**MASTER OF DRAMATIC ART BY COURSE WORK**

**RESEARCH REPORT DRAA 504**

# THE IMPACT OF DIGITAL TECHNOLOGY ON FILM PRODUCTION AND THE CONCEPT OF CINEMA: A CASE STUDY OF THE TERMINATOR TRILOGY SPANNING 1984-2003

**KAREN SARAH BOTHA**

**STUDENT NO. 0413875G**

**UNIVERSITY OF THE WITWATERSRAND**

**JOHANNESBURG 2008**

## ABSTRACT

Using the Terminator trilogy as a case study (spanning the period 1984 to 2004), this thesis will analyse the impact of digital technologies on live-action film production. The focus will be on the changing production techniques in the three films and the progressive implementation of increasingly powerful digital effects.

This paper will endeavour to show that, as a consequence of these changes, the concept of cinema should be reconsidered. Cinema in this new digital form should be redefined as: "a particular case of animation that uses live action footage as one of its many elements" (Manovich).

**DECLARATION**

**I declare that this research report is my own unaided work. It is submitted towards the degree of Master of Dramatic Art by Course Work in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination.**

**KAREN BOTHA_____**

**ON THIS THE _____ DAY OF_____2008.**

## ACKNOWLEDGEMENTS

I would like to start by thanking Christo Doherty, my supervisor, for his ongoing guidance and encouragement throughout the production of this paper. To my parents and siblings, who love unconditionally and support selflessly, I love you and could not have come so far without you. To Steven, thank you for everything you had to endure while I was completing my studies. To Michelle and Pippa, my class mates, I'm so proud of you both for completing your papers, you were my inspiration. A big thanks to all my other friends who put up with the mood swings and my general absence from society over this time. And lastly, an extra special thanks to Brendon who shared his new bride, Amanda my action hero. She swooped in and saved the day on many occasions and dragged me through some really hard times at early hours, words cannot sufficiently express my gratitude.

## CONTENTS



(Words in bold are defined in the Glossary.)

# INTRODUCTION

Digital technology has enabled the seamless integration of 3-D animation into live-action cinema as a special effect. As digital technology becomes more advanced, less expensive and more widely available, increasing numbers of movies are incorporating computer-generated effects into their live-action scenes. Computer-generated effects have not only replaced most analogue[1] special effects, but due to their versatility have replaced some live-action scenes as well. New technologies are transforming all aspects of movie-making, from the manner in which films are financed, produced and distributed, to the way in which they are ultimately viewed. The resulting transformations in the film industry have altered audiences' perceptions and expectations of entertainment.

The ability to produce photo-realistic footage on computer has raised questions about realism and the indexical origin of the content of cinema. Given that live action is essentially a series of photographs, arguments in this context are often substantiated with similar observations regarding digital photography. William Mitchell's study of digital photography, The Reconfigured Eye, goes so far as to say that the difference between a photograph and a painting no longer exists. He asserts that the inherent mutability of digital imagery weakens the value of photography as a record of reality (7). Digital cinema is similarly easy to manipulate, and frequently the final film shown no longer reflects the environment as it appeared before the camera. Even films containing a minimal amount of special effects often employ digital grading, sky replacement and digital painting for continuity errors.

Media theorists and film critics have responded in various ways to these new developments in the nature of film. Most pertinent to this paper are the views of Lev Manovich, Professor in the Visual Arts Department at the University of California, and

1 This paper will use the term analogue to refer to any data stored by a continuously changing range of physical qualities such as the photochemical reaction which happens on film. Analogue special effects thus include any physically created special effects, effects filmed on camera and optical effects created by using the properties of light sensitive photochemical film. This is in contrast to data stored digitally in numerical values.

Sean Cubitt, Professor of Screen and Media Studies at the University of Waikato, New Zealand. Both authors re-evaluate the history of moving images from the perspective of the digital era and analyse how new media and digital technology have affected cinema.

Manovich and Cubitt agree that, although discussions on the digital age often focus on the possibilities of interactive narrative, narrative is only one aspect of cinema. Manovich illustrates the dominance of narrative in pre-digital cinema by quoting Christian Metz, an influential French film theorist of the 1970s: "most films today…have as a common characteristic that they tell a story; in this measure they all belong to the one and the same genre, which is, rather a 'super genre' [*sur-genre*]" (294). This argument stems from classical film theory, which tends to focus attention on plot, narrative and character development. Manovich disagrees with this statement saying that narrative addresses only one aspect of cinema that is neither unique nor essential to it. Cubitt appears to concur, maintaining that "narrative is neither primary nor necessary to cinema and forms no part of any putative essence of the medium" (38). In classical theory, then, and as illustrated by Metz's statement, a great deal of importance was attached to the narrative element in cinema, an emphasis challenged by both Manovich and Cubitt. This study will similarly de-emphasize the narrative dimension of cinema and focus rather on technological influences on the medium.

Various technological influences on cinema, such as chemical photography, have altered its meaning in society. Since the introduction of a photographic method of creating films, live action has been the dominant form of cinema, shaping both the nature of the medium and our understanding of it. Similarly, as digital technology is incorporated into film production and replaces older techniques such as chemical photography, it is also likely to have a significant effect on cinema. In order to understand the current influences of digital technology on cinema it therefore makes sense to return to cinema's (pre-narrative and pre-photographic) origins, when it was simply defined as "the art of motion" or the art which "succeeds in creating a convincing illusion of dynamic reality" (Manovich 296).

Manovich's broad definition of cinema implicitly subverts the dominance of photographic cinema, or live action, while pointing to other forms of cinema, most notably animation. The definition also embraces media other than film projection or television, such as theme park rides and new forms of entertainment made possible by digital technology, such as video games. This broader outlook has challenged the very genre of film and media studies as conceptualized prior to digital technology. Some authors, referring specifically to the influence of digital technology on cinema, have expanded the boundaries of their discourse to include a variety of media such as video games, the Internet and virtual reality, under the more encompassing title, New Media.[2]

New Media generally refers to media created, distributed and/or exhibited by means of a computer (Manovich 19). Since the impact of the computer is widespread in society in general, it is easier to identify new cultural objects like computer games and websites as New Media than to define exactly how the computer is influencing already existing media such as cinema. This situation is further complicated by the fact that cinema is still created using both analogue technology and digital technology, or a combination of the two.

Situated within the emerging field of New Media studies, this thesis will focus on cinema, a cultural form which, although established prior to the effects of computerization, stands to be greatly affected by the New Media revolution. The New Media revolution refers broadly to the shift of all culture to computer-mediated forms of production, distribution and communication. Theorists are currently divided as to whether digital technology only expands the existing possibilities of cinema (Cubitt), or whether it has profoundly transformed the language and identity of cinema (Manovich). These opposing views are canvassed below, and will continue to inform discussion throughout the study.

2 Lev Manovich provides a list of the major areas of New Media which he covers in his book The Language of New Media: these are Web sites, virtual worlds, virtual reality (VR), multimedia, computer games, interactive installations, computer animation, digital video, cinema, and human-computer interfaces (7). Academics of New Media referred to in this paper, who look not only at digital cinema but other New Media objects as well include: Manovich, Klein, Wolf, Ndalianis and Lister.

In his book The Cinema Effect, Sean Cubitt views the very nature of cinema as a special effect in itself. For his opening sentence he quotes Christian Metz: "In some sense all cinema is a special effect" (The Cinema 1). The illusion of motion over time is constructed from thousands of constituent images tricking the eye into seeing continuous motion. The effect created by cinema is an uncanny one, produced by images and sounds that don't quite align with reality (Cubitt, The Cinema 5). Since Cubitt argues from the outset that all cinema is a special effect, the addition of digital special effects and 3-D animation does not fundamentally affect the nature of cinema as a whole. Whether a film contains physical effects filmed by the camera or optical effects or digital visual effects, they all constitute a part of the all-encompassing effect of the film itself. Cubitt does not believe that digital technology will profoundly change the language of cinema and writes: "Because cinema so clearly traces a history from mechanical to digital time, I have tried to indicate that the shifting temporalities of the commodity film have neither ceased to change nor mutated into something utterly different in the digital era" (The Cinema 8).

Although Cubitt does not believe that the nature of cinema has fundamentally changed he acknowledges the rise of digital 3-D animation to the pinnacle of the film industry as one of the more "startling aspects of 21st century cinema" ("Observations" 281). He defines animation not only as a filmic technique but more broadly as any attempt to give life to the inanimate, thus including animatronics, robotics and theme park attractions ("Cinema" 55). Central to the magic of animation is the uncannniness of viewing the inanimate brought to life. "Without a god to drive them, and in the absence of a human user, self moving things seem to have no explanation except mysterious forces…" (Cubitt, "Cinema" 52). Photo-realistic digital animation is frequently used in contemporary film to astonish, amaze and delight its audiences, often forgoing the narrative in favour of the spectacle. Cubitt observes that frequently the function of the narrative in effects-driven films is both to motivate the use of elaborate effects and at the same time to explain the uncanny away ("Observations" 277). For this reason science fiction and fantasy genres have become increasingly popular subjects for effects-

driven films, as bizarre creatures and imaginary worlds can be motivated by the narrative. The capacity of digital effects to induce shock and awe is not their only function, and in many instances the spectacle lies in the elaborate details bestowed on the imaginary world and the sweeping or soaring shots inviting the audience to lose themselves in it. A continuous motivation behind the creation of digital effects is the need to be 'cutting edge', to push the technology to its limits and offer something new to the audience ("Observations" 282).

Cubitt does not consider that the computer's ability to create photo-realistic animation will have a profound effect on cinematic language. He remarks that "distinctions between realism and illusion make no sense in an epoch when it was neither the illusion of life nor the illusion of illusion that fascinated but rather the spectacle of their making" (The Cinema 11). Here he places more emphasis on the importance of the process used in the making of the film and how that particular process expands the existing possibilities, rather than on the question of fundamental change in the nature of the medium as we know it. Digital technology and 3-D animation are film techniques employed to create a spectacular image.

In contrast to Cubitt, Manovich believes that "computer media redefine the very identity of cinema" (293). In his book The Language of New Media, Manovich considers the influence of computerization on our concept of moving images and new possibilities for film language. He discusses the nature of the computer-based moving image and relates it to the two most common types of moving image it replaces – the film image and the animated image (293-308).

As mentioned previously, Metz identified narrative as a "super genre" of cinema. Manovich points out that Metz did not mention another obvious characteristic of this genre at the time, that "fictional films are live-action films; that is, they largely consist of unmodified photographic recordings of real events that took place in real physical space" (294). Invoking this characteristic becomes crucial in defining the specificity of

twentieth-century cinema, because live-action footage is frequently combined with photorealistic three-dimensional (3-D) computer animation and digital compositing (Manovich 294). "What used to be cinema's defining characteristics are now just default options with many others available. Now that one can enter a virtual 3-D space… given time and money, almost anything can be simulated on a computer; filming physical reality is but one possibility" (Manovich 293-94).

Manovich points out that pre-cinematic techniques shared two important characteristics: they were created manually (e.g. a sequence of animated drawings) and they were animated manually (e.g. flipping through pages in a flipbook). It was discovered in the 19th century that a sequence of photographs could produce an illusion of motion similar to that which animation had already been doing[3]. Soon photography became the popular method used to create films and the manual construction of images originally used to create moving pictures became the peripheral art of animation. "As cinema enters a digital age these techniques are again becoming commonplace in the filmmaking process. Consequently, cinema can no longer be clearly distinguished from animation. It is no longer an indexical media technology but, rather, a sub-genre of painting" (Manovich 295). To conclude, Manovich defines digital cinema as "a particular case of animation that uses live-action footage as one of its many elements" (302).

This change in the identity of cinema brought about by digital technology may also have affected the language of cinema, but in order to assess this possibility of change it is first necessary to define what is meant by "the language of cinema".

