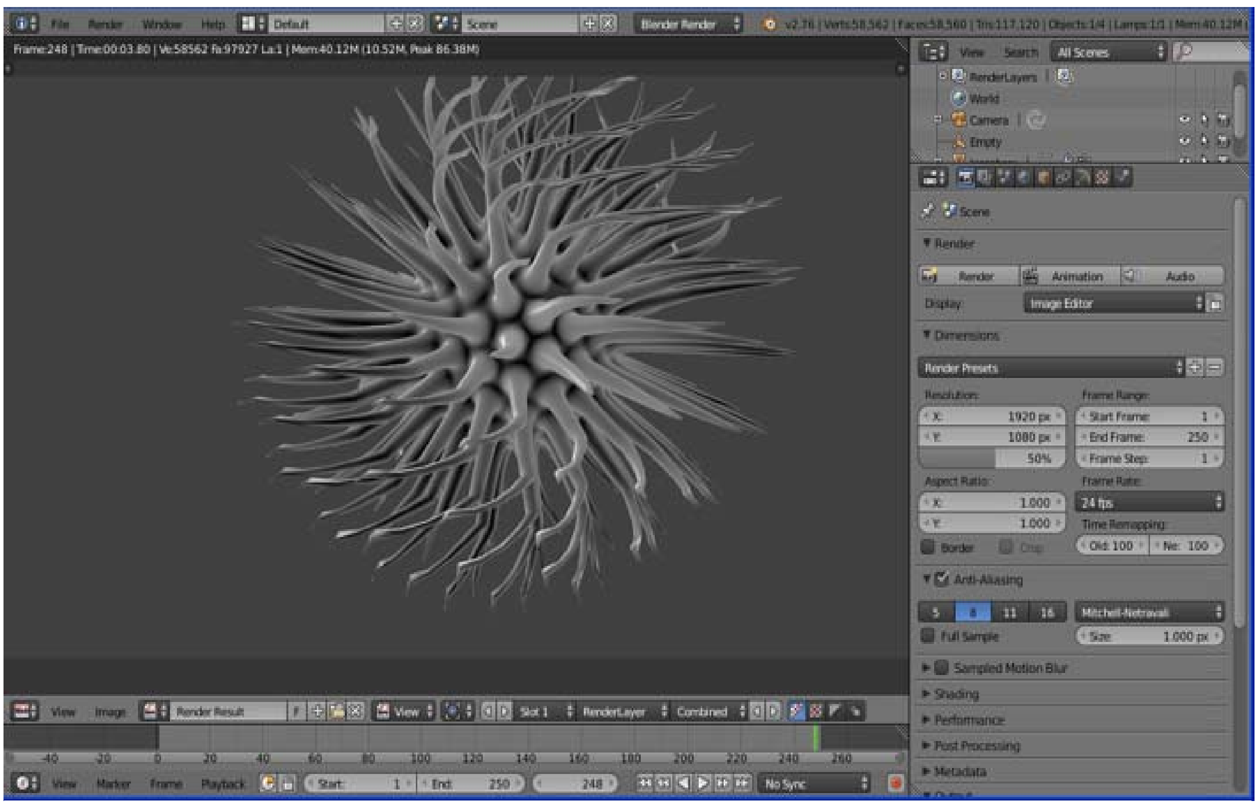

Figure 30. The lighting is adjusted again in 3D space using the code *G* so that from all views (right, left, top, bottom) it.

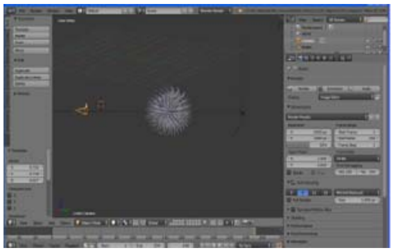

Figure 31. The camera is adjusted using the same coding processes: selecting the camera by typing *A*, moving it by typing *G*, and rotating it up by typing *R*.

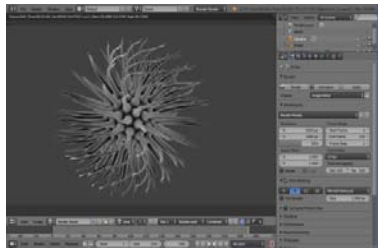

Figure 32. The virus now fits within the camera frame.

As Figures 24-32 show, procedural rhetoric is again used to manipulate effects of lighting and camera angles –which also affect viewer perception. For instance, the codes *G* to grab/move and *R* to rotate are used repeatedly and strategically to achieve the effect of a photographic negative. This effect, however, only results from the coded process of moving the lighting and camera from different perspectives in the 3D Viewport and then rendering the object. As Figure 26 shows, when the Hemi lamp's beam was first directed at the virus, the lighting was too strong, and as a result, the virus looked like white plastic. As Figure 28 shows, when the lamp was positioned behind the virus, more shadows appeared, but it still didn't look as if it was under a microscope. A continual process of selecting and moving the lamp's position in relation to both the virus and camera was needed to achieve the microscopic effect. In this case, the microscopic effect was achieved only by manipulating the lamp so that it was directly aligned with the virus and the camera. Again, strategic choices (using coded symbols) that were made throughout the process of creation affect viewers' perception of the look of the virus. However, believability is further achieved using several more processes: 1) the manipulation of World settings, 2) the adding of materials, and 3) the adding of textures, which the next section discusses.

3.6 World Settings, Materials, and Textures

World, material, and texture settings also affect perceptions of objects and persuade viewers of their believability. World settings, for instance, allow composers to manipulate backgrounds by adding color or special effects (Blender Online Reference Manual 2.77),[58] and this also creates a sense of location for viewers. Similarly, material settings allow composers to apply color to object surfaces while texture settings help composers to simulate the feel of objects. The importance of these settings in creating believability is emphasized by Hess (2010), who asserted, "Once surfacing has been added, the image becomes much more believable . . . . It plays with our expectations of what we should be seeing" (p. 6).[59] Hess (2010) further suggested that our understanding of objects changes when materials and textures are applied. He noted that our perception of wood changes when we consider different types of surfacing. Bark, which is rough and dark, is often associated with trees outside. Finished wood, which appears light and shiny, is often associated with indoor furniture and flooring (p. 4).

Yet, applying World, Material, or Texture settings is a highly complex, rhetorical construction process, and multiple methods can be used to simulate surfaces. In terms of applying materials, for instance, composers must not just select colors (e.g. from a color picker or by manually inputting RGB numbers), but they also must make strategic choices about color intensity (i.e. the strength of color), specularity (i.e. the amount and color of light that appears on

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[58] The manual, which has a Creative Commons 0 (or public domain) license, can be accessed here: https://www.blender.org/manual/render/blender_render/world/background.html

[59] Rhetorical scholars and others have also noted the importance of color in shaping meaning. Kress (2002) notes that color is not just used for affect, but also to signal identity (e.g. flags, rank); to create symbolism (p. 348); and to do things such as intimidate or increase attention (p. 348-9). Richards and David (2005) further assert that color can elicit "evaluative/cognitive reactions." They see these reactions also as Nussbaum suggests, "'a value-laden way of understanding the world' embodying a 'way of seeing' and emerging from one's own 'active ways of seeing and interpreting'" (p. 35).

the object), the “hardness” or “softness” of the light shining on the object,[60] and shading or translucence (Blain p. 93).

Similarly, the procedures used for applying textures are also complex and strategic – often requiring manual manipulation, experimentation, and play. Textures can be manually created using combinations of built-in program options, or they can be uploaded into the program from other sources. Numerous methods are also possible for applying uploaded textures. For instance, composers can apply textures via texture mapping (i.e. adjust a texture to an object); via displacement mapping (i.e. as Blain (2012) asserts, this includes deforming a mesh by using a texture such as by applying a wrinkly texture to the object); or via UV texture mapping, which “unpeels” the surface of an object, lays it on a flat surface, and then applies the texture to it (Blain, 2012, p. 114).

Perhaps just as importantly, materials and textures reciprocally affect each other. For instance, if the color blue is applied to an object using the Materials setting, and then the texture of red bricks is applied, the object, when rendered, may take on the look of red bricks with a slightly blue tint. Thus, there is a continual play among elements such as lighting, materials, and textures, which composers must account for as they manipulate these elements.

In his video tutorial, BlenderWiz (2012) shows composers how to strategically adjust Blender’s built in World, Material, and Texture settings and to combine them to create a more microscopic look and feel to the object. Figures 33-49 demonstrate how procedural rhetoric is used as various codes are applied to create materials and textures, which affect viewer perception.

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[60] This property is important for simulating the appearance of an object. “Hardness” is typically associated with objects like wood or glass while “softness” is associated with objects like cloth.

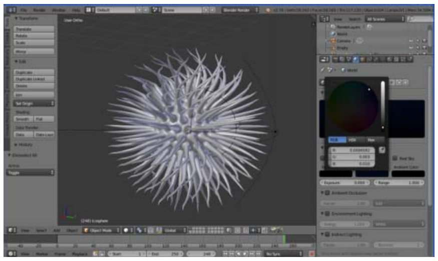

Figure 33. In the World setting, several selections are made: the Blend Sky setting is ticked, the Horizon setting in the color picker is slid to black, and the Zenith Color is slid to blue.

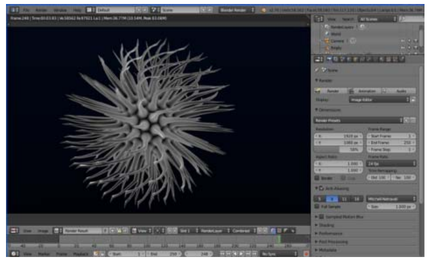

Figure 34. When rendered, the background scene appears black as if the virus is seen through a microscope. The virus, itself, however, has no color, so materials and textures are added.

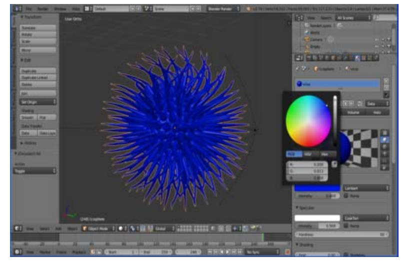

Figure 35. To adjust color settings for the virus, the color picker in the Material settings is selected and slid to blue. Specular intensity is adjusted to 0.1, and hardness is set to 10.

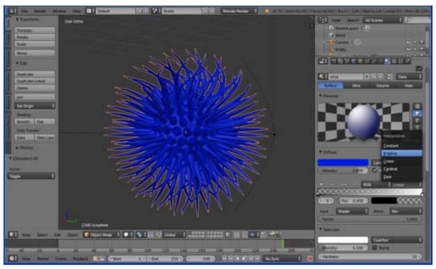

Figure 36. Additional selections are made: Ramp and B-spline settings are selected and a Positive color slider value is set to .504.

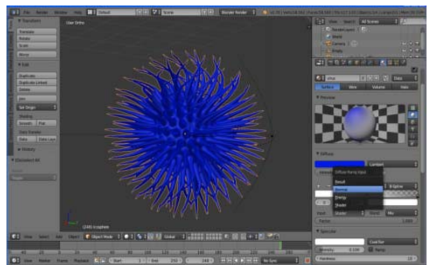

Figure 37. Shader settings are set to Normal.

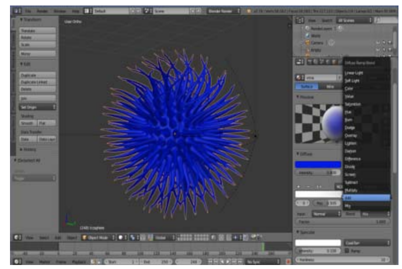

Figure 38. Blend settings are set to Add.

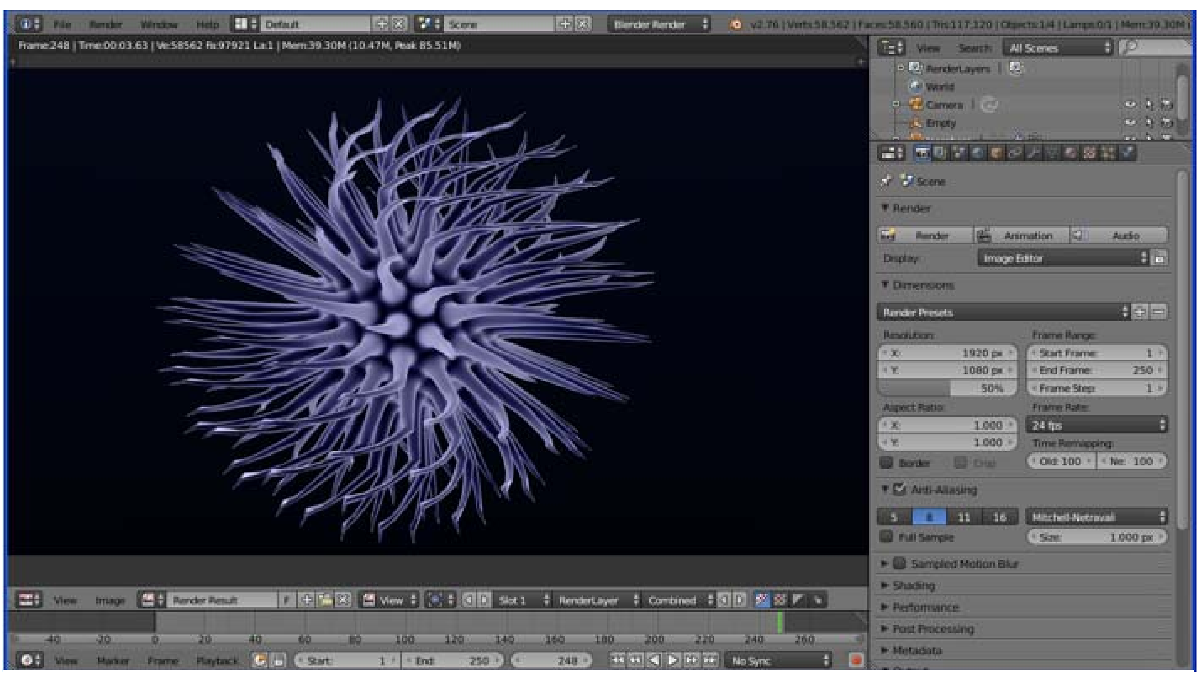

Figure 39. When rendered, viewers see that a slight blue tint has been added to the virus. No textures have been added. Continuing to adjust color settings and adding textures results in a more realistic looking virus.