To clarify the phrase "language of cinema" as it is used in this study, I turn to the definition offered by Manovich in his book The Language of New Media. Manovich uses

3 Cinema's most immediate predecessors in use in the nineteenth century such as the Zoetrope, the Phonoscope and Tachyscope followed similar principles in their operation. A series of handmade images designed to create a looping animation sequence, were placed inside a cylindrical device which turned as the viewer turned a handle revealing the animation ( Manovich 297). The Kinetoscope the first apparatus to show a series of photographs created by W.K.L. Dickson in 1888 was also displayed in a loop and operated by the spectator (Manovich 298).

the term "language" in the context of New Media "as an umbrella term referring to a number of various conventions used by designers of new media objects to organise data and structure the user's experience" (7). The "language of cinema" could be broadly defined in a similar way as referring to the various conventions used by the director of a film to organise data and structure the audience's experience. These conventions would include the formal parameters of film such as shot length, framing and camera movement. Visual language also includes the aesthetic components that Bruce Block identifies as space, line, shape, tone, colour and movement (8). Although all these components vary in every film, Manovich comments that the language of cinema, as we are familiar with it, acquired its final stable form, known as its "classical" form, during the second decade of the twentieth century (7). The shift from early or "primitive" cinema to classical cinema involved the reconceptualizing of the virtual space represented on the screen. Whereas primitive cinema keeps the audience positioned at a constant distance from the action as one would be positioned in a theatre, "classical cinema positions the spectator in terms of the best viewpoint of each shot, inside the virtual space" (Manovich 108). A variety of shot durations, camera angles, camera focal lengths such as close-ups and long shots, are edited together to make up the visual language with which we have become familiar when viewing cinema.

At the time of writing The Language of New Media, Manovich had established that although digital technology had the potential to bring about change in the language of cinema, the new techniques were primarily being used to solve technical problems. "Commercial narrative cinema continues to hold onto its classical realist style in which images function as unretouched photographic records of events that took place in front of the camera" (Manovich 309). There have been further changes in cinema subsequent to The Language of New Media, and this study will review Manovich's statement in the light of these changes.

In support of Manovich's argument that the concept of cinema should be reconsidered, I will endeavour to show that the New Media revolution has profoundly transformed the

identity and language of cinema. For this purpose, I will use the Terminator trilogy of films as a case study. The reasons for this choice are primarily because the Terminator trilogy, created between 1984 and 2003, spans the period of technological change, with each film using the technology available at the time to its full capacity.

The first film The Terminator (Cameron: 1984) employed only analogue movie-making techniques. Seven years later, the second film Terminator 2: Judgment Day (Cameron: 1991), on the cusp of the digital revolution, still employed state-of-the-art non-digital techniques but also made use of cutting-edge digital innovations. Terminator 3: Rise of the Machines (Moston: 2003), made 12 years after Terminator 2, is consistent with most contemporary blockbuster effects films, employing the latest digital technology. Since change is particularly evident in the visual representation of images within feature films, through an increasing emphasis on the special effects aspect of the cinematic process, this will be a dominant area of focus in this study.

Although another series of films, such as the Star Wars films, might also have been used for a case study few truly span this period of innovation. The fifteen years between Star Wars Episode VI: Return of the Jedi (Marquand: 1983) and Star Wars Episode I: The Phantom Menace (Lucas: 1999) were crucial in the development and implementation of the new technology as illustrated by Terminator 2.

As a pioneering film in the field of **computer-generated imagery (CGI)** and compositing, Terminator 2 is cited and analysed extensively within the body of literature covering new media, including Vivian Sobchack's Visual Transformation: Meta Morphing and the Culture of Quick-Change, in which every essay at least makes reference to Terminator 2. Many of these essays and other studies of Terminator 2 view the film in the context of its ground-breaking digital effects, and while these have been taken into consideration in this research project, it has been deemed necessary to approach the film in a new way. For the purposes of this study it has been important to view Terminator 2 in the context of its position within the timeline between the other two

Terminator films and to focus not only on its digital effects, but also on its analogue effects, the live action and many other aspects of the film often overlooked in other studies. Although there is a small body of secondary material pertaining to the first film, The Terminator, most notably French's book The Terminator, the film Terminator 3 appears thus far to have attracted no academic attention at all. It is therefore hoped that the new insights into the Terminator Trilogy presented in this study will make a contribution to the emerging field of New Media studies and also to film studies more generally.

The other benefit of looking at the Terminator trilogy is that the plot is in each case quite similar and follows a similar structure: Two characters, one good and one bad, are sent back from some time in the future to the present day. The bad characters from the future are the human-looking cyborg machines known as Terminators, programmed to kill specific present-day individuals, especially Sarah Connor played by Linda Hamilton and her son John Connor played by Edward Furlong in Terminator 2 and Nick Stahl in Terminator 3. Each film features a more advanced Terminator design. The first Terminator is known as the T-101 Series 850 (T-101): played by the actor Arnold Schwarzenegger, it features in all three films. The second movie features the Terminator T-1000, which has the ability to take on the form of humans and objects and is played mostly by actor Robert Patrick, while the third movie introduces the Terminator T-X, which can also take on the form of humans and is played mostly by actress Kristanna Loken (see fig.1). The good characters sent back in time to protect these targeted individuals are, in the first movie, a human called Kyle Reese played by Michael Biehn, and in the last two the reprogrammed Terminator T-101 played by actor Arnold Schwarzenegger.

Due to this similarity in plot all three films required similar shots. Thus in each film particular special effects scenes have been repeated yet readapted according to the technology available at the time. What changes is not only the means of producing the

shots but also the aesthetics of the shots themselves and the way the effects are revealed to the audience.

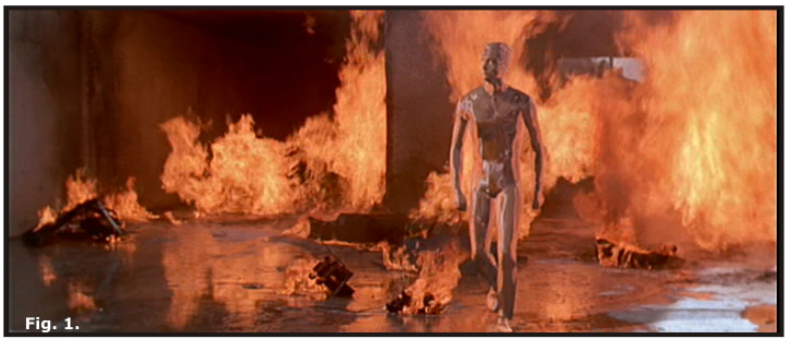


**Fig. 1.** The digitally created Terminator, the T-1000, has the ability to take on the form of humans and objects. In this sequence the character changes into actor Robert Patrick

Terminator 2: Judgment Day, Dir. and writ. James Cameron. 1991. Momentum Pictures. 2001. DVD.

Therefore, in addition to the production techniques used to create the effects in the Terminator films, the aesthetic representation of these effects will be explored. Changes in film construction such as story changes, cinematic pace, framing and cinematography made specifically to enhance the special effect, also stand to affect the language of cinema. This new filmic aesthetic has been dubbed the Neo-Baroque or Hollywood Baroque movement by academics such as Norman Klein and Angela Ndalianis.

Neo-Baroque refers to parallels drawn between seventeenth-century Baroque art and entertainment forms of the late twentieth and early twenty-first centuries. Norman Klein constructs a history of special effects which continually draws parallels between the Baroque era and the special effects of today (5). Elaborate deceptions in the form of special effects are explored in Klein's book The Vatican to Vegas: A History of Special Effects. In her book Neo-Baroque Aesthetics and Contemporary Entertainment, Angela Ndalianis similarly suggests that the Neo-Baroque "shares a baroque delight in spectacle and sensory experience" with the Baroque era.

This study chooses to reject the conventional separation of high and popular culture as well as the tendency of classical film theory to focus attention on plot, narrative and character development. These aspects are only addressed with reference to their aesthetic or visual representation and its mode of creation and production, and in order

to illustrate the change that it registers in film language in the industry as a whole. Films which make extensive and innovative use of CGI are usually the high budget blockbuster Hollywood films in the action, fantasy or science fiction (sci-fi) genres. Often these films fall into the category identified by Paul Watson as exploitation cinema, films which are often overlooked by academics and generally regarded to be in "bad taste" (Watson 66-88). But it is precisely because of their focus on the visual rather than narrative that the Terminator films have been chosen as the subject of this study.

The cultural impact of the Terminator franchise is apparent in the various objects designed as offshoots of the film narrative. These include a range of action toys by McFarlane Toys in 2003 (Lerner) and various video games including Atari's Terminator 3: Rise of the Machines (Meadows). The Universal Studios theme park attraction Terminator 2: 3D Battle across Time (1996), directed by James Cameron, the director of the first two Terminator films, combines multimedia with live action elements. The Sarah Connor Chronicles television series, which started production in 2007, is another spin-off of the original Terminator story. Although many of these Terminator items are important New Media objects, this study focuses exclusively on cinema and will only analyse the Terminator full-length feature films.

Primary research in this project involves study of the three Terminator films through first-hand observation and analysis. The secondary strand of research includes the examination of other studies made of the Terminator Films, and of literature and discourse surrounding New Media Studies. Secondary sources include books, articles, periodicals and electronic resources.

Although the effects of New Media on cinema are most apparent in international blockbuster films, the subject of this study is pertinent to the film industry as a whole. A reduction in the cost of digital technology, both software and hardware, has allowed independent filmmakers and smaller studios to create and market animated special effects both locally and internationally. Postproduction processes, in particular, have

become faster and easier, and so many complex processes and effects which might have been created in-camera are now added during the editing process, which includes complex compositing as well. Editing itself is done digitally and has come to be known as non-linear editing.

The addition of effects shots has now also become largely a postproduction process, involving the use of both in-house software and commercial software. Software in general has become more user-friendly, affordable and available even to smaller effects houses and individuals. SoftImage, a commercial animation software first used by high-end companies like the Industrial Light and Magic group (hereafter referred to as ILM) on Oscar-winning effects movies such as Jurassic Park (Spielberg 1993) is now widely used and affordable even for smaller companies and individuals (Cotta Vas 219).

Since its earliest beginnings, the history of cinema has been distinguished by innovation and new technology, as shall be explored in the following Background chapter. However no past developments have influenced as many areas of the medium as digital technology stands to, and it is the implications of this far-reaching change that this study sets out to explore.

## Chapter Outline

### Chapter 1 – Background

The purpose of this chapter is to give the reader some insight into the development of digital imaging and how it was integrated into film. The Terminator Trilogy will also be put into historical context.

### 1.1 The Director James Cameron

The creator of the Terminator franchise and director of The Terminator and Terminator 2 will be introduced.

### 1.2 The Magicians of Cinema

Magicians of the late nineteenth century embraced new cinematic technology as a spectacular part of their repertoire. The concluding chapter of the study will again refer

to these magicians and draw certain parallels between them and digital cinema as observed in the analysis of the Terminator Trilogy.

### 1.3 Development of Analogue Effects

With reference to Star Wars, this section traces the development of analogue effects, which reached their peak in the nineteen eighties.

### 1.4 The Rise of Digital Effects

The incorporation of digital imagery into live-action film, and its increasing ability to simulate reality, will be discussed here.

#### 1.4.1 The Abyss

The ground-breaking digital effects film The Abyss will be addressed in the context of the history of digital imaging.

## Chapter 2 – Compositing

The importance of digital compositing is central to digital special effects and plays a very important role in all three films. The limitations of optical compositing and the advantages of digital compositing will be investigated.

## Chapter 3 – The Terminator Trilogy, Production Analysis

This section analyses the Terminator trilogy, focussing on the progressive implementation of increasingly powerful digital effects. With the incorporation of the new technology, there has been a gradual shift through the films to a greater emphasis on post-production techniques.

### 3.1 Future Scenes

In all three Terminator films there are scenes that take place in the future. Although they are stylistically similar and depict the same fictional future, the methods of constructing these futuristic scenes differ in each film.

### 3.2 Makeup

By looking specifically at Arnold Schwarzenegger as the Terminator, this section traces how traditional techniques of makeup and **prosthetics** are gradually replaced by post-production techniques.

### 3.3 Models: Stop-Frame Animation and Digital Animation

In the three films, the Terminator characters are replaced by models, look-alike puppets and digital doubles for various effects scenes.

### 3.4 Morphing

The different techniques employed to create the morphing effect of the liquid metal in the second and third Terminator films will be analysed.

## Chapter 4 – The Terminator Trilogy, Aesthetic Analysis

This chapter will examine the aesthetic presentation of the effects, the audience's reception of these, as well as the significance of the actors and creators of digital films.

### 4.1 Role of the Audience

This section will investigate the relationship between the audience and digital entertainment, as well as the influence and effect they have on each other.

### 4.2 Showing-off Technology

This section deals with the desire on the part of the filmmakers of the Terminator Trilogy to "show off" their special effects. Each subsequent film had to match and improve upon the atom bomb scenes and chase sequences of its predecessors. The necessity to keep creating innovative effects is central to providing the audience with spectacular imagery.

### 4.3 The Decline of the Actor as Icon

The increasing status of the digital effect is compared to the traditional status of the actor.

## Conclusion - Digital Magic

Here reference will be made to the previous discussion of the implementation of cinematic techniques in magic shows in the nineteenth century. The critical arguments mentioned in the Introduction will be revisited in light of the film analyses. The discussion will give qualified support to Manovich's theory regarding the transformative impact of the New Media on the language of cinema.

## CHAPTER 1: BACKGROUND

The purpose of this chapter is to give the reader a brief background to and overview of the subject areas addressed in this study, including cinema, analogue effects, **digital** imaging and compositing. The chapter will provide both a chronological outline of key events and working definitions of key terms and processes used in filmmaking.

The first section of the chapter introduces James Cameron, the director and writer of The Terminator and Terminator 2. The second section outlines the early history of cinema and the development of analogue effects up to the point of digital integration. Section Three traces the development of digital imagery and its emphasis on simulating the photographic representation of reality, which leads to its eventual integration into film. The fourth and final section examines in detail the process of combining the various analogue and digital components of the final picture, known as compositing. In the course of this discussion the Terminator Trilogy will be put into historical perspective.

In modern times, new science and technologies, understood only by a select few, have been exploited as a spectacle in order to amuse, entertain and often trick the masses in the form of magic shows. While many of these gimmicks and attractions have been short lived, often lasting only as long as it takes the public to catch on to the techniques behind the illusion, others have taken on a momentum of their own in directions their creators could never have anticipated. Initially seen simply as a novelty, cinema has evolved into a medium of communication central to our culture today. Moreover, it is a medium characterised by constant innovation. Some new features fade away in time, while others become fixtures, such as the incorporation of sound in the 1920s (Rickitt 19), Technicolour in the 1930s (Rickitt 22); and in the 1950s, wide-screen technology like CinemaScope and Cinerama (Ndalianis 182), surround sound and 3D Stereovision

(Rickitt 25). To this list may be added Computer-Generated Imagery, introduced in the 1980s (Manovich 190). [4]

All new technologies incorporated into cinema have allowed for advances in film language. For example, new technology enabling the incorporation of sound into movies had certain limitations in the beginning. Some language choices and tendencies had to be put aside due to limitations in the system's capacity to synchronize the sound with the moving image. Despite this, for an audience that had previously known certain actors only as images, being able to listen to them seemed an ultimate degree of accomplishment in the reproduction of the real (Mourão). Such examples encourage us to view the history of cinema not as a linear progression towards one possible language but as a malleable language adapting to new technological breakthroughs.

Even when new technologies exist, they require creative open-minded individuals to harness their potential and create something new, and in this way advance the language of film.

## 1.1 Director James Cameron

James Cameron, director of The Terminator and Terminator 2, was one of the filmmakers who exploited the possibilities of digital effects in their early stages of development. At the outset of James Cameron's filmmaking career, digital imagery was very limited in its uses, and digital elements such as cloth simulation and hair and fur simulation were still undeveloped. The only material the computer could simulate accurately and fairly realistically was a smooth shiny reflective surface, and Cameron

4 Many of these attractions required movie houses to upgrade their facilities with new equipment able to support the new mediums. This expense on the part of the movie house was often the reason for the attraction to take a long time to be implemented or in some cases to fail all together. Sound and colour had a huge effect on the language of cinema and were both big turning points for the medium. Wide screen technology and surround sound, although introduced in the 1950s, only really took off in the 1970s with the release of Star Wars and has subsequently become a norm in the industry (Rickitt 25).

made use of this capability in two of his films The Abyss (Cameron 1989) and Terminator 2: Judgement Day (Cameron 1991).

Cameron had an extensive knowledge of and background in special effects, having worked at Rodger Corman's company New World Pictures. Corman, a master of low-budget guerrilla filmmaking, required his employees to work in many areas of film production, and gave Cameron experience in areas such as miniature building, the model unit, **matte** painting and eventually as an Art Director and Second Unit Director (Ling, "Other Voices" 2001).

Cameron was actively involved in the creation and writing of new scripts for the films he wished to create, including The Terminator and The Abyss. The Terminator, although a B-grade film with a small budget, became a huge financial and cultural success and a sequel, Terminator 2, was put in the pipeline. Cameron was in the process of writing the script for Terminator 2 when the computer-generated effects in The Abyss (which will be discussed later) won an Oscar for effects house Industrial Light and Magic (ILM). Relying on his storytelling ability and employing his knowledge of analogue and digital effects, Cameron immediately revised his Terminator 2 script to utilise all the best qualities of the different techniques he had used and discovered during the making of The Abyss. After viewing the capability of Computer-Generated Images (CGI) he also decided to redesign the main character as the mercurial T-1000, whose creation would be dependent on computer graphics. This was a big risk on Cameron's part, since the effects in The Abyss comprised only a small percentage of the film, whereas Terminator 2 would require one hundred elements and a total of 7,965 frames of three-dimensional imagery (Cotta Vaz and Duignan 201).

Despite the risks Cameron worked closely with ILM effects supervisor Denis Muren in the rewrite of the script, and while all the effects he desired would be ground-breaking they were also achievable. Denis Muren stated: "Cameron wrote it smart; he wrote it for what we could do with our tools. It was all doable" (Ling, "Other Voices" 2001).

In the light of this example of Cameron's ability to exploit the capabilities of new technology to their full potential, Rickitt writes: "Perhaps more than any other filmmaker of the 1990s, Cameron had the imagination and ambition to harness the potential of both traditional and cutting-edge special effects techniques" (36).

In an interview for the Terminator 2 DVD Cameron looked back on the audience's response to the special effects in The Abyss:

> Arthur Clarke had a theorem which stated that any sufficiently advanced technology is indistinguishable from magic. And that's how it's supposed to be for the audience. The audience response to the [morphing] sequence was overwhelming. They got the joke; they understood intuitively what was magical about the scene. They were seeing something which was impossible, and yet looked completely photo realistic. It defied their power to explain how it was being done and returned them to a childlike state of entertainment. The sufficiently advanced technology had become magic to them. (Ling, "The Ultimate T2", 2001).

Cameron's reference to magic in the context of the audience's reaction to new effects witnessed for the first time is a not uncommon metaphor in the filmmaking industry. The audience of 1989, which was accustomed to physically created effects and had probably never seen a digital effect of the sort demonstrated in The Abyss, would have found the effect inexplicable. As with a magic trick, members of the audience were aware they'd been had but were unable to fathom how. Most films, even films without special effects, aim to create the illusion of an alternative reality. The very nature of film is after all an illusion of motion created by a sequence of still images.

Erik Barnow quotes the famous filmmaker Ingmar Bergman: "I remind myself that I am really a conjurer, since cinematography is based on deception of the human eye…" (112). Bergman is referring to a phenomenon known as "the persistence of vision", the

fact that the human retina registers any image in front of it for a fraction of a second after it has already gone. It is this flaw in human vision which enables the illusion of motion to be created using a sequence of slightly differing images. This phenomenon was observed as far back as ancient Greece, and a large variety of pre-cinematic devices and techniques exploiting this characteristic were in use before the development of cinema as we know it today (Rickitt 9).

When the persistence of vision was exploited in the late 1800s to give the illusion that a series of photographs was moving, the audience thought it was magic. This era is explored in the following section, which describes how various magicians incorporated the earliest moving images into their magic performances.

### 1.2 The Magicians of Cinema

Special effects date back to the beginning of cinema, when they were central to the magical spectacle of the new form. Magicians of the late nineteenth century embraced new cinematic technology as a spectacular part of their magic repertoire. But, as Barnouw points out in his book The Magician and the Cinema, the role of nineteenth-century magicians in the exploration, development and distribution of cinema is often overlooked (6).

The Cinematograph, introduced in 1895 by the brothers Aguste and Louis Lumière, projected moving photographic images onto a wall, which to the unsuspecting audience was akin to magic. Due to the emotional reaction of the audience at just the sight of a moving photograph, the Lumière brothers initially exhibited simple live-action film without a narrative, but audiences grew tired of this. In contrast Georges Méliès, an aspiring magician at the time, had managed to acquire the Cinematograph technology and strove to keep the initial magic and spectacle of the medium alive. By exploring and experimenting with the medium to create special effects such as **stop frame animation** techniques and double exposure, using models and makeup or splicing different pieces of

film together, he pioneered an early film movement known as the "Trick Film" (Barnouw 88). Because of his pioneering work Méliès was one of the most important innovators in the early history of cinema, and is described by Rickitt as "the father of special effects" (12).

At his Théâtre Robert-Houdin, Méliès had gained experience in combining scenery with projections using a pre-cinematic technology called the magic lantern. The sets he created included the fires of hell, underwater scenes, and scenes able to change through the four seasons, as well as other exotic spaces which were combined with live magic performance to create fantastical stories (Rickitt 12). It is not surprising that with the arrival of the Cinematograph Méliès would continue applying these theatre techniques to his filmmaking.

According to Rickitt, Méliès' sci-fi epic A Trip to the Moon (1902) uses all the tricks of the trade including elaborate sets, trompe l'oeil paintings, optical illusions, and backdrops and props designed to give the illusion of depth. His exclusive focus on the spectacle and the purely visual aspects of film would eventually lead to his downfall, and by 1914 he was bankrupt. The simple story lines in his films served only as a linkage between one visual effect and the next. As a consequence the story was not strong enough to keep audiences entertained, and once they became familiar with the effects and tricks they sought other entertainment. Méliès also maintained a very static theatrical camera whereas other filmmakers were developing a new cinematic language. By 1903, filmmakers like Edwin S. Porter had already experimented with editing, shifting camera viewpoints and close-ups (Rickitt 15).

Researchers of New Media, such as Angela Ndalianis, frequently draw parallels between the spectacular nature of early cinema and cinema today. Ndalianis explores the relationship between the magicians at the time of Méliès with their use of early cinematic technology, and the cinema today with its use of digital technology. She asserts that Méliès' films wanted the audience to be astounded not at the illusion, but at the

technological prowess that made possible the illusion. This is similar to today's digital effects-driven films, which are often released with a detailed "making of" documentary to demonstrate the technology behind the effect (232).