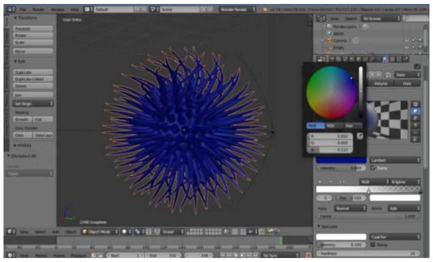

Figure 40. RGB color settings continue to be adjusted, with Red set to .028, Green set to .5777, and Blue set to .918.

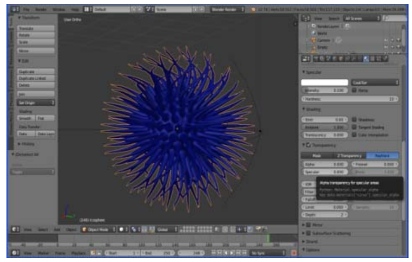

Figure 41. Transparency is set to Ray Trace, with the Alpha setting turned on and the specularity set to 0.

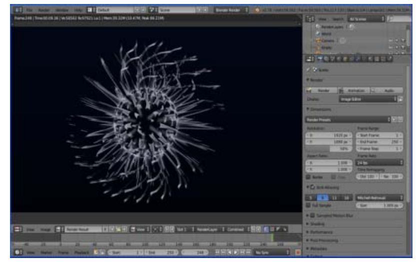

Figure 42. When rendered, the virus looks like this.

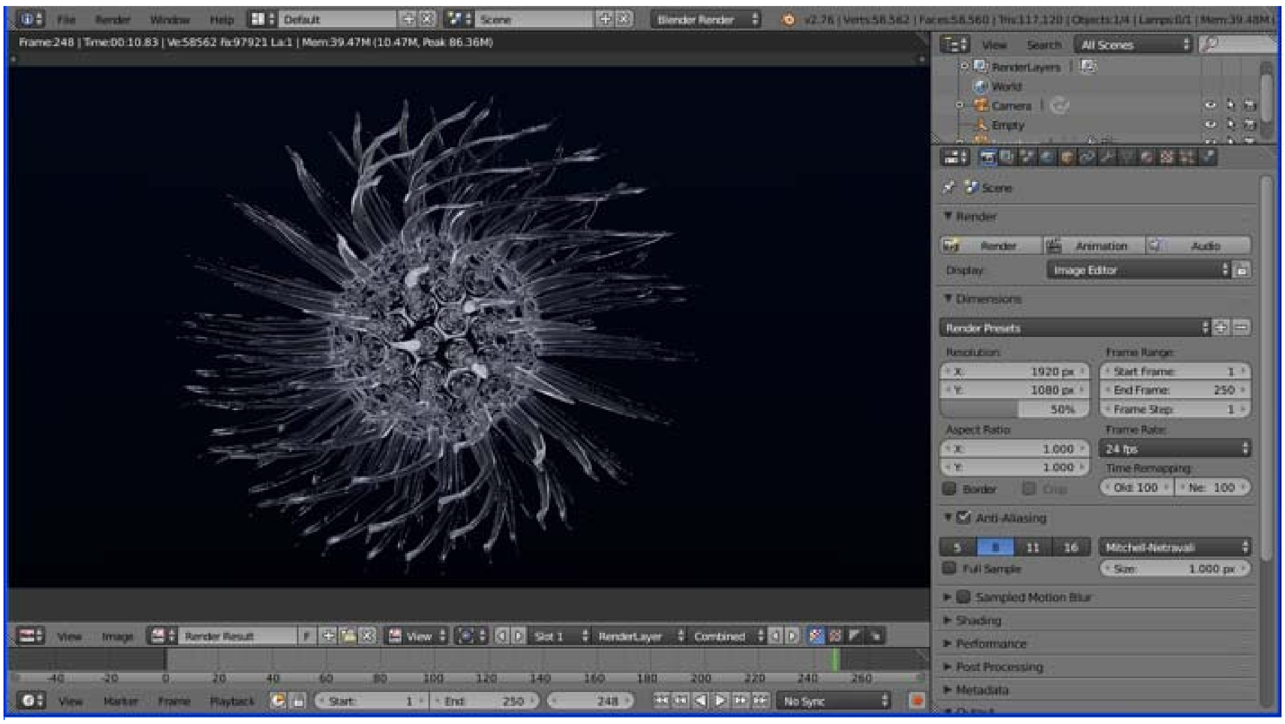

Figure 43. Increasing the IOR setting to 1.2 yields this image when rendered. Textures can now be added to again slightly change the look of the virus.

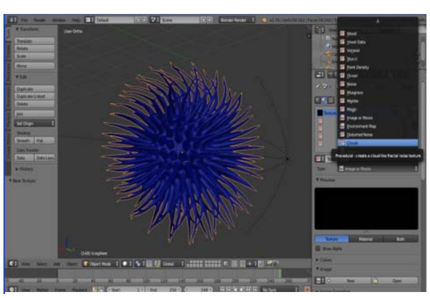

Figure 44. Built-in cloud textures are selected. Under *Texture Influence* the settings *Diffuse* and *Alpha* are selected.

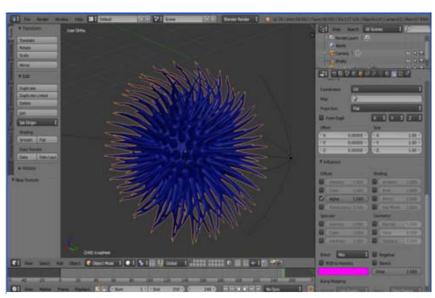

Figure 45. The setting *RGB to Intensity* is ticked. Under *Colors, Ramp* is ticked. *Positive* setting is turned to 5 and *Alpha* is turned all the way up.

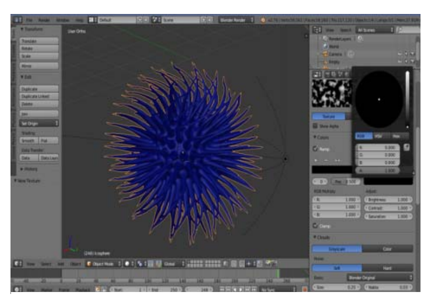

Figure 46. RGB settings are again adjusted to .04242 for Red, Green, and Blue.

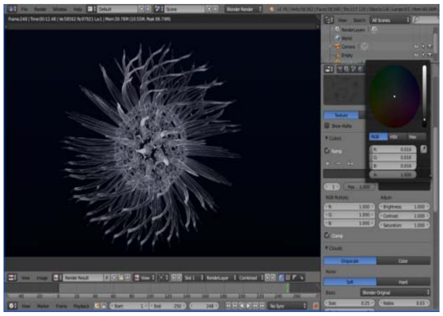

Figure 47. The setting Active Color Stop is set to 1 and all RGB settings are re-entered at 0.05072 as the color slider is also set to dark.

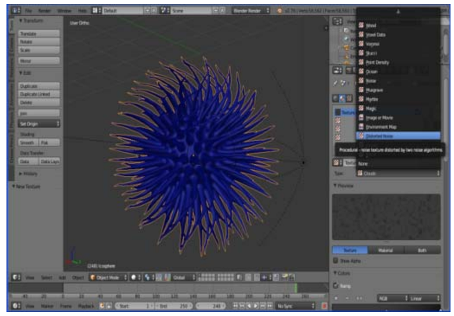

Figure 48. After several more adjustments in texture depth are made, a new texture, Distorted Noise is selected.

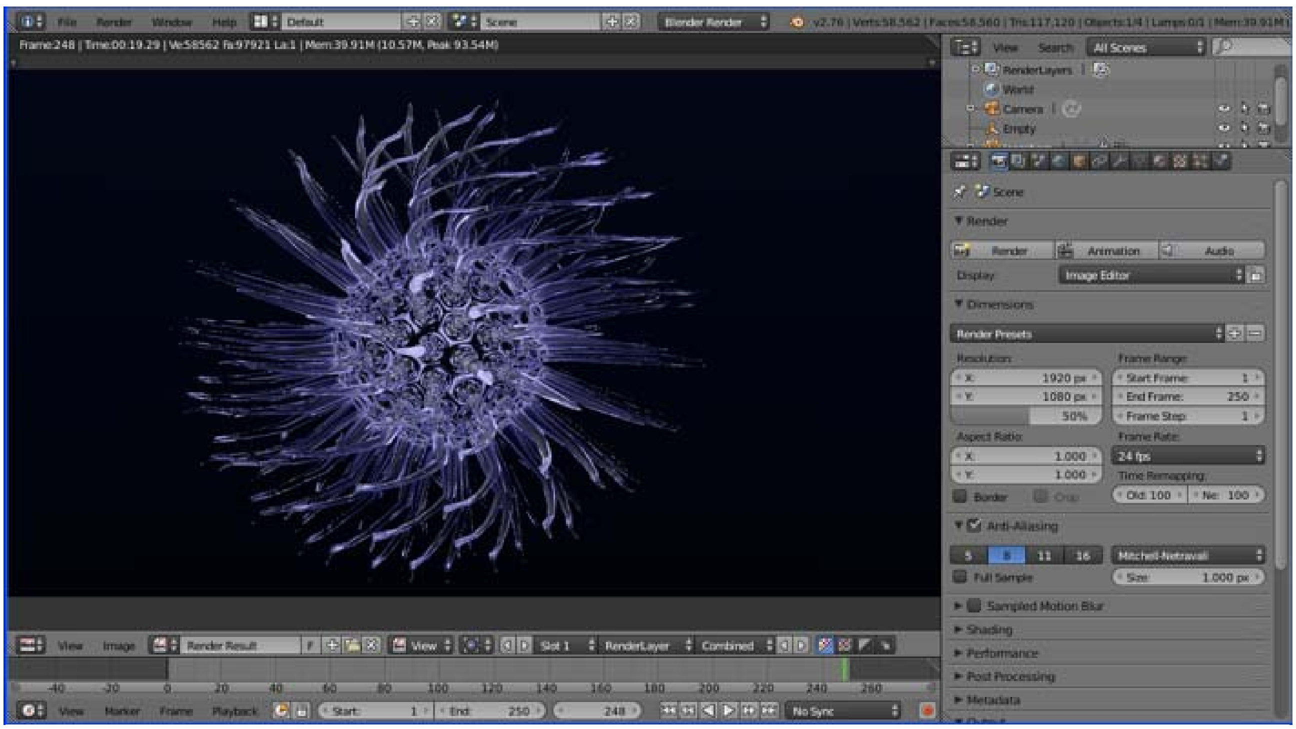

Figure 49. Additional adjustments yield the blue tint, seen here, on the microscopic virus.

As Figures 33-49 show, composers use procedural rhetoric by applying a series of codes to create materials and textures and to affect viewers' perceptions of objects. However, as the case above demonstrates, the "codes" – i.e. the "rules of behavior" – for adding materials and textures are different from those required to model objects. While the "codes" for modeling objects pair computer coded keys on the computer keypad with mouse movements, the "codes" for adding materials and textures constitute a series of complex selections and deselections of

buttons, color pickers, and numeric slider bars for various features. For instance, in the virus depicted above, a series of selections was made: The color picker was dragged to blue; the specular intensity was set at .01; the hardness of the specularity was set to 10; *Ramp* was selected under the specularity tab; the setting *B-spline* was applied; positive color values were set to.504; *Shader* settings were adjusted to *Normal;* and *Blend* settings were set to *Add.* However, had the Materials color picker been dragged to red, the specular intensity set to 5, the hardness of the peculiarity set to .2 – the rhetorical effects would likely be very different and they would shape viewer perceptions of the virus in very different ways. Each procedural selection or deselection, then, affects how the object is perceived and the extent to which viewers find it persuasive.[61] This observation is also true for selections and deselections made in animating, which is discussed in the next section.

[61]It should also be noted, however, that the procedures used to yield rhetorical effects are lengthy and nearly impossible for novices to understand. Composers who are not familiar with the menu options on the Materials and Textures settings will be unable to use (or combine) them strategically as the BlenderWiz (2012) does in his tutorials. The different menu features are also very rarely explained in video tutorials except to indicate what button or tab to select and how to numerically adjust the feature just selected. For this reason, novices who wish to gain an understanding of the menu options need to play with these features.