This study suggests a new line of comparison between twenty-first century cinema and its incorporation of digital technology, and the magician of the late nineteenth century and his embrace of the new cinematic technology. Barnouw's account of the various stages of the role and impact of magicians in early film history can be summarised as falling into three dominant phases (85-105). The first and most successful phase was the incorporation of the film as just another trick in the magician's repertoire – when the images themselves were magic, as illustrated by the films of the Lumière brothers. The second phase was the use of the film medium to enhance magic shows by creating the tricks on film as seen in Méliès' trick films. The third phase was the eventual usurping of the magic performance by cinema, as the audience grew tired of mere tricks and cinema developed a language of its own. This study argues that the special effects in the three Terminator films evolved in a similar way. The Terminator uses the best analogue effects available at the time of its making. Terminator 2 uses the same analogue effects as films before it, but includes digital effects to enhance the medium. Finally, Terminator 3 places a huge emphasis on the digital effects, which have not only replaced the analogue effects but also many live action elements as well.

Cameron's rewriting of the Terminator 2 script for the purpose of incorporating and showing off digital technology is also comparable to Méliès' films of the late 1800s, in which the tricks and special effects dictated the story. Some critics like Andrew Darley (102) believe that many films today focus more on digital special effects than the narrative, a topic to be explored later in this study. While there does not appear to be a decline in public interest in the effects-driven films created today, at the time of Méliès special effects lost popularity and many films in the emerging classical cinematic style contained very few effects. There were however a few special effects pioneers who created a niche for themselves and pushed the envelope of analogue effects.

## 1.3 The Development of Analogue Effects

Physically created special effects from the time of Méliès remained virtually the same in principle for almost 90 years, but the style of cinema underwent a dramatic change early in the twentieth century. Manovich describes the period of change in cinema between 1907 and 1917 as a shift from a "primitive" to a "classical" film language style (107). The primitive style, as used by Méliès, was closely related to theatre or vaudeville and kept the audience, which was free to come and go at will, at a psychological distance from the cinematic narrative. The style and the shots were strictly frontal, as one would view a theatre production. In contrast to the primitive style the classical style of cinema places the audience in the optimum position for every shot. Through filmmakers' use of techniques such as cuts, close-ups, staging and camera movement, to name a few, viewers find themselves within the fictional space of the narrative (147).

Many optical effects used by Méliès, such as stop frame animation, matte paintings or double exposure, required a frontal or static camera and a constant focal length. Barnouw describes a film by Méliès called Up to Date Surgery (1902), where a surgeon chops a patient into small bits and reassembles the pieces incorrectly. He tries again until the patient is restored to his original self. To achieve this effect the camera was stopped momentarily while the actor was replaced with a model, but it remained static with a constant focal length throughout the sequence (Barnouw 94).

From these early techniques stop frame animation developed. Stop frame animation is similar to traditional cell frame animation, except that rather than creating a minutely altered drawing for each $25^{th}$ of a second, a model is moved a fraction at a time until the illusion of movement is simulated.

For this reason many analogue effects were not greatly favoured by practitioners of the classical cinematic style, as a sudden static camera could adversely affect the pace of the film. Despite such pitfalls, there were films requiring the skills and techniques of

analogue effects, and these were refined and improved on by many artisans and craftsmen such as Willis O' Brian, Technical Director/ Stop Frame Animator of The Lost World (Holt 1952) and King Kong (Cooper and Schoedsack 1933). The Lost World is credited by Rickitt (303) as "The first great creature movie". O'Brian's apprentice Ray Harryhausen learnt and improved on many of the original stop frame animation techniques. His speciality lay in combining live action characters with stop frame animated miniatures so effectively that they appeared to be interacting with one another. His most memorable and technically exacting shot, which took four and a half months to complete, came from Jason and the Argonauts (Chaffey 1963) and consisted of seven skeletons fighting two actors. These analogue effects reached their peak in the 1980s after a 'special effects' revival brought about by the films Star Wars (Lucas 1977) and Close Encounters of the Third Kind (Spielberg 1977). The development of the computerised **motion control camera** was largely responsible for renewed interest in the older effects. As mentioned before, the limitations of having to keep the camera static was often considered a hindrance in classical cinema, but moving shots containing effects could now be achieved through the controlled motion of the camera.

Ndalianis (189) points out that neither Star Wars nor Close Encounters of the Third Kind introduced any breakthroughs in special effects: both were indebted to special effects supervisor Douglas Trumbull's revolutionary ideas used in 2001: A Space Odyssey (Kubrick 1968) and Silent Running (Trumbull 1971). However, all effects techniques employed, especially the computerised motion control in Star Wars, were used to such astounding affect that a new era of filmmaking was born. "With the emphasis on visual spectacle and changing audience experience and perception these two films would seal the dominance of a new baroque era in cinema" (Ndalianis 189). The originality of these films lies in their spatial organisation and their depiction of objects in space in a way that produces what has been termed a Neo-Baroque relationship between the spectator and image; that is, one which centres on "special-effects technology and its illusionistic potential" (Ndalianis 190).

As directors George Lucas and Steven Spielberg continued to invest in stories and plots demanding new special effects, the stage was set for the emerging digital age to become an integral part of this change. Rickitt identifies Steven Spielberg and George Lucas as "responsible for the rejuvenation – some would say juvenilization – of cinema in the 1980s" (Rickett 34).

The huge profits made from effects-laden family films like Star Wars justified investment in the research and development of special effects, most notably at Lucas's effects house, Industrial Light and Magic (ILM). ILM has contributed to some of the most innovative effects in modern cinema, which have received over 3 dozen Academy Awards (Industrial Light and Magic website). More than half a century after Méliès and his contemporaries, the association between special effects and magic was still potent, as is made apparent in the first ILM logo on the cover of Smith's book Industrial Light and Magic: The Art of Special Effects. The logo, designed by Drew Struzan in the late seventies, consists of industrial age cogs with a magician performing tricks and harks back to the early film pioneers and magicians at the time of Méliès.

ILM, initially an effects house created for Star Wars, revived many 1950s and 1960s film techniques such as wide screen technology, matte painting, stop-motion photography, miniature work and surround sound. More recently ILM has also been a forerunner in the introduction of ground-breaking digital effects technology. Although widely used today, early digital effects were met with much scepticism from Hollywood. It was at this time that the young filmmaker James Cameron entered the industry.

### 1.4 The Rise of Digital Effects

From the outset, it appears that the goal of digitally created imagery was for it to be successfully incorporated into live action films rather than to create a new genre of animated film. The success of Toy Story (Lasseter 1995), the first full length feature film completely generated on computer, was preceded by over a decade of live action films

containing elements of computer-generated imagery. These include Tron (Lisberger 1982), Young Sherlock Holmes (Levinson 1985), Willow (Howard 1988), The Abyss (Cameron 1989), Terminator 2:Judgement Day (Cameron 1991), Jurassic Park (Spielberg 1993), Forrest Gump (Zemeckis 1994) and Babe (Noonan 1995). The success of computer-generated images in all of these films, with the exception of Tron,[5] was based on their successful imitation of reality and convincing incorporation into live action film. The determination of filmmakers to merge CGI with live action, before even perfecting the medium to stand on its own as in Toy Story, is an indication of the dominance of the "live action" genre in cinema at the time.

By the 1980s, significant numbers of visual creators were exploring the computer's potential as a new art medium in short films and advertisements. It was the viewing of these short image sequences that inspired Steven Lisberger to create Tron (1982), the first full-length feature film to incorporate imagery of this kind (Burni).

The work for Tron included innovations such as the 1980s morphing[6] research of Tom Brigham at MIT, which consisted of the warping of geometric primitives (cubes, pyramids and spheres) into one another. Being the first film to incorporate the large-scale use of computer-generated images, Tron generated a lot of hype and its disappointing performance at the box office is perceived by some to have been a cause of scepticism towards computer-generated imagery amongst feature film producers at the time (Rickett 33).

After Tron, the trend was to hide the origin of computer-generated imagery by making it look as though it was filmed alongside the live action elements, such as the knight figure created by the Research and Development (R&D) Department of Industrial Light and

5 Tron, a story that happens in a computer game environment, is arguably one of the only films that made a conscious effort to modify the live action footage to relate better to the computer-generated images rather than the other way around. The process included using a prohibitive amount of hand painted mattes, rotoscoping and rear projection lighting done by hand for almost every frame (Tron 1982).
6 Morf, morph or morphing, slang for the word metamorphosis, has become the standard term in the field of motion pictures to describe a special effect in which one image, as seamlessly as possible, transforms into another. This transition between two, usually unrelated objects has been greatly improved by recent advances in computer techniques, which have enabled more convincing and fluid results.

Magic, who emerges from a stained glass window in Young Sherlock Holmes. After this digital success ILM went on to do the morphing effects for the film Willow (Howard 1988), and the morphing software created in-house by Doug Smyth would later receive an Oscar in 1992. Although simple, this work would form the foundation for coordinate-based morphing. This type of morph functions by assigning a coordinate to each point on a digital model and then changing these coordinates after the desired number of frames. As a result the model will animate from the first coordinates to the second coordinates over the specific time period (Wolf 90).

There is a scene in Willow in which a sorceress changes (morphs) into a series of creatures. (It was during the making of this movie that the effects team coined the term "Morf" [Willow 1988].) A combination of physically based methods and computer graphics was used. Each live action element of the metamorphosis – human, animal and animatronic puppet – was scanned into the computer. The new morphing software created by ILM programmer Doug Smythe was then applied to these elements to create the transitions between them. The images were two dimensional, i.e. flat film footage. Once the morphing process between each image was completed on the computer, the images were transferred back onto film. The diminished quality of these images is apparent when they are compared to the rest of the film (Wolf 91).

The fluidity of the digital morph contrasts sharply with older optical effects techniques such as stop frame animation or elaborate editing, which may have been considered had the digital technology not worked. Examples of these techniques being used to morph creatures can be seen in The Wolf Man (George Wagner 1941), which employed stop frame animation, and The Thing (John Carpenter 1982), whose mechanical puppets and animation seem jerky and clumsy in comparison to the smooth transitions in Willow.

The morph in Willow marked a significant change in cinematography brought about by digital technology: the tendency from now on was to keep the camera lingering on the effect so that the audience could appreciate and be amazed by the artistry and

technology involved. This also reinforced the illusion that the effect was real, filmed on set by a real camera – which has always been the primary goal of special effects.

Manovich observes that a typical computer graphics research paper presented at the SIGGRAPH conference includes a reference to realism as being at least one of its goals. SIGGRAPH (Special Interest Group on Computer Graphics of the Association for Computing Machinery) provides a platform for the display of the latest breakthroughs in computer graphics. Tens of thousands of delegates, researchers, designers and engineers attend the annual SIGGRAPH conventions. New algorithms producing specific effects are constantly being developed, and the films in which they are used are often specifically designed to show them off. These innovations are usually produced in academic computer science departments or large computer companies like Apple or Silicon Graphics, and then purchased by the smaller effects houses (Manovich 178 and 194).

In light of the ability of digital imaging to achieve a high degree of realism, some traditional assumptions about realism on the part of pre-digital film theorists such as the hugely influential André Bazin have been called into question (Curran and Wartenberg 40).

Bazin's essay "Cinematic Realism" views photography as a step closer to capturing reality than painting because it captures light and obviates the mediation of painterly technique. Because film incorporates both photography and the element of time (it captures photographs over a period of time), it achieves an even higher degree of realism than photography (59). According to Bazin, humans are obsessed with realism and people will continue to try to simulate it ever more accurately (Bazin 59).

Bazin's theory thus contradicts Manovich's theory that cinema is moving away from the photographic and returning towards the painterly. Stephen Prince explores the paradox of creating credible photo-real images of things which cannot be photographed, and

considers the viewer's interpretation of them. He suggests that while digital images may be referentially unreal they can be perceptually realistic (35). By this he is referring to photo-realistic images such as Jurassic Park's dinosaurs, for which there are no referents in reality but which remain consistent with similar elements in reality to which the viewer can refer. These elements include the movement of other animals like the wildebeest, the texture of elephant skin, and the dinosaurs' virtual interaction with the environment around them, such as casting shadows on the ground or reflections in windows or metallic objects on set. The first virtual character with a convincing level of perceived realism was the watery snake creature featured in The Abyss, as will be explored in the following section.