3.7 Animating Objects

Just as an object's form, materials, and textures shape our understanding and perception, so too does an object's movement. In Blender, object movement is manipulated in three ways: via object animation, character animation, or particle systems animation (and sometimes all three). Object animation allows composers to animate objects using key frames – or important object positions, which are placed along a timeline. The computer then calculates the "in between" positions between the key frames to simulate the appearance of movement.[62] Character animation allows composers to animate the bodies of human and animal models (among other anthropomorphized objects). However, character animation requires additional processes, such as rigging (i.e. inserting a kind of skeleton or armature inside the model shell); parenting (i.e. setting constraints to the rig – such as making one bone subordinate to another – so that the model will move in human ways); and skinning (i.e. applying textures to the model). Finally, particle systems animation allows composers to simulate such things as smoke and rain, or to simulate "flocks" of things like fish or birds. Unlike character and object animation, however, particle systems animation is predominately created using not key frames but rather features in the particle system menu.

Regardless of the type of animation, however, composers still use procedural rhetoric while animating to affect a viewer's perception of an object. Much like the "codes" – the rules of behavior" – used in modeling, the "codes" used to manipulate our perception of movement in object animation predominately include pairing coded letter keys on the computer keypad with

[62] In traditional, hand-drawn animation, the most experienced animators would draw the key frames while less experienced animators – called "inbetweeners" would draw the frame in between the key frames. In this case, the composer can set the key frames while the computer fills in the rest.

mouse movements. A simple object animation of the modeled virus (See Figures 50-55) demonstrates the procedural rhetoric used in animating.[63]

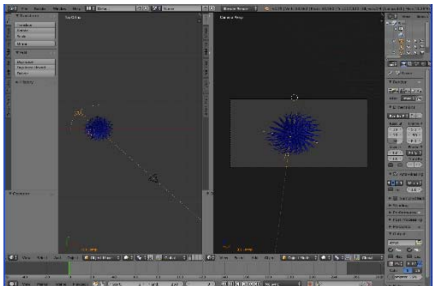

Figure 50. The interface is split to provide two perspectives: top orthogonal (left) and active camera view (right). Active camera view allows composers to see where objects are placed relative to the camera during animation.

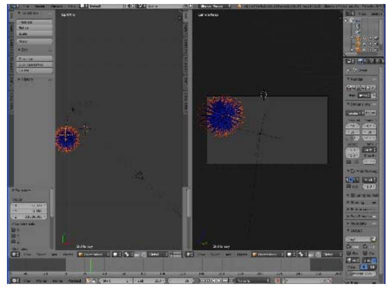

Figure 51. The object is moved by typing G, and the green line in the Timeline Window, beneath the 3D Viewport, is dragged along the timeline to the first key frame.

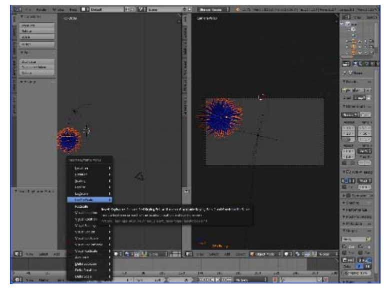

Figure 52. The code I is entered on the computer keypad to bring up a pop-up menu, and loc/rot/scale is selected. This creates the first key frame.

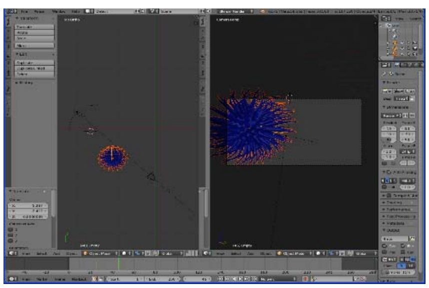

Figure 53. The object is then moved again – this time closer to the camera – by typing G – and the green line in the Timeline Window is again moved on the timeline.

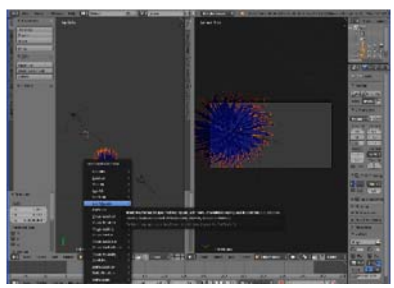

Figure 54. The code I is entered on the computer keypad and the code loc/rot/scale is selected to create another key frame.

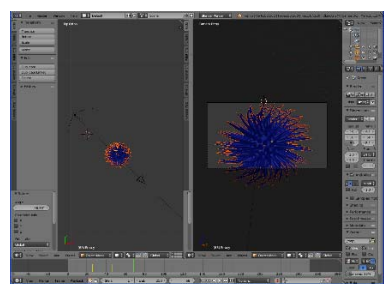

Figure 55. The process of moving or transforming the object, dragging the green line along the Timeline Window, typing I, and selecting loc/rot/scale continues.

As Figures 50-55 show, composers must engage in a repeated and strategic process of using the codes *I,* as well as *loc/rot/scale* while also dragging the object to various locations along the interface in order to create key frames to simulate movement. However, what the figures cannot show are the rhetorical effects created by strategic relationship created between the distance an object is moved on the interface and the amount of space between key frames on

[63] BlenderWiz (2012) does not animate his virus, so I have included only a very simple animation.

the timeline. For instance, the greater the space between the key frames on the timeline, the lighter an object appears to be and the slower it seems to travel – particularly when an object isn't moved great distances in the 3D Viewport. Thus, objects (such as balloons or viruses) whose key frames are farther apart on the Timeline and that are moved relatively short distances on the interface travel more slowly and appear to float, thus making objects like balloons or viruses more believable (and persuasive) to viewers. By contrast, when key frames are placed very close to each other, and the object is moved greater distances within the 3D Viewport, objects appear to move much more quickly and seem much denser. Therefore, by carefully controlling where a key frame is placed along a timeline as well as the distance the object moves in the 3D Viewport, composers can, again, manipulate viewer perception – by attributing properties such as lightness, density, or speed to objects. Of course, it should also be noted that more complex forms of animation, such as character animation, also use performance and gesture to shape meaning. However, since this form of animation was not used in this study due to its complexity, it will not be discussed here. In the section that follows, I briefly discuss other ways 3D CGI shapes meaning and why such strategic meaning-making is important.

3.8 In Conclusion

While form, color, texture, and movement all help to shape our understanding and perception of 3D objects, these rhetorical modes are often paired with others to shape meaning further. For instance, after animations are rendered (i.e. converted from the 3D file to a 2D file that can be read by most computers), they are typically video edited and audio is added in the form of narrative. Narratives, thus, shape our perception in additional ways as does the performance of them. As a result, our terministic screens are further manipulated.

Because 3D CGI is such a rhetorical, constructed, complex process – one predominately created by technical experts, whose creation processes are largely hidden from the public eye and the final product – it is well worth investigating how instructors can integrate 3D CGI composing into technical communication classes to teach rhetorical awareness and to interrogate how visual "truths" created by them are designed and developed. In the next chapter, then, I discuss the ways in which I integrated 3D CGI into three upper division sections of technical communication classes at The University of Texas at El Paso to teach not just traditional technical communication genres but to also foster rhetorical and design awareness.

Chapter 4: The Technical Communication Class as a Macro-Level Rhetorical Information Ecology[64]

4.1 Introduction

The last chapter discussed Blender's meso-level rhetorical informational ecology and analyzed it using Bogost's (2008) notion of procedural rhetoric. However, in this chapter, I examine the technical communication classroom as one kind of macro-level rhetorical information ecology. In this ecology, situated meaning-making processes are shaped by the institutional and class environments; the students, instructor, and classroom practices; classroom technologies; the multiple audiences (e.g. teacher, students, and outside audiences); differing situations (e.g. assignment requirements, projects selected, student abilities etc.); and the messages produced. This macro-level rhetorical information ecology has a great impact on how 3D CGI is used, what is produced, and how individuals feel about the technologies. In this chapter, then, I describe the macro-level 3D rhetorical ecology. I report the results of a Spring 2012 case study that integrated Blender into technical communication class at the University of Texas at El Paso. Chapter sections are organized as follows: **Section 4.2 Technical Communication Courses at UTEP** situates technical communication courses at an institutional level. **Section 4.3 Technical Communication Course Competencies and 3D CGI** discusses the competencies required to compose 3D CGI and how they align with course competencies. **Section 4.4 Integrating 3D CGI into Technical Communication Course Design** overviews how I integrated 3D CGI into a Spring 2012 technical communication course. **Section 4.5**

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[64] Yeats and Thompson (2010) differentiated between the terms technical communication, technical writing, and professional writing. Technical communication, they asserted, emphasizes "communication beyond the written word; Web design, document design, graphic design, visual communication, [and] new media design" (232). Technical writing, by contrast, focuses on "genres of workplace writing; reports, proposals, writing for the computer industry." Professional writing is "characterized by a number of courses in writing including essays, nonfiction, creative writing, public relations, speech writing, editing, and publishing" (p. 232). This project, which required students to write using technical writing genres, similarly emphasized visual and graphic design as well as new media design, and so I will use the term technical communication throughout the document.

People and Practices in the Macro-Level Ecology discusses the methods I used and the participants who agreed to take part in a class study that measured student learning outcomes. Finally, **Section 4.6 Comparing Studies** discusses the ways the Spring 2012 study outcomes resonated with prior research.

4.2 Technical Communication Courses at UTEP

At the University of Texas at El Paso, technical communication is directed by the Rhetoric and Writing Studies (RWS) program in the English Department. The course functions as a service component, preparing upper division students for writing in the health and social science fields.[65] As a service course, it presents unique instructional challenges. Instructors must anticipate and address the writing needs of diverse interdisciplinary students while also incorporating programmatic and professional disciplinary knowledge. Ideally, although not always,[66] the technical communication course introduces students to technical communication as a field and important issues within it; integrates rhetorical theories and humanistic perspectives embraced by the RWS program; teaches core competencies identified by the Society for Technical Communication (STC); and teaches more advanced, workplace-oriented composing to prepare students for writing in their specialized fields. Integrating 3D CGI into such a course, then, poses challenges for both instructors and students.[67] However, because 3D CGI composing requires many of the same competencies emphasized in the technical communication class, it can be integrated into the course to align with existing competencies, objectives, and assignments as the next section discusses.

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[65] Students required to take the course traditionally major in health sciences, social work, kinesiology, psychology, math, occupational therapy, physical therapy, and nursing although on occasion students majoring (or minoring) in chemistry, biology, or industrial engineering take the course. Interestingly, other engineering disciplines cannot take the course because of the hours required for engineering courses.

[66] What is taught often depends upon the instructor and his or her familiarity with technical communication.

[67] These challenges are discussed in Chapter 5.

4.3 Technical Communication Course Competencies & 3D CGI

Both 3D CGI composing and technical communication classes emphasize similar competencies. For instance, they both emphasize the importance of scientific, technological, rhetorical, visual, and multimodal literacies. They also emphasize working in teams; analyzing audiences and tasks; problem-solving and thinking creatively; planning and designing products; managing processes and product design schedules; and developing, designing, and distributing products.

Because 3D composing requires skills and processes technical communicators need, it allows instructors to align programmatic, institutional, and professional goals with student learning objectives. Table 1 shows how 3D composing aligns with major programmatic, institutional, and professional goals and student learning objectives.

Table 1. 3D Compositional Capacities, Course Goals, and Learning Objectives

Organization	**Goals**	**Student Learning Objectives**	**Composing Skills/Practices inherent in 3D**
RWS	• to develop an awareness of discourse communities and the rhetorical situation	• Students will compose a variety of multimodal documents for diverse audiences and purposes	• Animators/Graphic designers must work with different clients to produce products that meet their purposes and needs. • 3D composing appeals to diverse audiences, and is used for diverse purposes
	• to foster in students a rhetorical sensibility that enables them to see the constructed nature of all discourse (e.g. visual, verbal, non-verbal, multimodal)	• Students will be able to rhetorically analyze discourse (e.g. visual, verbal, non-verbal, multimodal)	• Animators/Graphic designers must analyze and understand how static images, moving images, gestures, colors, textures, narrative, sound, lighting, camera angles etc. affect a message's meaning and contribute to its mood and tone
	• to foster in students the ability to rhetorically construct discourse (e.g. visual, verbal, non-verbal, multimodal)	• Students will be able to produce effective rhetorical discourse	• Animators/Graphic designers must integrate static and moving images, narratives, and other compositional elements to create effective rhetorical messages that inform, persuade, and

			entertain audiences without distracting them.
	• to foster in students critical technological, scientific, design, and multimodal literacies	• Students will be able to understand the political, economic, ideological, and social agendas inherent in all literacies	• Animators/Graphic designers make political, economic, and ideological decisions as they work based on the contingencies of the situation.
Institutional	• to prepare students for writing in scientific and technical fields by introducing them to common technical genres and by refining their composing, revising, editing, and proofreading skills	• Students will compose proposals, instructional documentation, technical descriptions, memos, letters, and reports.	• Animators/Graphic designers must produce different kinds of documentation. Proposals are often required to obtain work from clients; they animate instructional documents and technical descriptions; they write memos and letters as part of their business communications.
		• Students will revise for content and consistency	• Animators/Graphic designers must revise/proofread communications to clients. They must also continually revise their 3D objects and animations to create the feeling of realism.
STC	• to produce competent technical communicators who can 1. Analyze users, tasks, experiences	• Students will "define the users of the information and analyze the tasks that the information must support" (p.281)	• Animators/Graphic designers must thoroughly understand who will use their animations, for what purpose, and their level of understanding. With this knowledge, they must also determine what information needs to be presented in the animations for the users, and what tasks must be done to ensure the information is developed.
	2. Design information	• Students will "plan information deliverables to support task requirements" and "specify and design the organization, presentation, distribution, and archival process for each deliverable"	• Animators/Graphic designers must plan the design and organization of both narratives and visuals. Typically, they must synchronize visuals and narratives using different levels of storyboarding, which reflect different levels of detail and sequences of revision.
	3. Manage processes	• Students will "plan the deliverables schedule and monitor the process of fulfillment"	• Animators/Graphic designers must carefully plan the production process to ensure schedules and budgets are met.
	4. Develop information	• Students will "author content in conformance with the design plan, through an iterative process of creation, review, and revision"	• Animators/Graphic designers must conduct visual and textual research to create the feeling of realism. They must also develop and revise both

			visual and textual content created.
	5. Produce information	• Students will "assemble developed content into required deliverables that conform to all design, compliance, and production guidelines" and will "publish, deliver, and archive."	• Animators/Graphic designers must also assemble content and "publish, deliver, and archive" it.