### 1.4.1 The Abyss

In the late 1980s Silicon Graphic Systems was one of the few systems able to manage the vast quantities of data computer-generated images required, and ILM was one of the few effects companies which could afford such machines and technicians. It was the only company capable of digitally producing the effects required in James Cameron's new film The Abyss (1989). The Abyss had a creature that Cameron referred to as a "Nonterrestrial Water Pseudopod". The crew of Deepcore, an underwater oil-drilling rig, encounter an underwater creature made entirely of water. When it encounters the human crew it morphs its watery tip into a likeness of their faces.

When Denis Muren, effects supervisor at ILM, heard of the "Nonterrestrial Water Pseudopod" that director James Cameron needed to create, he approached Cameron himself and arranged a hurried meeting (see fig. 2). The enthusiasm of ILM was such that not only was George Lucas present at the meeting but a computer-generated sketch by animator Jay Riddle was produced to illustrate to Cameron the possibilities of the new technology. Cameron awarded ILM the effects contract, knowing that the pseudopod was only a very small section of the film and that if the computer graphics were unsuccessful he would still have time to employ one of the other traditional methods he had been

considering, such as stop motion animation, sculptural replacement animation and hydraulic water systems (Cotta Vaz and Duignan 194).

Although only consisting of 20 separate shots, a total of 75 seconds of three-dimensional imagery, The Abyss special effect sequence was the most extensive computer-generated work that, up till then, ILM had had to produce for any one production. It required the expansion of the CG department in labour, equipment and tools. The tools included computer workstations produced by Silicon Graphics and software from Alias (Cotta Vaz and Duignan 195).


**Fig. 2.** The digitally created creature from The Abyss is referred to as a "Nonterrestrial Water Pseudopod". The model reflects and refracts the live action environment.

Pinteau, Pascal. Special Effects: An Oral History. New York. Harry N. Abrams, Inc. 2003. 118.

The software at the time of The Abyss was not capable of successfully creating a digital simulation of water, **Fluid Dynamics**, such as one would employ today. Instead a simple digitally created model was used and by animating points on the surface of the model the ripple effect was created. The process was laborious since it would take the computer an entire day just to process the instructions for the ripple effect (Cotta Vaz and Duignan 196).

While the digital three-dimensional model of The Abyss tentacle was rather simplistic, the element which would really sell it as water was the way in which it reflected and refracted light. This was controlled using **the "normal"**. Knoll, effects supervisor on The Abyss, noted that in reality water reflects ten to fifteen percent of light rays and refracts

the rest of it. Since water is transparent the refraction would bend towards the normal, distorting what one would see through the water. For higher accuracy **Raytracing** might have been used for the Abyss scene, but at the time it was too time consuming and unpredictable to be relied on for a feature film (Cotta Vaz and Duignan 198).

To be perceived as real, as mentioned previously, a special effect needs to blend seamlessly into its environment (Prince 35). To achieve photo-realism for the reflections on The Abyss pseudopod, the actual set environments had to be photographed and converted into digital data in order to be used by the software. A **cubic reflection environment**, a cube created with six of the photographs of the real set, was placed around the digital object and used by the programme which rendered the final image to simulate reflections. The computer calculates which direction an incoming light ray would be reflected according to the surface normal of the three-dimensional object, in this case the pseudopod, and which part of the cubic environment that particular normal in turn represents. Once all the variables are calculated, a specific colour is assigned to one specific pixel and the process is repeated until the entire image has been created. This is then repeated for every image in the animation sequence (Cotta Vaz and Duignan 198).

As a result, the process of creating the short sequence of effects shot for The Abyss was time consuming and expensive. However Cameron's application of these short but revolutionary effects in The Abyss diverges from the normal use of special effects. Rather than being employed in high action sequences, as effects often are, the digital effects in The Abyss were used in an elegant and graceful moment, which in itself served a dual purpose. First, the use of the special effects in a low action sequence highlighted that this was something new and different from other effects. Secondly, for those viewing digital effects for the first time there was a sense of lingering, of having time to focus on the spectacular image and admire the ground-breaking technology that had created it.

Although created on computer, The Abyss effects still had to be copied onto film and joined to the film using old methods. The completed footage from The Abyss, both the film elements and digital elements, had to be optically **composited** as there was still a possibility that film quality would be lost in the process of scanning the film into a computer. The final digital elements were transferred back to film and it took approximately four hours per frame, a total of seventy-five full days, to accurately combine the optical and digital footage (Cotta Vaz and Duignan 198). After the success of the digital effects in The Abyss a concerted effort was made to perfect the processes of getting high quality data from film footage into the computer, and from the computer back onto film. To better understand the impact of digital compositing it will be necessary to identify the limitations of optical compositing and other compositing techniques, by looking back at early examples and how they were used in the Terminator films.

## CHAPTER 2: COMPOSITING

Key to all the films in the Terminator Trilogy is the combination of images filmed at different times and locations with elements generated on the computer, which creates the illusion that the fantastical story took place. The act of putting these different elements together is called compositing, a crucial element in digital filmmaking and to a large extent characteristic of the blockbuster effects movies of the late 1970s and 1980s.[7] The goal of image combination, or compositing, is usually to create the illusion that all the footage was shot at the same time using the same camera. The creation of artificial realities within the cinematic medium is important to this study to the extent that it focuses on the ease of manipulation of images as a result of digital technologies. The latter has had a direct impact on the language of cinema and the way we have come to define cinema.

In classical cinematic language, the editing of the various shots filmed at different times and locations is essential in creating the illusion of a realistic environment. Positioning two shots beside each other in a cut, say an outdoor shot of Paris and then a close up of a character at a café, leads the viewer to make the assumption that they exist at the same location, thus creating an illusion of contiguous space. Manovich calls this "temporal montage" and believes it is "cinema's main operation for creating fake realities" (149).

Manovich suggests that montage was the dominant aesthetic throughout twentieth-century classical cinema, while its counterpart, digital compositing, is becoming more prominent in current filmmaking. Montage strives to create a deliberate dissonance between the visual, emotional and stylistic elements of the film, while compositing, in

7 Rickitt lists the following blockbuster films, amongst others, as "special effects landmarks": Star Wars IV: A New Hope (Lucas: 1977), Star Wars Episode V: TheEmpire Strikes Back (Kershner: 1980), Blade Runner (Scott: 1982) and Close Encounters of the Third Kind (Spielberg: 1977), Indiana Jones: Raiders of the Lost Ark (Spielberg:1981), Aliens (Cameron: 1986). Created before digital compositing, these effects-laden films required extensive optical compositing.

contrast, aims to merge the elements seamlessly into a continuous whole (Manovich 144). Before digital compositing, creating a seamless moving image of various elements was a difficult and time-consuming task. So as to explain the differences between optical and digital compositing the technical aspects of each will be explored in the following sections, with reference to the Terminator films.

## 2.1 Optical Compositing

Before digital technology the compositing of all the possible layers included in a film such as models, miniatures, backgrounds and live action was done using an optical printer. Optical Compositing involves the combination of various pieces of film captured at different times and in different conditions.

Although the compositing of layers had been used in the late nineteenth century by pioneer filmmakers like Méliès, there were at first no more than two or three layers of film to be combined. It was also easier in the primitive cinematic style for two reasons, the first being the static frontal camera angles, and the second, that the black and white film stock hid any misalignments better than colour film stock. A common compositing method was achieved by only exposing half of the film frame by blocking light to the area which required the effect. Later that area was exposed to the effect, thus creating a final composite image. This method was known as a **two-shot**.

The most obvious problem encountered with combining two elements from two separate pieces of film is **ghosting.** Ghosting occurs when two objects have been exposed on the same piece of film and the areas where they overlap create the impression that the image is transparent like a ghost. To block the light to a specific area of the film so that only part of it could be exposed necessitated the use of a **matte** (or in the case of moving objects a travelling matte). The matte would block out the area on the background on which the actor would later be placed (see fig. 5). Hand-drawn mattes,

created by tracing over the object, a frame at a time, are sometimes required when other methods are not possible.[8]

At its simplest, this means that an actor filmed in one location can be put into another shot of a background filmed at another location. First the master positive of the background is combined with a matte of the actor, also called the male matte, resulting in a copy of the background scene with an unexposed area of film in the shape of the actor. This film in the camera is wound back to the starting position and re-exposed to the actor. A female matte, the opposite of the male matte, prevents light getting to the already exposed background area so that only the actor is exposed. The result is a satisfactory composite image of all the images combined. The introduction of colour film in the 1940s presented new problems for this simple compositing technique, and new methods were developed which required many more layers and variable elements (Rickitt 63).

While this concept of optical compositing is simple in practice it is laborious and time consuming and requires highly skilled operators to produce satisfactory results. Even images misaligned a thousandth of an inch produce noticeable **matte lines**. This becomes even more complex when there are hundreds of elements in a shot, and even one little mistake can ruin weeks of work. Although separate departments are employed just to keep track of the vast amounts of footage, there is only one master copy of the footage, which if lost or damaged during this process would have to be shot again.

Rickitt identifies shots in the 1977 Star Wars production which consist of hundreds of layers of film. Travelling mattes such as those used in the outer space dog fight sequences could, for each individual element in the shot, have a plate for every colour of

8 Before digital techniques, hand drawn mattes were achieved using rotoscoping techniques developed and patented by animator Max Fleischer. Star Wars:Return of the Jedi (1983) used rotoscoping to create mattes that were employed to enhance the effect that the animated vehicles and robots were actually interacting with elements in the forest scene. By rotoscoping certain elements, like trees in the forest as the animated models moved past, it gave the impression that the vehicles and robots were actually walking in-between the trees (Rickitt 54).

light: red, green and blue, the male and the female mattes as well as a background plate.[9] Besides the technical complexity of combining all the layers together accurately and cleanly, the vast quantities of film produced required the employment of a full-time person to keep it organised (60).

Each element to be composited exists as three black and white colour separations, red, green, and blue. Each of these can have coloured light added to a greater or lesser degree during printing, in order subtly to change the final output image. Depending on the filming conditions this subtle colour grading will be different for each layer needing to be composited, and through trial and error the correct mix must be found to get all the layers appearing as if they were shot from the same camera. Optical printers have been fine tuned to be as accurate as possible, and built to control every part of the process. Despite this, there are still uncontrollable factors. Optical processes, being photochemical, are affected by variables such as light, the quality and consistency of the chemical bath used to develop the film, voltage charges, weakening lamps, fading filters and many other elements imperceptible to the eye until the final output image (Rickitt 63).

Considering all the physical elements that could go wrong with optical compositing such as matte lines, damage to the film and dust between the composited layers, it is better to have fewer layers to put together. In order to keep postproduction costs to a minimum in the low budget movie, The Terminator, as much footage as possible was achieved "**in- camera**" by Gene Warren, special effects supervisor from effects house Fantasy II Productions. This meant that as many elements as possible were caught at one time on the camera film, leaving fewer layers for eventual compositing (Ling, "Other Voices" 2001).

9 In the re-release of the original Star Wars saga a lot of digital cleaning was done because shots consisting of so many layers of physical film had accumulated dust and dirt during the compositing process. Once digitised this dirt could be digitally removed (Rickitt 60).

The compositing of the miniatures with the actors was achieved using both **front screen projection** and **rear screen projection** (see fig. 3-4). These two processes require the combination of two separately filmed elements. Usually this is a background which is combined later with foreground elements, such as characters shot against a **blue screen** or **green screen**. Gene Warren, accomplished at both front and rear screen projection, planned each shot out carefully so that it was known exactly what was needed for the processing shots (Ling, "Other Voices" 2001).

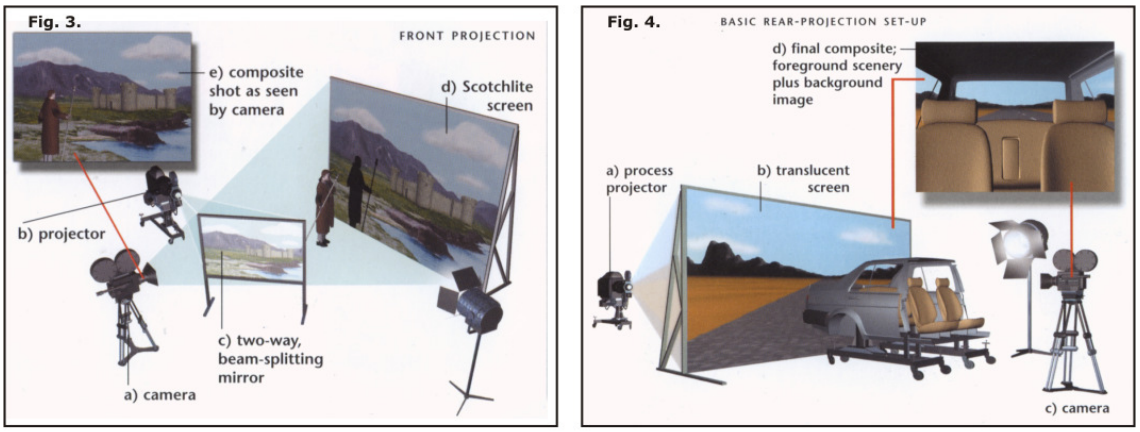


**Fig. 3-4.** Front Screen Projection and Rear Screen Projection.
Rickitt R. Special Effects: The History and Technique. London. Virgin Books, 2000. 66 and 69.

With the success of The Terminator the budget for Terminator 2 increased, as did audience expectations. Not only were scenes more elaborate but they were much more complex as well, with digital and traditional effects footage needing to be merged into one continuous body.

All the non-digital effects in Terminator 2 were optically composited using front screen projection and rear screen projection, the same methods previously used in The Terminator. Gene Warren of Fantasy II, who worked on both the first and second Terminator films, has spoken of the difficulties encountered in compositing the elements of the future war scenes. More elaborate the second time around, they consisted of miniature landscapes, model tanks, flying machines and full-scale live action shots of fighting actors. What made the compositing process more complicated was that both

full-scale and miniature elements had their own fires and explosions going off. The problem during postproduction was creating corresponding lighting in all the layers to make it look as though the explosions in the background affected the foreground and visa versa, thus maintaining the illusion that everything was going on within one single environment (Rickett 63).

The downside to using both front screen projection and rear screen projection is the difficulty of hiding the artificial nature of the space. Due to the frontal static camera which seems like that of primitive cinema, the shot stands out from other shots. It gives the viewer a chance to analyse the shot, and even with the additional work put in to achieve corresponding lighting between the layers, they are still apparent.

With all the instability and unreliability of the optical compositing process, what became the goal of many filmmakers after The Abyss was to find ways to use digital technology to assist in compositing. By 1991 many of the glitches in the process had been resolved and Terminator 2: Judgement Day contained a few scenes of digitally composited footage (Cotta Vaz and Duignan 198).

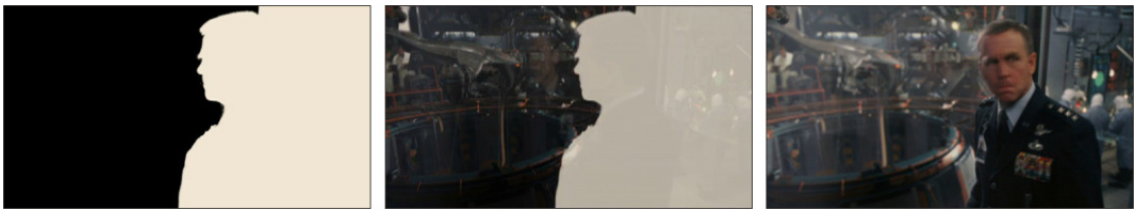

**Fig. 5.** Frame 1: shows the male matte for the foreground objects and actor David Andrews. Frame 2: shows the background image combined with the foreground matte. Frame 3 shows the final composite image as it appears in Terminator 3. "T3 Visual Effects Lab", Terminator 3: Rise of the Machines. Prod. Michael Meadows, and Mitchell Taubin . Columbia TriStar Home Entertainment. 2003. DVD.

## 2.2 Digital Compositing

Discussion of Terminator 2 is likely to appear in almost any paper or book concerning the development of New Media in cinema. It is often seen as the film that made the use of computer-generated effects a fixture in Hollywood, the film that turned the slang term for metamorphosis, 'morph', into a household word. However, Terminator 2 was a pioneer in neither Computer-Generated Imagery (CGI) nor morphing. Morphing

technology was developed and the term 'morph' was coined during the making of the film Willow, and CGI techniques were used before that in adverts, music videos such as Michael Jackson's Black and White, and the movie The Abyss. Such a huge emphasis is placed on CGI in the Terminator 2 film, or it is so expertly presented, that one tends to forget that there are only five minutes of CGI in the entire film.

It is seldom mentioned that Terminator 2's real breakthrough and perhaps greatest influence on subsequent films was that all its digital effects were digitally composited (Rickitt 86 and 305).

Film is an analogous medium. It uses a chemical process to record and store the information of an image of the scene it was exposed to. As the light hits the emulsion on film there is a chemical reaction, and its physical properties change according to the amount of light. In all analogue media, transcribing the content of one medium into another through direct physical relationship causes an inevitable loss in quality between the master and the copy, especially if the process is continually repeated.

Digital systems, however, work purely with numerical values and can therefore be copied and duplicated without a loss of quality. Although digital compositing techniques had already been used for television during the eighties, the required **resolution** for television is significantly lower than that of a standard motion picture.[10] The quantity of processing power and computer memory required to manipulate film resolution images for a feature film meant that it was not cost effective in the 1980s. At this time scanning of the live action footage, manipulating it, and then outputting it back onto film resulted in a noticeable loss of quality. The other problem was that the processing power of even the strongest machines was insufficient to handle the huge amounts of data required to store such high-resolution images (Rickitt 74).

10 Television resolution in Europe and South Africa would be 720 px x 576 px at 72dpi while cinema resolution for standard 35mm film would be around 2048 px x 1494 px at 72dpi.

A comparison test between optical compositing and digital compositing was made by ILM in 1991, using old blue screen footage from Willow and Indiana Jones and the Last Crusade (Spielberg 1989). Selected footage was scanned into an Apple Macintosh and manipulated in the software package, Photoshop. The completed images were then transferred back onto film. In a screening room the resulting digital composits were compared with the optical composits, and not only was the quality good enough for film, but there also were no matte lines at all on the digital composits and the general characteristics between the layers had improved (Cotta Vaz and Duignan: 117).

At first digital compositing was primarily used in shots that were tricky to composit optically, such as shots with **motion blur** or shots with **blue spill** or green spill. Blue spill occurs when light reflects off the blue screen onto the object being photographed, making it hard to remove the blue for compositing (Cotta Vaz and Duignan: 118).

In the three years between the making of The Abyss and Terminator 2, Industrial Light and Magic (ILM) effects house had upgraded their older ILM-Kodak prototype input scanner to a new Trilinear Multicolor High Resolution CCD Digital Input Scanner, on which development had begun in 1989. This scanner was the first device capable of outputting multicolour, high-resolution footage which could be intercut with actual production footage. The scanner was the means by which the ILM effects team could move data into and out of the digital realm. Besides the introduction of the scanner which made it possible to accomplish the effects in Terminator 2 (1991), the digital effects department expanded to over 35 Silicon Graphic work stations and the staff grew from 8 to more than 40 individuals (Cotta Vas 201).

As a result of Terminator 2's success, both as a film and in terms of its digital compositing technology, numerous effects houses including James Cameron's company Digital Domain were created or expanded. The old matte painting department at ILM was replaced by computer hardware and painting software. Old motion control cameras were superseded by computer graphics workstations, and the optical-printing department was

almost entirely supplanted by scanners and digital systems. Digital effects advances have allowed filmmakers to produce seamless invisible effects that range from the creation of synthetic (or virtual) sets to the replication of a dozen extras into a cast of hundreds (Nadilianis 166).

In digital compositing the problems associated with compositing film by hand are eliminated because the footage consists of purely digital data in a virtual realm. In contrast to optical compositing where layers are kept to a minimum, the general trend in digital compositing is actually to have as many separate layers as possible, giving the compositor greater flexibility when it comes to combining the images.

When a computer generated image is complete it will be divided into **render** layers or render passes which are processed by the computer into the final image. While different objects in the scene can be rendered separately, different visual aspects and qualities of objects can also be put into separate passes. For instance a render layer can consist solely of an object's specularity (shiny properties), transparency (Alpha), or even its reflectivity.

The most common render passes include: Diffuse Pass (also called the Beauty or Colour pass), Alpha Pass (Transparency), Shadow Pass, Reflectivity Pass, Specular Pass (Highlight Pass), Depth Pass (Z-Depth or Depth Map), and Occlusion Pass (Ambient Pass). Many studios use many more passes than the above, and these passes can in turn be broken down even further. For example the Colour Pass can be separated into a pass for every light in the scene which may be affecting it.

Dividing up the image into render passes not only saves on computer memory but also means that if any changes need to be made, only the specific passes with the problem need to be re-rendered. Integration of the computer generated element into live action is also more efficient, and subtle adjustments can be made individually to each pass. For example, if the shadows in the live action are blue in tone the Shadow Pass of the CGI

can be tinted blue without affecting the other passes. The Depth Pass can be used to influence the **depth of field** or for atmospheric effects.

This illustrates a change in the mindset of visual artists. In the past it was more efficient and cost effective to film as few elements as possible to be optically composited into a scene. With digital compositing it is more flexible and effective to have more layers.

Manovich states that: "on first glance computers do not bring any new conceptual techniques for creating fake realities. They simply expand the possibilities of joining together different images within one shot" (152). In Manovich's opinion, to say that digital compositing only expands the possibilities of joining together different images within one shot is deceptive, because digital technology does offer a qualitatively new step in the history of visual simulation – it allows the creation of moving images of nonexistent worlds. Unlike front and rear screen projection which require a frontal camera, the digitally created camera can zoom, pan and dolly through the environment. It has achieved a more accurate emulation of the established language of cinema than optical compositing techniques (Manovich 152).

Manovich goes on to argue that in the digital era the ability to assemble moving images redefines our concept of the moving image. To once again highlight Manovich's distinction between montage and digital compositing: in digital compositing, the elements are not juxtaposed but blended, their boundaries erased rather than foregrounded, as is the case with montage (155). In the next chapter the significance of this difference will be illustrated through the study of relevant scenes in the Terminator films which have been created using either **analogue** or digital compositing techniques.

In addition to the montage-compositing difference between classical filmmaking and digital filmmaking, Manovich highlights another important paradigm introduced by the computer era. This paradigm is concerned not with time but with space. Digital compositing makes the dimensions of space and frame as important as the element of

time. While film practice has since its beginnings privileged the temporal development of the moving image, computer technology privileges spatial dimensions (157).

Manovich explains that just as montage was concerned with juxtaposing various images consecutively along a time line for emotional and aesthetic effects, compositing juxtaposes objects within the three-dimensional space of a virtual environment in a process he refers to as 'spatial montage'. Compositing is often wrongly seen as a purely technical operation, so to see it as spatial montage emphasises its conceptual potential (158).

As will be illustrated in the following chapter, compositing in the Terminator Trilogy has been central in the development of techniques for creating a single convincing composite image fusing virtual spaces, painting, photography and cinematography.