While 3D CGI aligns with programmatic, institutional, and learning objectives, it also allows instructors to integrate what Fink (2003) called "significant learning goals" – learning students retain after completing the course. According to Fink (2003) significant learning goals include "learning how to learn" (e.g. "becoming a better student; inquiring about a subject; becoming self-directed learners"); "caring" (e.g. 'developing new feelings, interests, and values"); discovering the "human dimension" (e.g. learning about others and oneself); "integrating" (e.g. "connecting ideas, people, and realms of life"); "applying" (e.g. thinking critically, creatively, and practically, and managing projects); and gaining "foundational knowledge" (e.g. "understanding and remembering information and ideas") (p. 9).[68]

These significant learning goals are inherently part of 3D composing. For instance, while instructors may teach students the basics of 3D composing, students must learn how to apply what they've learned to new contexts to create their own projects. This requires that they learn, on their own, how to use new features of the 3D programs. Additionally, because 3D composing requires that students work in teams, students inevitably learn about "the human dimension": they learn about their own strengths and weaknesses in working in teams, and they learn (by trial and error sometimes) how to productively interact with others, whose values, interests, and work habits differ. 3D composing also requires students to apply critical, creative, and practical

[68] Interestingly, these goals also align well with the humanistic goals technical communication courses often strive to teach.

thinking. Students must think creatively in developing their designs for a project; they must apply what they know to begin a project; and they must problem-solve to develop and refine their initial visions (including their narrative visions) while using the technology. Additionally, they must continually adjust the project's scope and timeline to suit practical contingencies, such as their technological skill with the software and project completion deadlines. Creating 3D compositions, further, helps students retain foundational knowledge since they must thoroughly understand a topic in order to create visual and audio narratives in 3D.

Integrating 3D composing strategically into the course also fosters active learning. According to Fink (2003), holistic active learning combines experience (e.g. "doing, observing, actual, simulated, rich learning experiences"), information and ideas (e.g. "primary and secondary sources" and "accessing them in class, out of class, and online"), and reflective dialogue (e.g. "learning portfolios, journaling about the subject" etc.). To create 3D animations, students must first gather visual and textual information from primary and secondary sources. They must analyze previously created animations, images, and narratives. They must create animations with the technology and dialogue with members of their teams to problem-solve and share ideas. Teams must also continually reflect on their work to refine their 3D animations. This reflection may be combined with a variety of writing assignments to help students more thoroughly integrate their learning experiences.

Of course, integrating 3D CGI can create significant challenges for both instructors and students. Instructors, for instance, must know the 3D software they want their students to use before assigning projects, and learning such software is time consuming. Instructors will also likely find that delivering instruction on software is best done through "non-traditional" instruction – such as through video tutorials and in-class labs – which may require instructors to

learn additional screen recording software. In addition, instructors must ensure that they strategically balance course content and required capacities with technological leaning.

Students will also need lots of support. The technology, which has a high learning curve, places students outside their comfort zones and requires them to adapt to an inquiry-driven, problem-based, collaborative, and highly technical (i.e. scientific and technological) environment. Working in such an environment requires students to make mental and social adjustments. They must learn to think positively; to be proactive; to problem-solve; to be persistent; to be patient; to be productive; and to be professional (i.e. polite and personable) – characteristics that they may not practice – even in their part- or full-time jobs.

Despite such challenges, instructors *can* integrate 3D composing effectively into technical communication courses, and the next section discusses how I did so in one Spring 2012 section of technical communication.[69]

[69] A pilot study was also conducted in Fall 2011 across two sections of technical communication. The results of the pilot study, however, will not be reported here.

4.4 Integrating 3D CGI into Technical Communication Course Design[70]

Before introducing 3D CGI into my Spring 2012 technical communication course, I introduced students (during the first two weeks of class) to theoretical readings on rhetoric, visual design, technology, and science to help them begin to think critically (and rhetorically) about these discourses and to provide a foundation for practical learning. These readings included Brummet's (1979) "Three Meanings of Epistemic Rhetoric"; Berkenkotter's (1993) "Rethinking Genre from a Sociocognitive Perspective"; Kress and Bezemer's (2008) "Writing in Multimodal Texts"; Salinas' (2009) "Technical Rhetoricians and the Art of Configuring Images"; Katz's (2010) "Science as a Social Enterprise"; Trumbo's (2000) "Seeing Science"; and Breuch's (2009) "Thinking Critically about Technological Literacy."

After this theoretical foundation, I introduced students to technical communication's more practical aspects: technical writing style and the principles of visual design. Once students demonstrated competency in technical style and visual design, I then introduced students to the final project, the 3D animated video tutorial, around which all assignments were scaffolded. The 3D animated video tutorial asked students to research "an open problem" in science or medicine and to explain how some medical or scientific process related to that problem worked. Students then learned various technical communication genres. They wrote proposals, requesting to study a particular problem in science or medicine. Once proposals were accepted, students wrote technical descriptions and created a 2D technical description poster, which both defined the concept being researched and described how it worked. These 2D technical description posters

[70] To attempt to effectively integrate 3D CGI into her Fall 2011 Technical Communication classes, I followed Fink's (2003) course design model. In this model, Fink (2003) emphasized three stages of course design. During the first stage, instructors need to build strong primary components. This includes identifying situational factors, learning goals, feedback and assessment procedures, and teaching/learning activities. The second stage, described here, includes assembling components into a coherent whole and requires instructors to create thematic course structures, instructional strategies, and learning activity schemes. In the final phase, instructors create grading systems, look for possible problems, write course syllabi, and plan course evaluation methods.

not only were used to help students visualize a process they would develop in 3D, but the textual descriptions also later served as a draft of the 3D audio narrative.

Finally, during the eighth week of class, I introduced students to Blender software. To do so, however, I decided to change the instructional method.[71] Rather than using lecture-style workshops, I created a series of seven video tutorials to help students learn the software more quickly.[72] Students viewed the video tutorials at home, and then worked on in-class labs that asked them to create 3D artifacts, based on their learning the night before, and to write memos or letters about that learning. Structuring instruction in this way allowed students to work more independently or in pairs with their peers, and it also allowed me to help students who were having difficulty resolving their own computer issues. Additionally, in-class labs occurred daily.[73]

Once students learned the basics of the new technology, they created lengthier instructional guides on a feature of Blender they hadn't been taught, and they posted their instructional guides to BlackBoard so that other students could reference them. Students then storyboarded their 3D videos, modeled their objects, textured them, added animation, and

[71] During the Fall 2011 pilot study, teaching Blender using traditional, teacher-centered, lecture-style workshops proved ineffective. I had to continually stop instructing to assist individual students with a multitude of unforeseen technical problems that took class time to resolve. For instance, when some students dragged a reference image into Blender's 3D viewport to model objects, images sometimes imported sideways. Unlike word processing programs that allow users to move or rotate images by clicking and dragging on an image's corners, Blender does not allow users to move reference images this way. Images had to be deleted and then reimported using a longer series of intricate steps. Sometimes, too, as students zoomed into or out of their models using the very sensitive 3rd button on the Mac mouse, they either zoomed so far out of their objects that the objects disappeared or objects took up the entire screen, and students needed help resizing the image. At other times, students accidentally brushed their fingers the wrong way across the keypad and unknowingly activated a feature of Blender that neither they nor the researcher could figure out how to undo. They, thus, had to exit the program, restart it, and then catch up with the rest of the class. This took considerable class time to resolve. To alleviate this problem, I created written labs for students in the Fall 2011 pilot study to follow. However, these written labs were also problematic and they frustrated some students because many of the concepts taught – like the mirror modifier – took 13 steps to complete. Students who performed the steps incorrectly often felt increasingly frustrated because they had to begin over again.

[72] These tutorials included 1) An introduction to Blender's interface, 2) Navigating in Blender, 3) Basic Modeling 1 (with primitives), 4) Uploading a Reference Image & Basic Box Modeling, 5) Adding Materials and Textures, 6) Adjusting Lighting and Camera, and 7) Animating.

[73] In the Fall 2011 course, a weekly 3D schedule was implemented; however, students seemed to forget from week-to-week what the commands were and procrastinated on the assignments.

transducted[74] their 2D technical description narratives into 3D animated videos. As with the pilot study participants, after students created their 3D animated videos, they wrote analytical reports on their learning and presented their 3D tutorials along with their findings to the class.

[74] Kress uses the term transduction to describe the changing from one mode or medium to another. Moving from the modes of written text to audio, or moving from the medium of paper to a DVD are examples of transduction.

4.5 People and Practices in the Macro-Level Ecology[75]

During the Spring 2012 semester, I conducted a case study[76] of students in my technical communication class. The study attempted to answer three questions: 1) How did participants feel about integrating 3D CGI into a technical communication classroom? 2) What did they generally learn as a result of integrating 3D CGI? 3) What did they learn about specific concepts taught as a result of using 3D CGI? This section presents the participants and the study, analyzes the results, and discusses its implications.

4.5.1 Soliciting Study Participants in the Spring 2012 Study

Identifying and Selecting the Sample

Participants identified for the Spring 2012 study included 19 undergraduate students enrolled in one section of the researcher's English 3359 Technical Communication course.[77] The researcher asked an impartial colleague to recruit participants and left the classroom during recruitment so that participants would not feel coerced. The potential participants were given an informed consent form approved by UTEP's Institutional Review Board (IRB), and the recruiter read and explained the form aloud.

Out of the 25 potential participants identified, 20 signed consent forms to take part in the study and took the beginning-of-the-term survey. Of the 20 students who initially signed a

[75] Before integrating 3D CGI into the course, I consulted with individuals using 3D CGI both inside and outside of academe to determine the feasibility of incorporating 3D CGI into a Technical Communication course. These individuals included Academic Technologies director Sunay Palsole; computer science professor, Dr. Rodrigo Romero; chemistry professor, Dr. James Salvador; kinesiology professor, Dr. Rebecca Reed-Jones; and art professors, John Dunn and Vincent Burke. Individuals outside of the academy included Saul Gutierrez, founder of InRadius Systems, a company that designs 3D CGI objects for clients, and Ysleta high-school teacher Adrian Hernandez, who taught 2D Flash animation to his students.

[76] I chose to use a case study because I wanted to investigate whether using 3D CGI would develop a rhetorical disposition in students. Since I was the only instructor in my department using 3D CGI, I had to study participants in my own classes.

[77] The course has now been renamed Rhetoric and Writing Studies (RWS) 3359: Technical Communication.

consent form, one withdrew from the course before the drop date because he was failing the course. As a result, 19 total participants were recruited for the study.

<u>Demographics of the Sample</u>

The 19 participants consisted of 10 women (52.6%) and 9 men (45.%), enrolled in one English 3359 (Technical Communication) course at UTEP. Of these participants, 13 (65%) were between 18-22 years old; 5 (25%) were between 23-25 years old; and 1 (5%) was between 30-39 years old.

In terms of ethnicity, 2 (10%) reported being Caucasian; 16 (84%) reported being Hispanic/Latino(a); and 1 (5%) reported being Multiracial.

In terms of academic majors, 4 (20%) participants reported majoring in math; 7 (35%) participants reported majoring in kinesiology; 1 (5%) reported majoring in psychology; 1 (5%) reported majoring in linguistics; 1 (5%) reported majoring in social work; 1 (5%) reported majoring in criminal justice; 1 (5%) reported majoring in nursing; 1 (5%) reported majoring in in pre-occupational therapy; 1 (5%) reported majoring media journalism; and 1 (5%) reported majoring in health promotion.

In terms of academic classification, 1 (5%) was a sophomore; 14 (73.6%) were juniors; 1 (5%) was a senior; 1 (5%) was a graduate student; and 1 (5%) reported the classification as “science.”

In terms of familiarity with 3D CGI programs of the 18 participants who answered the question, 16 (84%) reported never having used 3D CGI programs before. One (5%) participant reported using Bryce in a high school course, and 1 (5%) responded “not applicable” to the question.

Participants were also asked to report additional factors that described them as students in the end of term survey. Of the 12 participants who responded at the end of the term, 2 (16.7%) stated they worked full-time jobs and 5 (41.7%) said they worked part-time jobs. Students who reported working indicated that they worked between 12-33 hours per week. Seven (58.3%) respondents indicated they went to school full time, while 2 (16.7%) respondents stated they attended part-time. Students who reported going to school full or part-time indicated that they took between 12 and 17 credit hours. Two (16.7%) respondents indicated they were a parent of one or more children, and one (8.3%) respondent stated he or she was a single parent of one or more children. Three respondents (25%) also indicated they supported themselves financially. Table 2 more succinctly summarizes these demographics.