**Fig. 6.** Frame 1: The foreground elements shot against a green screen background. Frame 2: The final composited image with the digitally created background matte painting. "Documentary: Making of The Terminator 3". "T3 Visual Effects Lab", Terminator 3: Rise of the Machines. Prod. Michael Meadows, and Mitchell Taubin . Columbia TriStar Home Entertainment. 2003. DVD.

## CHAPTER 3: THE TERMINATOR TRILOGY PRODUCTION ANALYSIS

In the light of Manovich's arguments about compositing, this chapter will study specific examples from the Terminator Trilogy in order to highlight changes spanning the period of digital integration. With the incorporation of the new technology there has been a gradual shift through the Terminator films to an emphasis on postproduction techniques, like digital compositing, as well as a progressive implementation of increasingly powerful digital effects, like computer-generated imaging (CGI). It is relevant to highlight, once again, Manovich's comparison between montage and digital compositing because it is central to the construction of the films: in montage elements are purposefully juxtaposed for aesthetic and emotional reasons, whereas in digital compositing the elements are not juxtaposed but blended to create a seamless whole.

Effects techniques selected for each final picture were not only influenced by the technology available at the time but also by the budgets allocated to the making of each film. The Terminator (1984), considered a B-Grade movie, was initially budgeted at $4 million and reluctantly raised to $6.5 million (French 6). Capitalising on its predecessor's success, Terminator 2: Judgment Day (1991) was allocated $102 million and Terminator 3: Rise of the Machines (2003) $187 million (French 64).

Changes in production techniques, film language and formal parameters can be analysed by focusing on specific scenes and elements that recur in the films, such as the Future War, makeup, the use of models and morphing effects. For stylistic continuity through the trilogy, the general look and design of these elements have remained fairly consistent but their presentation and aesthetics clearly differ from film to film. Also, due to technological advances over the twenty-year period, the methods used in the construction of each scene changed dramatically, and many old techniques including live action were replaced by computer-generated effects.

The limitations of the technology can also restrict the director's options when he is deciding on the formal parameters of the shot. Michael Allen explores the impact of digital technologies on film aesthetics in The New Media Book, and considers formal parameters such as shot length, framing and camera movement. He discusses a few films spanning a similar timeline to this study, 1989 to 1998, but focuses specifically on the films The Abyss (1989), Jurassic Park (1993) and Godzilla (1998) (109-118). Where relevant, some of the formal elements discussed by Allen will be considered and applied in the analysis of the Terminator films.

This chapter is concerned primarily with the changes in production techniques from film to film in the Terminator trilogy, and secondly with the possible influence of these changes on the aesthetics of the films. Analysing these aspects will establish whether Manovich is correct in his assessment that the concept of cinema should be reconsidered and if the language of cinema has been affected.

### 3.1 Future Scenes: Miniatures and Camera Movement

Despite the low budget for The Terminator, James Cameron knew that somewhere in his film he would have to show scenes from the future, a war-stricken environment with futuristic machinery that would convince the audience of the possible existence of a society with Cyborg robots in it. Cameron said in an interview about the film: "What a director is always doing is weighing aesthetic verses monetary, working in constraints of the budget and schedule". He had to plan carefully which special effects were absolutely essential to the plot (Ling, "Other Voices" 2001).

In the opening shots of The Terminator, (see fig. 8) captioned: "Los Angeles 2029 A.D.", the audience is introduced to the dismal nuclear-blasted future in a dark, almost film noir style, reminiscent of director Ridley Scott's futuristic film Blade Runner (1982). This was a deliberate stylistic decision made by Cameron; later on in the film he names the nightclub Tech Noir (French 62). The future environment is populated with humans, humanoid robots and vehicles created using **physical effects**. Gene Warren, the effects

supervisor, recalls: "Jim [James Cameron] wanted to use those techniques of hanging wires on models, wanted high speed photography, **in-camera effects** particularly" (Ling, "Other Voices" 2001).

Future War sequence: Terminator 1

Fig.7. ▲


Fig. 8. ▲

**Fig. 7.** The miniature environment, containing a Hunter Killer hovercraft controlled by wires and string, is filmed and then projected as a background for the actors in the foreground of the frame. **Fig. 8.** The atomic bomb destruction, created with miniatures using artificial perspective.

**Fig 7-8.** The Terminator, Dir. and writ. James Cameron. Perf. Arnold Schwarzenegger, Linda Hamilton and Michael Biehn. 1984. MGM Home Entertainment, 2001. DVD.

Future War sequence: Terminator 2

Fig. 9. ▲

Fig. 10. ▲

**Fig.9.** The Hunter Killar hovercraft is still controlled with wire and string.
**Fig. 10.** The future war in Terminator 2 although created using the same methods used in The Terminator , contains more elaborate lighting and explosions. This makes the compositing of the layers very complicated.

**Fig. 9-10.** Terminator 2: Judgment Day, Dir. and writ. James Cameron. 1991. Momentum Pictures. 2001. DVD.

In The Terminator, a futuristic tank-like machine passes carelessly over ground strewn with human bones. This composite reality of miniatures, puppets, and humans almost succeeds in selling itself as an existing location, and perhaps it did to audiences in 1984. However, the static camera and the strict containment of the humans in the foreground plane is a giveaway to the use of rear projection compositing, and the Hunter Killer units (ground to air assault hovercrafts) hint at their existence as miniatures. Twenty-seven seconds into the film the hovercraft blows dust up from the ground and then makes a jerky motion, a not so subtle reminder of its model origins. As it stops it seems to rock back and forth slightly, as if swinging on a string – which, in reality, it is (Cameron 1984).

The effects house Fantasy II started with shots needed later for rear projection, such as the scenes of the future war sequence, which required huge landscapes of destroyed cities and rubble. Because of limited space on the studio stages where they were building the models, they often made use of false perspective to give the illusion of a larger area of space. This illusion was emphasised by the use of smoke to create an additional feeling of atmospheric depth and perspective. Joe Viskocil, the miniature **pyrotechnician** specialist for the film, notes that Gene Warren is a master of false perspective photography, a skill acquired in the course of the various projects he has worked on (Ling, "Other Voices" 2001).

In Terminator 2, Fantasy II Productions was again involved, and under the supervision of Gene Warren, greatly expanded the future war sequences from the first film. Live action special effects sequences were combined with effects photography to create these shots. Although technically there were no innovations in the making of the future war sequences, the bigger budget allowed for more intricate layering and postproduction work. All the miniatures were remade to a larger scale to allow for more detail (Ling, "T2: More" 2001).

As with The Terminator, the intro of Terminator 2 takes us into the bomb-destroyed world of the future, only this time we get a hint of the atomic bomb which will be revealed at a later stage in the film (see figs. 9 and 10). As is typical of effects films, Terminator 2 tried to outdo the effects of its predecessor, and French says the audience is treated to "a whole army of cyborgs" patrolling the same skeleton-strewn ground as in the first film (French 64). This "army" consists of six robots; in reality only two physically constructed robots were animated in front of a rear projection of explosions in the miniature terrain. This composite image is again rear projected during a live action scene of two full-scale puppets in the foreground. This combined footage was then **rotoscoped** for the addition of lazer guns, muzzle flashes and reactive lighting effects, a very difficult shot to achieve. The flying machine still changes direction with a slight shake of string and the close-up of it makes the swing more obvious, but this is almost concealed by

some additional camera shake.

The artists doing the miniature work and stop frame animation complained about the hot conditions under which they were working. Besides the hot summer weather, they had to use very intense bright lights to light the miniatures convincingly, and this together with the surrounding smoke made for extremely unpleasant working conditions. Due to the tight deadlines, parts of models were filmed and sent to postproduction to receive optical effects, such as lasers and search lights, as soon as they were completed. Many of the searchlights visible in the shot were accomplished on set using hand-held torches. In the last sequence of the future war, once all the other shots were accomplished, many of the models and all the hovercraft flying machines were blown up to achieve the final shot. Many hours of work are put into the creation of the models, but once filming is complete the models have served their purpose; and in films such as the first two Terminators, they are destroyed as part of the script (Ling, "The Ultimate T2" 2001).

The image of effects artists as men in a workshop working under dirty conditions has completely changed with the introduction of digital effects. The addition of lights, dust and smoke, or any other effects added to a shot, can be accomplished by a person sitting in front of a computer monitor. But although the working conditions are much better, creating effects digitally remains a time-consuming task. There is no need to cheat perspective, as Warren did in The Terminator and Terminator 2, because the three-dimensional environment is already simulating depth which can be enlarged at will. The only space that could potentially 'run out' is disk space or computer memory. Unlike all the physical models destroyed for Terminator 2 in a shot that had only one take, computer generated models can be virtually duplicated and destroyed any number of times until the desired shot is achieved.

Most of the effects for the future scene in Terminator 3 were created digitally. After a detailed computer-generated atomic explosion in the opening shot of the movie, there is a cut to cheering humans in the battlefield of the future. This army of humans was

filmed on green screen and had the background added digitally. The victory scene cuts to a shot of skulls underwater, with the searchlights of the hovercraft flying machines highlighting various areas of the set (see figs. 11 and 12). This scene, one of the few featuring physically created miniature sets in Terminator 3, uses **forced perspective** and is filmed in a dense smoky environment to give the illusion of being under water. Although the shot originated as a miniature set it was **digitised** and digitally manipulated to blend seamlessly into the computer-generated shots following it. As the camera moves up, eventually breaking the surface of the water, the miniature scene merges into a completely computer-generated scene. This one shot required one week of miniature work and about three months of digital work. Digital effects are more expensive and time consuming than analogue effects, but the result is so effective and impressive that the process is viable for high-budget films like Terminator 3.

Future War sequence: Terminator 3

Fig. 11. ▲

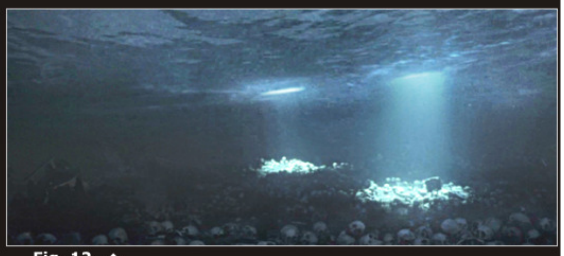

Fig. 12. ▲

Fig.13. ▲

Fig. 14. ▲

**Fig. 11-13 .** The future war sequence in Terminator 3 is far more elaborate than the previous films. These images represent frames from a sequence using one camera movement**. Fig. 14.** The army of digitally created robots demonstrates e duplicated as many times as its needed. Terminator 3: Rise of the Machines. Dir. Jonathan Moston. 2003. Columbia Tri Star Home Entertainment, 2003. DVD.

For the first time in the three films the audience is shown a close up of the hovercraft. Its motions are mechanically precise and almost graceful compared to the swinging ships in The Terminator and Terminator 2. The shot lingers on the ship where in the other two films the ships were flying behind obstacles and layers of composited film. The simulation is enhanced by the extremely realistic computer-generated water which gets

displaced by the Hunter Killer's engines as it skims the surface (see fig.13). This interaction with its environment helps to reinforce the apparent photo-realism of the scene.

In contrast to the previous films, which maintained the same camera angles as required for rear screen projection, this water shot is followed by yet another future scene from a new camera angle. A bird's-eye view shows the computer-generated enemy army, vehicles, regiments of robots and at least three hovercraft circling in the air (see fig.15). Also starting with a close-up of a hovercraft, the dramatic digital camera spirals up in a manner far too steady, precise and fast to be accomplished with a real camera. If the entire environment is generated on computer and there is no live action footage, then there is no need to match the movements of an existing physical camera. This swift motion unaffected by gravity relates more to computer games than cinema, and indeed, a virtual camera movement that is impossible to achieve with a real camera is categorised by Quart as belonging to the "Video-game Cinema" genre (32).