Table 2. Demographic Characteristics of Participants

Characteristics	***Number***	**Percent**
Gender		
Women	10	52.6%
Men	9	45%
Age		
18-22	13	65%
23-26	5	25%
26-29	0	0%
30-39	1	5%
40 and over	3	9.7%
Ethnicity		
Hispanic/Latino(a)	16	84%
Caucasian	2	10%
Multiracial	1	5%
Major		
Math	4	20%
Kinesiology	7	35%
Psychology	1	5%
Linguistics	1	5%
Social Work	1	5%
Criminal Justice	1	5%
Nursing	1	5%
Pre-OT	1	5%
Media Journalism	1	5%
Health Promotion	1	5%
Classification		
Junior	14	73.6%
Senior	1	5%
Graduate	1	5%

Failed to report	1	5%
Familiarity with 3D Software		
No	16	84%
Yes	1	5%
n/a	1	5%
Additional Factors		
Full-time students	7	58.3%
Part-time work	5	41.7%
Parent of one or more kids	2	16.7%
Financially independent	3	25%
Part-time students	2	16.7%
Full-time work	2	16.7%
Single parent of one or more kids	1	8.3%

Note: In this study, there was significant attrition. Questions concerning gender, age, ethnicity, major, classification, and familiarity with 3D software were asked in the beginning-of-the-term survey, which included 19 students. Questions about additional student factors were asked in the end-term survey, which only 12 participants responded to.

Because this sample population comprised volunteers and was a sample of convenience, it is impossible to generalize results.

4.5.2 Understanding Practices: Instrumentation Used in the Spring 2012 Study

Both qualitative and quantitative instruments were used to determine participant learning outcomes using the end-term survey instruments.

Qualitative Instrumentation

Qualitative instruments (i.e. students' end-term analytical reports and open-ended questions from the end term survey) were used to provide specific feedback about participants' general and specific learning and to provide insight on participants' quantitative responses. The analytical report required participants to analyze four things: 1) the textual sources they used, 2) the visual sources they used, 3) the 3D projects they created from those sources, and 4) their learning about scientific discourse, technology, visual design, and 3D CGI. After conducting their analysis, participants discussed the strategies they saw used in the textual and visual

sources; explained the strategic choices they made in their projects; refuted or defended key assertions made in the class; and discussed the key insights from the course.[78]

Students were also asked 15 open-ended questions on the end-term survey. The open-ended questions asked about students' attitudes in using 3D CGI; about students' knowledge of and attitudes about rhetoric; about students' attitudes about science and technology; about students' composing practices; about students' perceptions of scientific, digital, visual, and writing literacies; and about the personal characteristics, habits, mind-sets, or behaviors students had to develop while working with 3D CGI.

I analyzed qualitative data using Glaser and Strauss' (1967) Grounded Theory approach, an inductive analytical method which requires researchers to code data in a series of document reviews as well as through note taking and memo writing to identify key phenomena and the reasons for its emergence (Neff, 1998). For the purposes of this study, I began the first stage of coding, called "open-coding," by identifying key terms, concepts, or themes from participants' paragraphs of text. These key ideas were categorized and charted in tables for each student. I then also jotted down on a separate table notes about how participants used terms and what their use of terms demonstrated about their learning. Concepts in both tables were then compared, and I compiled key findings in a third table.

During the second stage of analysis, called axial coding, I reviewed the table of key findings as well as previously compiled tables to identify key phenomena about participants' attitudes, general learning, and specific learning on concepts taught. After identifying the key phenomena in these areas, I then hypothesized reasons why these key phenomena emerged. To do this, I charted the causal conditions that may have caused the key phenomena to emerge, the

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[78] These were changes made to the Fall 2011 pilot study, and changes were made because participants in the first study did not critically discuss their sources, their literacies, or the key issues discussed in the course.

contexts in which the phenomena occurred, and the intervening conditions that impacted participants. I also hypothesized the strategies that participants used as a result of the key phenomena and the consequences that resulted from their use of such strategies. Finally, during the final stage of analysis, selective coding, I reviewed all notes to find specific examples of the hypothesized key phenomena and the contexts in which they emerged.

Quantitative Instrumentation

Quantitative data was also collected for the study. Quantitative data was collected from beginning-and end-term surveys posted on SurveyMonkey to show general trends in participants' attitudes, general learning, and specific learning on concepts taught.

The beginning-of-the-term survey included 50 open-and-close-ended questions divided into six parts: demographic information; student attitudes about using 3D CGI; student knowledge of and attitudes about rhetoric; student attitudes about science and technology; student composing practices; and student perceptions of scientific, digital, visual, and writing literacies. However, because of coding errors in the electronic version of the survey, most of the close-ended questions about rhetorical knowledge, scientific and technological knowledge, student composing practices, and perceptions of scientific, digital, visual, and writing literacies could not be used, and comparisons between the beginning- and end-term surveys could not be made. For this reason, the beginning-of-the-term surveys were used only to provide demographic information about students.

The end of the term survey included 70 questions (15 open- and 55 close-ended) divided into six parts: demographic information; student attitudes about using 3D CGI; student knowledge of and attitudes about rhetoric; student attitudes about science and technology; student composing practices; and student perceptions of scientific, digital, visual, and writing

literacies. End-term surveys from the study were analyzed by a paid graduate consultant[79] with experience using SPSS to compare end-term learning outcomes between the two classes.

4.5.3 Results of the Spring 2012 Study

Three primary questions guided the Spring 2012 study: 1) How did participants feel about integrating 3D CGI into a Technical Communication classroom? 2) What did they generally learn as a result of integrating 3D CGI? 3) What did they learn about specific concepts taught as a result of using 3D CGI? This section explores results of the quantitative and qualitative data that answers these three questions.

1. How did participants feel about integrating 3D CGI into Technical Communication?

Quantitative Survey Responses

The quantitative survey questions measuring attitudes asked participants to rate, using a five-point Likert scale, their satisfaction with the course, their perception of its difficulty, their perception of the time they spent on assignments compared to a traditional course, and their perception of the amount of teamwork required compared to a more traditional course (See Table 3).

Table 3. Participants' Responses on Integrating 3D CGI

Category	**Satisfied-to-Very/ More-to-Much More . . .**	**Moderately . . .**	**Unsatisfied-to Not at All/ Less-to-Not at All . . .**
Satisfaction with the course	100%		
Perceived course difficulty	90.9%		9.1%
Perceived amount of time spent on assignments	81.9%	18.2	
Perceived amount of teamwork required	90.9%	9.1%	

[79] Elsa Martin was the Ph.D. Candidate in the RWS program. She was recommended as an appropriate consultant because she completed a Master's thesis, using quantitative methods, in Psychology.

Out of the 11 participants who responded, all (100%) said they were satisfied-to very-satisfied with their experience in the class. A majority of participants also felt the course was more-to much-more difficult than a traditional class (90.9%); required more-to much-more time to do assignments (81.9%); and required more-to much-more teamwork than a traditional class. Participants provided comments such as these:

> "This class put confidence in me that I felt I was lacking. I usually back away from technology, but here I had to face it. I felt this course is demanding yet it is what college should be, and if you want something you have to work for it. This class helped me see that aspect."

> "I'm satisfied with the projects my team and I completed over the course. I was really lucky to get into a group of positive, intelligent people who I've become great friends with. Though I feel unsatisfied with my *Blender* capabilities, I feel like I have a much better understanding about rhetoric, discourse communities, and technical writing. Though the course load was heavier than I thought, I feel very satisfied with my instructor, my work, and the class overall."

Qualitative Survey Responses

The researcher ascertained participants' attitudes about using 3D CGI through three open-ended questions: a) How did you feel about using 3D CGI in this course? b) What were the advantages and benefits of using 3D CGI in this course? c) What were the disadvantages and drawbacks of using 3D CGI in this course?

a) How did you feel about using 3D CGI in this course? Why?

Participants had mixed feelings about using 3D CGI in the course. Out of 10 participants who answered the question, 50% provided a mixed response. Participants used both negative terms such as "hard, frustrating, difficult, and overwhelmed" in addition to positive terms such as

"reward, good, excited, enjoyed, satisfying, awesome, proud, and happy" to describe their experiences. Participants made comments such as these:

> "I was initially excited to learn a new kind of technology, but learned (very quickly) that I become frustrated easily. Also, I don't feel like I had enough time (because of other work- and school-related activities) to devote to Blender, so I don't feel satisfied with it. But overall, I enjoyed learning about a new kind of software. It was especially satisfying to see the finished product in my team's final presentation."

A third (30%) of participants responded positively. These respondents used terms like "awesome and interesting" to describe their experience, and they made comments such as these:

> "It was an awesome opportunity to learn a new skill that if utilized properly can further improve my writing skills and visual presentation in future classes."

Twenty percent of participants responded skeptically, and stated,

> "The program was new to me and caused some nervousness."

b) What were the advantages and benefits of using 3D CGI in this course? Explain.

Participants identified four advantages to including 3D CGI in the course: 1) learning new software, which they felt made them more marketable (30%); 2) being creative (30%); 3) displaying ideas with 3D (10%); and 4) experiencing a more challenging course. Participants provided responses such as these:[80]

> "The advantages of using 3D include learning how to use a new kind of technology (expanding technological capabilities); sharpening time management skills (having deadlines to complete the labs); and simply being able to include Blender in the list of other types of software you know (something you can put on a resume to make you more marketable).

> "I like how you are free to create as you wish, the images, lighting, frames, etc. instead of having to just look for what's already available on the web."

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[80] Two participants provided responses that did not directly answer the question.

c) What were the disadvantages and drawbacks of using 3D CGI in this course? Explain.

Participants identified two disadvantages to using 3D CGI in the course: 1) Blender had a steep learning curve (50%) and 2) Blender was time-consuming to learn (40%). Participants provided responses such as these:

> "It was a brand new program to all of the class . . . . it required [learning] a brand new program [and] expecting immediate work from it."

> "[It was] time consuming, and if you weren't knowledgeable or are limited to knowing how to use certain tools and functions, you are limited [in] what you can achieve."

One participant felt there were no disadvantages to including 3D in the course. This participant wrote,

> "I don't think there were any disadvantages or drawbacks of using 3D CGI. Though I often felt pressed for time and frustrated with the software, it was more advantageous than disadvantageous.

<u>2. What did participants generally learn as a result of integrating 3D CGI?</u>

Qualitative Survey Responses[81]

Participants said they generally learned five things as a result of using 3D CGI: a) They developed personal habits (20%); b) They learned the importance of interpreting visuals (20%); c) They learned animation was a useful presentation form for audiences (20%); d) They felt 3D CGI helped them communicate with audiences (20%); e) They learned what it felt like to be a creator (10%). Participants provided responses such as these:

> "As a result of incorporating 3D CGI in the course, I've learned the importance of patience, time-management, and teamwork."

> "There is a lot more you can achieve than just writing a document. Visual interpretation is just as important."

[81] The end-term survey did not include quantitative questions regarding general learning.

> "I learned that in conjunction with writing, 3D animating can be useful in presenting information in a format that almost anyone can understand."

Analytical Reports

In their analytical reports,[82] which were submitted at the end of the semester, participants said they generally learned two things: a) 3D CGI required increased communication and team work, and b) They developed personal capacities that they did not typically associated with writing.

a) Participants stated 3D CGI required increased communication and teamwork.

Participants in the Spring 2012 study said they learned 3D CGI required more teamwork and communication, which they were unused to. One student, for example, said,

> "I realized how important it is to work well in teams. By being open to other's ideas and ways of doing things, you can learn much more than if you had worked on something individually, which is what I had preferred to do before taking this class. However, after working with three very different people, I've come to enjoy working in teams because I improve the way I do things and I sharpen my communication skills. This will help me tremendously when I seek a professional job" (Hilary, Spring 2012).

Several female students also said that they had to learn how to voice their opinions in teams and had to learn to trust others for progress to be made. One student, who was the only woman on her team, said,

> "I learned how valuable communication skills are. I realized that I had to speak up, to tell the others when I didn't agree with their ideas or actions, because if I didn't, no progress would be made and our group project would be reduced to four individual projects under the same name. I learned to trust people, because I

[82] The analytical report is a technical communication genre that essentially analyzes the results of a study. It typically follows an Introduction, Methods, Results, Analysis, Discussion (i.e. IMRAD) format. In this study's case, I asked students to follow this format; however, in the results section, I also asked students pointed questions about what they learned about topics covered in class.

> constantly found myself wanting to check and double check the work of my teammates and make sure they were doing their part of the project correctly. Out of everything that happened this semester, I found that, at least for me, working with other people was the most difficult" (Ruth, Spring 2012).

b) Participants developed personal capacities they generally did not associate with writing.

Participants mentioned two personal capacities they acquired: Creativity and self-reliance. Participants expressed the notion of creativity differently. For instance, some participants enjoyed expressing their "imagination and creativity" as well as the freedom to design their own work. Others noted creating and viewing 3D objects developed very different kinds of knowledge. One participant, for example, asserted,

> "Creating an animation is very different from just watching one; just like baking a cake is very different from just eating one! I would say that viewers have it much easier off than the producers, and producers most certainly know much more than the viewers" (Casey, Spring 2012).

Still other participants felt closer to their work as creators because the work meant more to them after putting so much time into it. Participants also mentioned learning self-reliance. For some participants, developing self-reliance meant seeking out information online when they had questions about how to create objects. One participant stated,

> "I also learned that sometimes it's necessary to seek out new ways to do things on your own. For instance, in one of the tutorials, I couldn't figure out how to make a certain thing happen on my computer, so I sought out information on the internet. I found forums and websites dedicated to that specific thing, and I just had to research a little more" (Hilary, Spring 2012).

For others, self-reliance meant using features of Blender they felt comfortable with to accomplish their work. Rather than using the box modeling method taught in class, several students taught themselves how to use the "sculpt" feature of Blender, either because they felt it was an "easier and quicker way around" box modeling or because the angularity of box modeling didn't produce the smooth curves they needed to create realistic organs, such as hearts

and brains. One participant learned the sculpt tool, in part, because he had difficulty using the box modeling technique taught in class. He stated,

> "I was in charge of creating the heart model. I sculpted the heart using the Sculpting Tool to create the base model for the heart. This was because I never really got used to using box modeling. I knew that I would have an easier time of something that I was already used to. This made it easier to manipulate. By pushing and pulling various points using the sculpting tool, it was possible to shape the UV sphere into something that resembled the human heart minus certain veins and arteries. It also held a realistic contour that we had not anticipated, but greatly appreciated having. We would later use this to our advantage. Our intent was originally for simplicity. . . . We found better and better ways of portraying our animation and making it convincing." (Francisco, Spring 2012)

In this participant's case, his inventiveness – his learning "a way around" box modeling ultimately benefited the team because they created a more realistic image using a different method of modeling.

<u>3. What did participants learn about specific concepts taught by using 3D CGI?</u>

Quantitative Survey Responses

The Spring 2012 survey asked participants to use a five-point Likert-type scale to rate responses to various statements about rhetorical, scientific, technological, design, and composing literacies.

a) Rhetorical Perceptions

I asked participants to rate the extent to which they considered political speeches, scientific discourse, scientific visualizations, lighting, sound, colors, movement, and technology use as rhetorical. Out of the 11 participants responding to these questions, most participants agreed-to strongly-agreed these elements were rhetorical (See Table 4).

Table 4. Participants' Perceptions of What is Rhetorical

Mode/Medium	Agree/Strongly Agree	Moderately Agree	Disagree/Strongly Disagree
Political speeches are rhetorical.	72.3%	9.1%	18.2%
Scientific discourse is rhetorical.	90.9%		9.1%
Scientific visualizations are rhetorical.	81.8%	9.1%	9.1%
Lighting is rhetorical.	81.8%	9.1%	9.1%
Sound is rhetorical.	81.8%		18.2%
Colors are rhetorical.	81.8%	9.1%	9.1%
Movement is rhetorical.	81.8%	9.1%	9.1%
Technology use is rhetorical.	90.9%		9.1%

Interestingly, participants ranked technology use, scientific discourse, scientific visualizations, lighting, sound, color, and movement above political speeches. This may suggest participants developed a more critical awareness of these discourses than other kinds of discourses.

b) Objectivity of Scientific Discourses/Visualizations

I asked participants to rate the degree to which they felt scientific discourses (written and visual) were objective (unbiased) and conveyed or created truths about our realities. Participants were more skeptical of these discourses (See Table 5). Out of the 11 participants who responded to these questions, 45.5% disagreed-to strongly-disagreed that scientific writing was objective. More participants (45.5%) also moderately agreed that scientific writing conveys truth about the world and our lived realities. Fewer participants (34.6%) agreed-to strongly-agreed scientific writing creates truth about reality. Participants also seemed more skeptical about the objectivity of scientific visualizations as only 27.3% of participants agreed-to strongly-agreed that scientific visualizations are objective and unbiased and 45.5% disagreed-to strongly-disagreed that

scientific visualizations were truthful representations of reality. Moreover, 54.6% of participants disagreed-to strongly-disagreed that computer technologies were neutral, objective tools.

Table 5. Participant Responses about Objectivity of Discourses

Statement	**Agree/Strongly Agree**	**Moderately Agree**	**Disagree/Strongly Disagree**
Scientific writing is objective and unbiased.	36.4%	18.2%	45.5%
Scientific writing conveys truths about the world and our lived realities.	36.4%	45.5%	9.1%
Scientific writing creates truths about the world and our lived realities.	54.6%	27.3%	18.2%
Scientific visualizations are objective and unbiased.	27.3%	36.4%	36.3%
Scientific visualizations are truthful representations of reality.	18.2%	36.4%	45.5%
Technologies are a neutral/objective tool the humans use.	36.4%	9.1%	54.6%

(Out of 11 participants)

End Term Survey Qualitative Responses

To ascertain what participants' learning on specific concepts taught, I asked seven questions: a) What is your current understanding of rhetoric? b) How has your understanding of rhetoric changed as a result of composing with 3D CGI? c) How have your attitudes about science and technology changed, if at all, since composing with 3D CGI? d) Did your composing process change as a result of using 3D CGI? e) How did composing with 3D CGI change the way you made your arguments? f) Did composing with 3D CGI change the way you thought about truth or reality? g) Did composing with 3D CGI improve your literacy in science, technology, design, or writing?

a) What is your current understanding of rhetoric?

The 10 participants who responded to this question defined rhetoric in three ways: 1) as a foundation of knowledge (20%); 2) as an art of discourse (20%); and 3) as a strategic use of language or visual images (20%). Respondents provided answers such as these:[83]

> "Rhetoric is the foundation for all knowledge."
>
> "Rhetoric is the art of communicating something in a certain way to communicate a message of some sort."
>
> "Rhetoric is the way you use language to provide knowledge to others."

b) How has your understanding of rhetoric changed as a result of composing with 3D CGI?

Most participants (80%) felt their understanding of rhetoric changed as a result of composing with 3D CGI. Participants stated it helped them 1) see communication strategically (20%); 2) see rhetoric as omnipresent (30%); 3) see 3D CGI as a form of rhetoric; 4) see rhetoric as both necessary and always present (10%). Participants provided responses like these:[84]

> "While working with 3D CGI, I learned things can be manipulated to make the viewer understand what you want them to."
>
> "I now view mostly everything as rhetorical – I think everything has a purpose, even the small detail of lighting in our animation was used to make it seem a certain way."
>
> "The way I design my 3D CGI might stand for a complete idea for someone else. I have to be very careful and understand who I am going to show my 3D animation [to]. I have to make my 3D animation so that the audience will find interest in it, understand it, and believe it."
>
> "It has made me be more aware of how I use language and the meaning I'm trying to get across."

[83] Four (40%) participants provided either answers that did not respond directly to the question or that did not make sense.
[84] Two (20%) participants provided responses that did not answer the question or that did not make sense.

c) How have your attitudes about science and technology changed since composing with 3D CGI?

Participants said composing with 3D CGI changed their view of science and technology in at least three ways: 1) It made them more aware of the bias in scientific discourse and technology use/design (50%); 2) It make them view 3D as a resource for communicating scientific information (20%); and 3) It gave them a better appreciation for technology (10%). Participants provided responses such as the following:

> "I now wonder how real the information that is portrayed is and how much of it is just manipulated to make you feel or think a certain way."

> "I've realized that science and technology isn't neutral – they're created using rhetoric. I think that science and technology all have purposes, and they are all designed (especially topics that can't be seen with the naked eye) to convey a certain message and cater to a specific discourse."

> "My understanding of science and technology was greatly influenced by the use of 3D animating because I saw an enormous opportunity to increase scientific knowledge by incorporating visuals into our learning habits."

d) Did your composing processes change as a result of using 3D CGI?

Although some participants (20%) felt their composing processes did not change by using 3D CGI, half of the participants (50%) felt their processes had changed. They provided responses like these:[85]

> "I was more aware of the audience that I was going to present this to. My group and I made sure that the definitions weren't too technical and we could break the information down to where it was more understandable."

e) How did composing with 3D CGI change your arguments?

[85] Two (20%) participants stated that it did not change their composing process, while three (30%) provided unclear responses or ones that did not answer the question.

Participants felt composing with 3D CGI changed their arguments in three ways: 1) It made their composing more visual (30%); 2) It required them to think more carefully about what they visually portrayed (20%); 3) It caused them to rethink the arguments being made (10%). These participants provided responses such as these:[86]

> "Being able to visually demonstrate an idea or concept helps support an argument because it allows the viewer to interpret your visual and determine its truthfulness."

f) Did composing with 3D CGI change the way you thought about truth or reality?

Most participants (80%) felt composing with 3D CGI changed the way they thought about truth or reality. Participants provided answers such as these:

> "It makes me question what the creators are trying to show as being real and how real it actually is."

> "I can see how anyone with the ability to use these programs can portray anything they want regardless of it being truthful or not."

Twenty percent of participants felt that composing with 3D CGI did not change the way they thought about truth or reality.[87]

g) Did composing with 3D CGI improve your literacy in science, technology, design, or writing?

Most participants (60%) felt their literacies in science, technology, and design improved. Participants provided responses such as these:

> "I believe that 3D animating further improved my skills in interpreting science related topics and presenting them in a more clear format."

> "I now think of what is being shown and for what purpose."

[86] Three (30%) participants provided answers that did not respond to the question.

[87] One (10%) provided responses that did not make sense.

Twenty-percent of participants asserted that their literacies had not changed. One participant provided this response:[88]

> "I don't believe 3D imaging changed my literacy completely but [it] did add to it."

Analytical Report

In the analytical report, participants seem to have learned four things: a) They demonstrated an understanding of the myth of objectivity; b) They demonstrated a strategic awareness of the ways modes/media are used and viewed themselves as strategic designers; c) They demonstrated an awareness that realism and naturalism made 3D objects (and designers) more credible to the audience; and d) They developed a better understanding of writing.

a) Participants demonstrated an understanding of the myth of objectivity.

Participants seemed more aware of the bias inherent in scientific, visual, technological discourses. In terms of scientific discourses, participants critiqued the economic or ideological agendas tied to them. One participant noted,

> "Before this semester, I thought that scientific publications were always neutral and their only purpose was to inform. Now I understand that even if they are only reporting solid facts, the way that those facts are represented can drastically affect the way they are interpreted. In fact, scientific discourse is more likely to have an ulterior motive for presenting information a certain way because there is much more at stake. The article from Miromatrix Medical illustrates this point. They presented the same information that Dr. Taylor and her team did, but they made it sound like it was a perfect solution for the problem at hand. They also had much more to gain than the University of Minnesota team because they had the potential to manufacture organ matrixes and sell them for profit." (Ruth, Spring 2012)

[88] Two (20%) participants also provided responses that did not directly answer the question.

Participants made several points regarding visual discourses too: 1) They questioned visual media more, 2) They showed an awareness that cultural and social beliefs and values impact visual designs, and 3) They saw visual media as persuasive. For instance, one participant said he developed a new way of "seeing" visual and textual artifacts:

> "Having studied engineering courses, my views on the designs of buildings, streets, or even any inanimate object have changed. I analyze every little detail on the design of those objects I think of the materials that were used and I think of the integrity; is it safe to use that? Will the materials be strong enough? . . . .This course has done the exact same thing except I look at the design of textual and visual content of anything and everything. I can't look at bill boards the same any more. I can't look at advertisements the same any more. I can't look at commercials and fliers the same anymore . . . . I even sometimes think that I could improve the marketing and the promoting of what I see. I think of the rhetorical discourse that the creators or authors must have experienced just to show what I see as the final product. I ultimately learned that . . . you the author have the power to influence your audience in any way that you wish." (Louie R., Spring 2012)

Other participants demonstrated more awareness, especially in designing their own animations, of the cultural and social expectations of visual images. Several participants, for example, said they used common images of space or of DNA in their own projects so that they would correspond to audiences' preconceptions of these concepts. Still other participants more broadly asserted, "Every aspect of visual design exerts an influence, even if it is not intentional" and "images influence beliefs, attitudes, opinions, and even actions" (Alex, Spring 2012).

Participants also emphasized two points about technologies: 1) Technological designers create technology with certain users in mind – particularly those with certain social or economic means, and 2) Technologies can be used for multiple, and different purposes. Several participants noted technologies were imbricated in social and economic factors. One participant observed,

> "[Technologies] are only available to those with access to them, and the programs require some time to learn and sometimes money. For example, in class we used Blender. I would have never been exposed to Blender had I not been studying at a university in the first place. To learn the program took a lot of time and effort, and it took tutorials. I was lucky enough to get these tutorials for free, but not

> everyone has that option. This shows how technologies are socially and economically more available to those with the time, money, and education to use them." (Andrea L., Spring 2012)

Although Blender is an open-source software with many free tutorials on line to help new users, the participant correctly suggests companies often sell Blender materials online.

Participants additionally asserted technologies could be used for many purposes –good and bad. One participant who went online discovered the following:

> "Blender may have been created for a certain purpose, and we were using it simply to convey information, but I saw many *Blender* animations on YouTube that did nothing more than express an idea, good or bad. The most memorable was the one of animated characters shooting each other in the head and swearing. I recognized that any kind of technology can be used for any purpose." (Ruth, Spring 2012)

b) Participants demonstrated a strategic awareness of the ways modes/media are used and seemed to view themselves as strategic designers.

Participants also demonstrated an awareness of the ways designers strategically craft modes and media. Participants, especially, discussed the multiple ways in which they strategically used (and saw other 3D tutorials strategically use) modes such as narratives, still and moving images, light, and color. Interestingly, participants said they used movement rhetorically to create focal points, to help show a process, to show changes and stages, to create dynamism and grab the audience's attention, to force the audience to track an object with its eyes, and to show a third-person view, enabling the audience to see all around the object.

Participants noted they used color rhetorically to create focal points; to create contrast; to enable audiences to identify with objects; to dramatize images; and to make images "more believable." One participant, in fact, asserted,

> "I believe that the colors used are a big part of what determines if the video is persuasive and informative. If [designers] don't use colors that catch the audiences' attention, the image portrayed will not mean much to the audience.

> The same goes if the colors are not believable. They may not be conveying what the real process looks like, but with the proper colors and lighting, the target audience may believe that it is reality." (Andrea S., Spring 2012)

Participants also thought carefully about the rhetorical use of light and its effect on their objects. One participant, for example, noted the different lighting effects cast on his team's object – a heart – influenced how viewers perceived it, and thus, the team could, without saying a word, persuade viewers to feel positively toward it. He stated,

> "By making the lights fewer and weaker, the heart could be cast in more shadow. We also found that shining the light beneath the heart has a similar effect. A darker looking heart is a less healthy picture, and less sympathetic to the audience. A lighter heart is a more pleasant thing to look at, which is why all the images we found online were brightly colored and lit. This meant one could convince an audience to like the heart without having to tell them explicitly to do so." (Francisco, Spring 2012)

Participants paid similar attention to their rhetorical use of sound (both voice and music). One team, rather amusingly, decided to use a female British accent for an audio narrative about gamma-ray bursts because they felt it would be more scientifically credible to their audiences. This participant stated,

> "We chose a female voice with an English accent because the people who we were going to show our video to probably associate that type of accent with similar videos shown on the Discovery Channel or National Geographic . . . . we chose to include music in our video for the purpose of adding a dramatic effect to it. Because some viewers might see our topic as dull and scientific, our goal in adding dramatic, instrumental background music was to grab the audience's attention. In addition to adding the music, we adjusted the volume to make certain parts stand out more." (Hilary, Spring 2012)

Participants also developed a greater awareness of themselves as strategic designers of discourse. They commonly used terms such as "manipulate," "strategic," "tactics," "influence," and "persuade" as they discussed their own 3D objects and their effects on the viewers.

c) Participants demonstrated an awareness that "realism" and "naturalism" created greater credibility.

Participants often discussed creating "realistic" or "natural-looking" 3D objects, which they associated with fostering greater credibility with the audience. One participant observed that his team tried to both model a realistic brain and tried also to apply a realistic looking texture because the topic was "scientific" and his team wanted to "make . . . images look as real as possible." He continued, "Realistic images at face value usually appear to be believable" (Louie R, Spring 2012). Other participants felt that creating realistic images enabled them to better explain concepts. One student wrote,

> "By keeping the animation as real as we could, we feel the audience was able to get the best experience of gene therapy that we could produce [with] a nonmedical background." (Andrea S., Spring 2012)

In each case, participants assumed their ethos as producers depended on the realism of the finished product.

d) Participants developed a better understanding of writing.

Participants in the Spring 2012 study also tended to talk more about writing in their analytical reports, and they discussed writing in different ways. Some participants discussed the subjectivity inherent in writing. One participant stated, "Everything we write or say or do carries our influence, whether we want it there or not." (Ruth, Spring 2012)

Other participants focused their analysis on the pathos in some science writing. One participant, who had researched gamma-ray bursts said,

> "Writers used some emotional strategies to influence readers. They used emotional appeal by writing sentences like *extremely energetic explosions* or *imagine an explosion so fierce and intense that it carries with it the power to destroy everything in its path for hundreds if not thousands of light years away.* In these examples, the writers create a fear in the readers. An appeal to pathos causes an

> audience not just to respond emotionally but to identify with the writer's point of view and consequently to take an action." (Claudia, Spring 2012)

Furthermore, in their multimodal composing, participants used more visual analogies, which they paired with written or vocal narrative. Participants compared full organ decellularization[89] to wooden house frames and the brain to both supercomputers and search engines. Other participants felt influencing and persuading required consideration of audience, style, research, evidence, and structure.

Finally, participants indicated the course helped them "refine" or "refresh" their writing skills and noted learning about technical writing style and genres.

4.5.4 Discussion of Results

Several key phenomena emerged during the 2012 study. Participants felt technology made the course more difficult; however, they also viewed their experiences positively. This may have been because learning the technology via video tutorials made it somewhat easier for the Spring 2012 participants to learn the technology. For instance, participants were given CDs with video tutorials on them, and participants viewed the tutorials and experimented with Blender for homework before lab days. Labs and video tutorials were also posted online for participants to view prior to lab days, and participants were also encouraged to view video tutorials in class on lab days if they needed additional help. Moreover, the labs given to participants reflected their "beginner" status. Box-modeling was pushed to a third lesson to allow participants more time to engage in creative problem-solving as they created objects by manipulating primitives first. Students were also not taught more difficult concepts like using

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[89] Full organ decellularization is a process used to create organ tissue. Cells are removed from an existing organ structure and healthy cell tissues are then regrown See Gilbert, Sellaro, & Badylak (2006).

mirror modifiers[90] Scaffolding the technological learning in this way developed participant confidence.

Additionally, on the first day of the course, I provided participants with a brief list of expectations. Participants were expected to be positive; to be proactive and to problem solve; to be persistent; to be patient with themselves, others, and the technology; to be productive; and to be polite and personable. Knowing instructor expectations in advance assisted participants greatly because attitudes visibly changed, and rather than depending solely on the instructor for all guidance, participants began problem solving and became more proactive and self-reliant.

Despite the intervening conditions (e.g. most participants had no prior experience with 3D CGI; most worked full or part time; and about a quarter were parents), participants stated they felt comfortable problem-solving with technology. In fact, 70% of participants indicated feeling comfortable problem-solving with technology. Participants' comfort levels, thus, likely affected the more positive attitudes demonstrated. Participants also seemed to adapt well to the inquiry-driven, problem-based, collaborative environment.

In terms of general learning, the Spring 2012 study showed correspondence between open-ended survey questions and the analytical report. In both instruments, participants emphasized significant learning goals. On the end-term survey, for instance, 60% of participants indicated learning some kind of personal habit (i.e. "learning how to learn"), such as patience, positivity, inquiry, practice, time management, better work ethics, creating, communicating with others, and interpreting information. Only 20% of participants mentioned technological learning such as using animation as a presentation form. In the analytical report, participants, similarly, emphasized working in teams and developing self-reliance. Participants' emphasis on significant

[90] A mirror modifier allows a user to model one side of an image while the computer "mirrors" the actions on the other side. Mirror modifiers are often used to reduce modeling time; however, setting up the mirror modifier requires time, and if it is done incorrectly, the model will not be joined in the center.

learning goals during the Spring 2012 study may suggest that while learning the technology was difficult for participants, they viewed it as just one component, and not *the only component,* of the course.

Additionally, the correspondence among learning outcomes may have resulted, in part, from intervening conditions. As participants worked with Blender*,* they constantly practiced habits emphasized in the course syllabus: i.e. being patient, positive, productive, persistent, and proactive. These course expectations affected how participants viewed their responsibilities in the course, their attitudes, and even their own expectations for themselves.

In terms of specific learning, participants in the Spring 2012 study demonstrated an awareness of the "myth of objectivity" – an awareness that all discourses, visual, verbal, non-verbal, and multimodal, are designed to suit the needs of particular communities and *create* as much as *convey* social and cultural truths.[91] Spring 2012 participants also developed a strong notion of themselves as strategic designers, who created and manipulated the discourses they conveyed.

Qualitative survey questions also reflected this critical awareness of discourses as strategically created. Participants demonstrated a critical attitude toward scientific writing, scientific visualizations, and technology. The critical awareness likely resulted from the intervening conditions such as the integration of theoretical readings on scientific writing, scientific visualization, and technology use as well as the requirement to analyze scientific and visual discourses used in the end-term analytical report.

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[91] The term "myth of objectivity" is used here rather than the term "rhetoric" because participants themselves never used the term "rhetoric"; rather, they continually expressed skepticism about discourses they examined throughout their writings – including in the end-term course surveys and in the analytical reports.

4.5.5 Limitations

Despite students' learning, the Spring 2012 study was still problematic. The study's biggest limitation was its high attrition rate. Of the initial 19 participants who took the beginning-of-the-term study, only 12 participants opted to take the end-term survey, and some of these students skipped the open-ended questions. Participants likely opted not to take the end-of-term survey for at least two reasons: first, the survey was too long, with 70 questions total, and second, the surveys were given to participants on the day of the final after participants sat through two hours of class presentations. Participants may have been tired, and they may have also been concerned about their other finals. For these reasons, they may have decided to forgo the end-term survey. Thus, study results cannot be generalized. The results, however, show some resonance with the findings from other studies as the section below discusses.

4.6 Comparing Studies

The outcomes discussed resonate with the learning outcomes discussed by Dufflemeyer and Ellertson (2005), Ellertson (2003), and Orlowicz (2010).

Like Dufflemeyer and Ellertson's (2005) findings with Flash, the Spring 2012 study suggests using 3D CGI enabled participants to develop an understanding of the constructed nature of texts (and other modes/media); an awareness of themselves as composers and readers of texts (and other modes/media); and a sense of agency.

Similarly, as with Ellertson's (2003) study using Flash, participants in the Spring 2012 study also developed an increased awareness of multimedia techniques, an awareness of multimodal rhetoric, and an increased awareness of audience.

Moreover, as Orlowicz's (2010) article on using Flash in the classroom suggests, participants in Spring 2012 study also developed an awareness of the "end user/viewer," as part of the design/creation process. Additionally, using 3D CGI fostered media literacy; communication competence; critical thinking and systems thinking skills; problem identification and solution skills; creativity and intellectual curiosity; interpersonal and collaborative skills; social responsibility; self-direction; and accountability and adaptability (p. 202).

Using 3D CGI also fostered additional competencies not discussed in these previous studies. Participants worked in long-term teams; revised narratives; synchronized audio-visual narratives; and asked questions. Additionally, participants learned technologies can foster and inhibit communication, and perhaps most importantly, participants developed an awareness of the myth of objectivity in all discourse.

4.7 Conclusion

Of course, scholars should justly consider the results presented. Rhetorical scholars (Selfe, Banks, Scenters-Zapico) will rightly suggest that complex literacies cannot be measured only through surveys and open-ended responses collected at the end of one term. They will rightly question whether the technology alone, or its inclusion with scholarly articles, textbooks, and in-class discussions developed (or impeded) such literacies. And they will also rightly question the veracity of participants' responses regarding their own learning – and any interpretations of those responses, which are always influenced by the researcher's inquiry paradigms, world views, and bias. Still, integrating 3D CGI into technical communication courses enabled participants to become more aware of the processes inherent in 3D composing, and this knowledge will enable them to become more critical consumers of this digital rhetorical form – particularly when they encounter it in the macro-level rhetorical information ecology.

Chapter 5 Best Practices and Future Directions

3D CGI programs are typically quite complex and have very high learning curves, which can lead to student frustration – particularly in writing courses where students expect writing to come first and technology second. For this reason, before implementing 3D CGI in a course, instructors should carefully consider a variety of pedagogical, technological, and institutional issues – which are not always easy to separate from each other. This last chapter addresses these issues, and it offers insights on how 3D CGI might ideally be implemented. Chapter sections are organized as follows: **Section 5.1 Pedagogical Planning Considerations** discusses questions instructors should ask themselves before integrating 3D CGI into their courses. **Section 5.2 Technological Research and Planning** discusses questions instructors should ask as they begin planning their courses. **Section 5.3 Pedagogical Implementation** presents questions instructors should ask themselves about how they can scaffold learning, and **Section 5.4 Ideal Implementation in Writing Courses or Across Programs** suggests other types of courses that might benefit from integrating 3D CGI.

5.1 Pedagogical Planning Considerations

Instructors wanting to use 3D CGI as a multimodal form of composing in their courses need to first ask themselves the following questions:

- What are my course goals, objectives, and learning outcomes?
- What, specifically, do I want students to learn as a result of creating with 3D CGI?
- What, specifically, do I want students to be able to do/produce with the 3D technology?
- Does this fit into my course goals, objectives, and learning outcomes (and if so, how)?
- Could students create 2D animations to achieve the same goals etc.?
- Could students analyze already-created 3D CGI products to achieve these goals etc?

These initial questions are important to ask because while 3D CGI can be implemented in many courses (and in many different ways within those courses),[92] 2D animation technologies, such as *Adobe Flash* or the animation features in *PowerPoint,* can often be used to teach the same goals and objectives in much less time and with much less effort. Similar types of products, such as instructional videos, can also be created much more easily. Analyzing already-created 3D CGI products is an even simpler way for students to achieve similar learning outcomes and takes much less time than having to create 2D or 3D objects. However, if instructors determine that students need to use 3D CGI to create and view objects from multiple perspectives, they should then determine what they want students to be able to do with the technology and what products they want students to create with it. Understanding, specifically, what students will do with the technology and the products they will create is vital because 3D CGI programs have vast capabilities. Students unfamiliar with 3D CGI (or even with the particular 3D program being used) will not be able to master or develop proficiency in all of a program's capabilities in a typical 14-week term. In fact, writing instructors should expect students to develop just a very

[92] At UTEP, for instance, 3D technologies are implemented in varied ways using different programs in different courses. One kinesiology professor, Dr. Rebecca Reed-Jones, uses 3D technologies to help map body movement. A Chemistry professor, Dr. James Salvador, uses 2D and 3D technologies to help students learn about the structure of certain molecules and compounds. And Art professor, John Dunn, has students use 3D technologies to design and create jewelry, which they then print off on a 3D printer in the Engineering Department.

basic understanding and use of several of these features since more course time will be spent on writing than on learning the technology.

5.2 Technological Research and Planning

After determining what students will do and produce with the 3D technology, instructors should begin investigating different 3D programs to determine which will allow their students to most easily do what instructors want them to and to determine the feasibility of using the software on their campuses. Questions instructors might ask themselves include the following:

- What 3D programs, if any, does my institution have on its computers?
- What 3D program should I use?
- What are the program's capabilities?
- How easy or difficult to use is the program?
- How much does it cost?
- What support (if any) does my institution provide for learning the program?
- Is the program compatible with other computers or software at the institution?
- Can institutional computers support the program?
- What kinds of access do students need to have to the program?
- What core skills will students need to know and how long will it take to learn them?
- Can I productively integrate learning these 3D CGI skills into existing course content and assignments so that students will still learn what they need to?
- Do I (and my students) have time to learn the technology?

Instructors should begin by determining whether or not their institutions already have some kind of 3D program on them, whether such programs are reserved for discipline-specific students, and what kinds of support, if any, the institution offers for helping students learn the program.[93] Instructors should also ask IT personnel whether campus computers (and computer labs) have large enough memories and video cards to support such programs.

If institutional computers do not have 3D programs on them, instructors will need to begin researching and experimenting with different programs to determine which would be best suited for course projects, which would be most cost-effective, and which would provide students with

[93] Although 3D programs may be available on institutional campuses, often these programs are purchased by individual departments and are intended to be used only by students enrolled in these programs. If such programs are already available on campuses, instructors may need to request permission from other departments to have their students use them.

the best access.[94] Ideally, instructors should also experiment with different programs by creating the projects they want students to produce so that they can determine which programs will work best for the assigned project, so that they can anticipate student problems, and so that they can develop scaffolding strategies to help students learn the technology.

Although learning different 3D programs is time-consuming, doing so will be useful because there is a great deal of variability among 3D programs, and the program chosen needs to be the one that will best help students complete the assigned project. For example, an instructor who chooses Blender, a free, open-source 3D program, will find that it offers a variety of modeling and animation capabilities and can be used on all computer platforms, including Windows, Mac, and Linux. For these reasons, Blender is a very accessible program for students, who can easily (and cheaply) download and install the program on their home computers. Instructors can also easily (and cheaply) have IT personnel download and install the program on institutional computers. However, this ease of access is countered by Blender's unfriendly user-interface and relatively high learning curve. Instructors will, therefore, need to develop scaffolding strategies to make the program easier for students to use if they choose to use Blender at all. Additionally, instructors will find that though Blender can be used on all platforms, it was initially developed to be used on Windows systems. As a result, certain commands cannot be performed the same way across all platforms, and so instructors need to first understand which commands do not translate across platforms (by experimenting on different systems) so that they can show students how to perform these commands. (This is especially true for instructors who teach in computer labs that have different computer platforms in them.)

[94] Because 3D programs generally have a high learning curve, and because creating 3D CGI is normally very time-consuming, students will likely need to have both home and school access to complete projects successfully.

By contrast, instructors who choose Rhinoceros, a proprietary 3D modeling program, will find that the program predominately uses NURBS-based modeling (i.e. modeling with lines and curves). The program allows for much more precise modeling (down to millimeters and centimeters), and its interface is much more user-friendly and intuitive than Blender's. The program, in fact, has built-in video tutorials to help users learn how to perform many tasks. The program is also typically used by jewelers, graphic designers, and industrial designers, so students going into such careers will likely use the program frequently. However, Rhinoceros costs $195 per student license. That price only includes a 3D modeling (and not animation) program. Currently, Rhinoceros is available for Windows-based platforms (although the program is undergoing beta-testing for the Mac), so students with Mac computers may have less access to the program than students with Windows platforms. Additionally, while the interface is more intuitive than Blender's, new users will likely feel that they have less control in manipulating 3D objects in Rhinoceros unless they purchase specialized joysticks to assist them. Of course, the 3D program instructors select should be determined not only by its cost, but by the program's capabilities, by its ease of use, and by project requirements. These very specific details, however, can only be discovered if instructors spend considerable time researching, learning about, and using the programs.

Once instructors do decide on software programs, however, they should also determine the core 3D skills students need to learn to produce the desired projects, so that they can teach these core skills to students. As previously discussed, 3D CGI programs are very complex, and students will be unable to master programs in the span of one semester. Most 3D CGI programs allow for different modeling processes, which achieve different effects, and can take a great deal of time to learn and use. Many also come with built-in texture templates, which require

additional programmatic (and artistic) knowledge to modify and to create a sense of realism. In addition, animating processes (e.g. particle animation, object animation, character animation) will differ greatly and may require knowledge of additional program features. For instance, character modeling in Blender requires that one understand how to add, adjust, and constrain rigs (i.e. skeletal structures that fit inside mesh models) so that models will move correctly. Character modeling also requires that one understand how to "skin" models – constrain meshes to the rigs using processes such as weight painting – a method of assigning rigs more or less control over parts of the mesh. For these reasons, determining core 3D skills that students need to use to complete projects will assist instructors in developing materials that scaffold such skills. Experience with the programs will also help instructors determine where shortcuts can be taken. For example, in Blender, box-modeling (i.e. modeling by manipulating cubes) is much easier than NURBS modeling (used to create objects with lots of curves), and it's also much quicker than poly-by-poly modeling, which is used to create very intricate details on contoured surfaces (e.g. modeling heads and faces). Reference images can be easily uploaded into Blender to guide less artistically-inclined students. Additionally, if textures are important to the look of the 3D object, they can be freely downloaded from existing online libraries with Creative Commons licenses and can then be applied to models. Understanding the 3D skills needed (and the short-cuts that can be taken) can also help instructors develop assignments that use simple, core 3D skills and can help instructors steer students away from projects requiring more complex 3D competencies. Knowledge of the program's features will also better help instructors 1) determine how much time it will take for students to learn the 3D skills and to create with them; 2) determine how much time they need to allot for projects; and 3) determine what projects would best suit course objectives and learning outcomes.[95]

[95] Instructors asking students to box-model very basic 3D objects, apply materials, and animate them, will probably

5.3 Pedagogical Implementation

Implementing 3D CGI into writing courses needs to be done very carefully. Instructors should minimally ask themselves the following questions:

- Where will students learn the core 3D skills they need? (i.e. Will they need to learn them on their own at home? Will I spend class time teaching them? Will they learn in a lab?)
- How will technology instruction be delivered to students? (i.e. Face-to-face tutorials, video-tutorials, instructional manuals, etc.)
- How can instruction best be scaffolded?
- What additional resources or support outside of class will students need?
- What kinds of emotional and mental support will students require or will I demand?

Instructors need to decide how they feel students will learn the core skills best and whether or not they want to devote class time to teach the core skills. Such decisions must be made based on the complexity of the program being used, students' access to the program at home and at school, the amount of class time available, and instructors' personal philosophies student learning.

Instructors will also need to decide the best method of delivery for instruction. Such decisions will depend upon how much support instructors have in class (i.e. whether they have support staff to help them teach the technology), and how much support they feel students need. Because 3D programs are complex and require multi-step processes, and because class times are very short, it may be best to provide students with video tutorials, which students can reference on their own time and at their own pace. (While face-to-face tutorials can be helpful, instructors teaching the technology without support staff will likely find that individual students will need help during the tutorials, which will require instructors to stop the class too frequently to accomplish much.). Instructors should also consider scaffolding tutorials so that students learn and practice skills one at a time before beginning their own projects. For instance, instructors might first have students view a tutorial about basic modeling strategies at home. In class,

need to allot at least 6 to 8 course periods to the technology before students begin using the program on their own. Instructors should also develop additional materials if class time will not be spent learning the technology.

students might then be required to complete a lab that requires them to practice what they learned using the skills provided in the tutorial. Scaffolding skills in such a way gives students more confidence as they attempt to learn a difficult technology.

Of course, instructors also need to make students aware of additional resources where they can go for additional assistance outside of class. These resources may include online forums where new users can get help (e.g. the Blender Newbies Forum). They may include websites that provide video tutorials showing students how to create certain objects or perform certain basic tasks (e.g. Blender Cookie, Blender Guru, YouTube, etc.). They may include online user-manuals or training courses (e.g. http://gryllus.net/Blender/3D.html). They may also include IT assistance at campus computer labs. Introducing students to such resources is important so that they can get help from multiple sources without relying too heavily on the instructor.

Instructors also need to ensure that they provide students with the mental and emotional support they need to complete the projects required. Although students are initially excited to learn 3D CGI, they also do not anticipate how much creativity, teamwork, problem solving, artistic skill, critical thinking, time, and attention to detail that creating 3D objects requires. As students begin their own projects, therefore, they can easily become frustrated by the technology, by their limited knowledge of it, or by their own lack of patience, ability, problem-solving skill, etc. Some students may also feel less confident with their ability to use the technology. For these reasons, it is important for instructors to develop mental and emotional support systems. Instructors might do this by having students work in small teams, by creating discussion boards that allow students to reach out to each other, by providing class time for creating projects (and for networking with other teams), by frequently checking-in with them about their projects, by working one-on-one with individuals and teams experiencing more difficulty, and by

establishing some etiquette guidelines that encourage positive mental and emotional frameworks. For instance, at the beginning of the semester, I usually ask students to be

- Positive – Contribute to a better learning environment by keeping a positive outlook when things don't go "right."
- Proactive and productive – Start assignments early, ask questions often, and use class time wisely.
- Problem solve – Look for solutions to problems rather than expecting others to find solutions for you. Network with peers and experts, and search online, etc.
- Persistent – Everything is possible – the "impossible" just takes longer and often requires more work.
- Patient – Find ways to work with others, and make things (especially the technology) work for you.
- Polite and personable – Be respectful in all your communications, whether written, verbal, or gestural. Be kind to each other.

Developing these support frameworks does not guarantee that students will have fewer troubles working with the technology; however, it will help ensure that students complete the projects and it will also help them to feel supported as they do so.

5.4 Ideal Implementation in Writing Courses or Across Programs

3D CGI is a complex technology that takes a great deal of time to learn. For that reason survey courses (such as technical writing, or first-year-composition courses), which typically have very full course curriculum requirements, may not be ideal for implementing the technology. Such courses often "burden" students with having to learn both new technologies and new writing styles at the same time. Additionally, students in these courses are often troubled by having to learn a technology that they feel they'll never use again once they enter their own discipline.

Ideally, then, 3D CGI might work well in a course that allows instructors a great deal more creativity (and freedom) to determine course curriculum and that is offered as an elective. For instance, 3D CGI might work well in a Computers and Writing course, a Visual Rhetoric course, or as a specialty course, such as *The Rhetoric of 3D CGI,* in a graduate program. 3D CGI might also work well in an honors undergraduate or advanced writing course, where students have already developed strong writing skills and expect to be challenged in new ways. Ideally, students taking such courses would also already have some level of familiarity with 3D CGI, would have a technology lab that accompanied the course, or would be students who already had an interest in learning the technology.

Ideally, too, instructors from different disciplines might work together to have students integrate writing and 3D CGI technologies. Engineering or Biology students, for instance, might use 3D technologies to complete projects for their writing and core courses. Instructors might further pair students from different disciplines to work together to create community projects that integrate writing, disciplinary knowledge, and 3D CGI. For instance, technical writing students might collaborate with graphic design students to produce instructional community tutorials.

Because 3D CGI is used so commonly in popular culture to convey complex scientific and technical concepts, as well as in advertisements and in entertainment, options for using 3D CGI in writing courses is almost limitless. In addition, as the technology becomes easier to use and more available, instructors and students will have many more options for teaching multimodal composing.

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Vita

Nikki Agee earned her Bachelor of Arts degree in English and American Literature from the University of Texas at Austin in 1996. She earned a Master of Arts in Rhetoric and Writing Studies from the University of Texas at El Paso in 2009 and entered the doctoral program in 2008. While pursuing her doctoral degree, she worked as a Research Assistant, a Program Coordinator, an Assistant Instructor, and a senior lecturer in the RWS Program. She taught both upper and lower division undergraduate classes, including RWS 1301 (Rhetoric and Composition I), RWS 1302 (Rhetoric and Composition II), RWS 3355 (Workplace Writing), RWS 3359 (Technical Communication), and RWS 3366 (Advanced Composition II). She also designed and co-taught a digital innovations course and is currently piloting an RWS 1302 Technical Communication course for engineering students. Additionally, while at UTEP she founded the campus' Society for Technical Communication (STC) chapter and is the primary researcher on an IRB-approved study investigating the academic and professional writing needs of interdisciplinary students in the RWS 3359 courses. She has presented her research at national conferences, including the Conference on College Composition and Communication, the Rhetoric Society of America's Biennial Conference, the Council for Programs in Technical and Scientific Communication Conference, and the Southwest Teaching and Learning Conference.

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