**Fig. 15.** A computer generated shot demonstrating digital cinematography. The fast and steady spiraling camera motion would be impossible to achieve with a real camera.

Terminator 3: Rise of the Machines. Dir. Jonathan Moston. 2003. Columbia Tri Star Home Entertainment, 2003. DVD.

Angela Ndalianis highlights the concern contemporary action films have with continuous fast paced motion and a kinaesthetic priority which is especially evident in camera movements such as "high-velocity pans, tracks and fast-paced edits to 360 degree summersaults", enhanced by vivid imagery and sounds. The restless scanning of the screen in search of details which may disappear or appear at any instant is a characteristic of most computer games. This also represents the blurring of the boundaries between digital-based genres. Endless zooming in or out and a continual change of focal point, feats impossible in the natural world, are made possible by

computer (155). Ndalianis' observations support Manovich's argument that computer technology privileges spatial dimensions (157). This view is further supported by the spiralling, fast-moving, digitally created shot in Terminator 3. Because of computer generated effects, outer space, or the inner space of the mind, or cyberspace in science fiction, can now be portrayed with illusionistic depth. In fact the scope of subject matter and the illustration thereof have become limitless.

John Gaeta, effects director of the Matrix Trilogy (1999), has been talking for years about the promise of virtual cinematography, a confluence of technologies that will allow directors to sculpt actors' performances with the ease of tweaking a digital image. In the Burly Brawl scene of The Matrix: Reloaded (Wachowski: 2003), this goal was realised in a sequence containing completely digital imagery. The sequence in The Matrix: Reloaded is enabled by a camera movement similar to that of the physically impossible spiralling camera in Terminator 3. The camera starts at an ordinary eye level – at this point the entire set and actors are digitally simulated – then suddenly pulls back at such a speed that a real camera would have come apart if it had made the same move. Just as suddenly it then zooms forward, again at an unrealistic speed, into an action sequence consisting of hundreds of digitally-simulated Agent Smith characters based on the actor Hugo Weaving (Silberman).

Once a model has been generated on computer it can be duplicated an infinite number of times, and in Terminator 3 the robot army has grown from the six T-101 robots in Terminator 2 to twenty-one. The decision as to how many robots there should be in the composition of the shot has become a purely aesthetic matter, as each one comes complete with motion blur, perspective and depth of field.

While physical models and miniatures were not completely supplanted by computer simulations in the Terminator films, during the period spanned by the trilogy there was a significant move towards doing most of the work in postproduction. Digitally constructed models in the film can be infinitely duplicated: physical models used in Terminator 3 are

digitised, digitally composited and undergo digital manipulation, regardless of their analogue origins.

When the camera work used for the future sequence in the three films is compared, it is apparent that The Terminator and Terminator 2, which were shot using the older techniques, are stylistically the same. The combination of overlapping layers, miniatures and live action against blue screen, or using front or rear screen projection and forced perspective, require that the camera remain on a single plane and at a constant focal length. The camera remains static or pans across perpendicular to the scene, and the careful viewer can identify the different layers. In Terminator 3 the shots are stylistically completely different. Starting under water the camera follows the search lights of the hovercrafts, then emerges from the highly realistic computer-generated water which is sprayed up by the jets of the flying ship. There is no narrative reason for these machines to be flying over the water other than the elaborateness of the shot itself. In the physically-created shots there is a certain amount of unpredictability involved, since different teams of people work on the different layers which will eventually be composited together. With real explosions the pyrotechnician can only plan up to the point where the explosion is detonated, and then an element of chance comes into play. In a digitally created shot, on the other hand, every water particle, every explosion, even the colour of each pixel – as illustrated in the future shots from Terminator 3 – have the look of a well-composed painting. This supports Manovich's view of digital cinema as a painting where all the elements of the image, including the live action, can be manipulated with the same flexibility.

### 3.2 Makeup

The digital era has encroached on some of the most traditional areas of special effects, including that of prosthetics and makeup. This section compares the changes in the three films with regard to makeup, examining how specific shots are approached both during filming and in editing and compositing. In some recent films such as Terminator 3, makeup has become a postproduction technique. While the traditional methods

remain more cost effective by far, there is a level of detail and depth which cannot be achieved physically, especially when the audience is required to see through the actor's body.

For the first two Terminator films Arnold Schwarzenegger, who performed as the Terminator (T-101) character, was required to reveal the robot hidden beneath his biological exterior (Rickett 243). A pivotal decision made early on by Cameron and special effects and makeup artist Stan Winston was that there would be no man inside a suit, and that the viewer should rather get the impression that Schwarzenegger's skin is the suit on top of a metal endoskeleton. While much of the film portrays Schwarzenegger without elaborate makeup, at a climatic point a chrome skull would be revealed through the wounds on his character's face (Pinteau 316). This decision dictated how the construction of many of the puppets and makeup effects would be approached. Schwarzenegger, when viewing the concept sketches for proposed Terminator makeup to be applied to his face, expressed the opinion that he didn't believe it was humanly possible to achieve what was depicted in the drawings. Winston reassured him that it would be possible, but at the cost of hours and hours of his patience (Ling, "Other Voices" 2001).

When the required shot could no longer be achieved using makeup, duplicate puppets of Schwarzenegger were used instead. Although made to look as realistic as possible, the entity's origin as puppet, not flesh and blood, is hard to hide from the audience. It requires an elaborate sequence of shots deliberately constructed to hide the nature of the puppet while still displaying the special effect. Half an hour into the film the Terminator character has to remove his damaged eyeball from his head. The sequence consists of many cuts between the real Schwarzenegger head and the puppet head, which is usually shown with Schwarzenegger's real hand in the foreground to ground it in reality. The movements are unnaturally jerky and unsteady as Schwarzenegger uses his real hand to put dark glasses on the puppet head, which then admires itself in the mirror. Seconds later there is another shot of the real Arnold admiring himself in mirror

– an unnecessary double shot of the same thing in order to sell the puppet head to the audience (see figs. 16 and 17). If we consider, as Manovich suggests (144), that montage strives to create a deliberate dissonance between the visual elements of a film, it could be argued that the placement of two such similar shots only serves to reinforce their differences in an uncanny way.


**Fig. 16.** Puppet of Arnold Schwarzenegger. The Terminator, Dir. and writ. James Cameron. Perf. Arnold Schwarzenegger, Linda Hamilton and Michael Biehn. 1984. MGM Home Entertainment, 2001. DVD.


**Fig. 17.** A shot of the actor Arnold Schwarzenegger follows the shot of the puppet. The Terminator, Dir. and writ. James Cameron. Perf. Arnold Schwarzenegger, Linda Hamilton and Michael Biehn. 1984. MGM Home Entertainment, 2001. DVD.

For the T-101 character in Terminator 2, played again by Schwarzenegger, Winston enhanced the makeup designs by breaking up the process into various stages in which one could see more or less of the endoskeleton (see figs. 18 and 19). This was not only very laborious on the part of the makeup artists, but very taxing on the actor as well. At the most extreme stage one of Schwarzenegger's eyes had to be completely covered in make-up and as a result he had no depth perception during that part of his performance. Winston states in the Terminator 2 DVD commentary that "an actor going into this must know that there is physical stress with this process". During the make-up process, artists Jacob Donne and Steve Lapor had to apply the loose flesh and metallic make-up pieces to Schwarzenegger's face about thirty five times, which amounted to almost six consecutive days or an average of four hours a day in the makeup chair (Ling, "Other Voices" 2001).

Digital effects are perceived to be slicker and cleaner than analogue effects, but the time needed to create them is usually far longer than that required for physical effects (see figs. 20 and 21). This is instanced in the computer-generated makeup for Terminator 3,

where the damage to Schwarzenegger's face needed to be so extensive that ordinary makeup could not be used. What previously took days to accomplish with traditional makeup would now take months to fine-tune on computer, and as a result the actor is less involved. Nevertheless, the additional expense of moving makeup to postproduction is justified by the final spectacular image.

**Terminator 2 Make-up**

Fig.18. ▲

Fig. 19. ▲

**Fig.18.** The Terminator prosthetic makeup. **Fig.19.** The Terminator prosthetic makeup.

**Figs.18-19.** Terminator 2: Judgment Day, Dir. and writ. James Cameron. 1991. Momentum Pictures. 2001. DVD.

**Terminator 3 Make-up**

Fig. 20. ▲

Fig. 21. ▲

**Fig. 20.** The greenscreen prosthetic plate used to mask areas where digital make-up will be placed.
"T3 Visual Effects Lab", Terminator 3: Rise of the Machines. Prod. Michael Meadows, and Mitchell Taubin . Columbia TriStar Home Entertainment. 2003. DVD.

**Fig. 21.** The final digitally composited make-up shows more depth than the analog make-up effects.
Terminator 3: Rise of the Machines. Dir. Jonathan Moston. 2003. Columbia Tri Star Home Entertainment, 2003. DVD.

The makeup for Terminator 3 was created using a technique developed by Winston while making A.I. Artificial Intelligence (Spielberg 2001), in which an effect of robotic humans whose skulls were largely missing was created through a blend of makeup with green screen accents and ILM's digital technology. Winston explains that traditional makeup was used as far as possible, and then green fabric was applied where the digital model would be placed. A computer-generated metal endoskeleton had to be matched and animated according to Schwarzenegger's movements and then be composited onto the areas of green. Tracking markers were placed on the **greenscreen** facial makeup so that Schwarzenegger's movement could be matched by the digital model. For very complex shots Schwarzenegger was filmed wearing greenscreen makeup against a

bluescreen background so that the two screened elements could be separated (Pinteau 328). Don Burgess, director of photography on Terminator 3, acknowledges that lighting the prosthetic greenscreen makeup is difficult as it needs both to be lit brightly enough for the digital artists to replace the green area with another image, and still be dark enough to maintain the drama of the scene. If the light is too bright the mood of the sequence is ruined, but if it is too dark the greenscreen cannot be removed from the shot (Magid 1).

To create the digital outer body model, Schwarzenegger's body was scanned into the computer. A digitally created robot skeleton was then built to fit inside the digital Schwarzenegger outer body and connected to it so that it would move according to the outer body. Once Schwarzenegger's performance had been filmed, a complex application of key frame hand animation, **motion capture,** and a newly developed 3-D **rotoscoping** technique called "**matchimation**", were used to animate the model on computer, frame by frame, to match his motion. Pablo Helman, visual effects supervisor for Terminator 3, explains: "Much of our R&D [Research and Development] focused on developing this very sophisticated tracking tool [matchimation], because we had to create the T-101 endoskeleton, the muscle tissue, the skin and the Terminator's leather jacket, which is full of holes that you can see through" (Magid 2).

Due to the modular nature of computer-generated imagery the detailed models of Schwarzenegger and the endoskeleton could be re-used for other purposes as well. In the following section the use of full body doubles and models will be explored.

### 3.3 Models: Stop Frame Animation and Digital Animation

Replacing actors with other actors for stunt purposes, or replacing actors with models or look-alike puppets, is a technique that has been employed since the beginnings of cinema. The replacement of any live action element with a substitute is important to this study insofar as it supports Manovich's argument that live action is only one element among many which a filmmaker may or may not choose to use. Barnouw records

numerous films featuring decapitation or mutilation where at some point in the shot the actor is replaced with a dummy, as in Georges Méliès' 1902 film Up to Date Surgery (94).

The techniques for duplicating actors remained fundamentally the same until the advent of digital technology. This is not to say that techniques remained completely unchanged, for naturally they improved over the years, but the principles remained the same. From fabric dummies to detailed plaster casts, to animatronic controlled sculptures, these simulations of actors were built by hand, and if more than one model was needed it had to be rebuilt from scratch. In The Terminator more than seven different models were needed for the T-101 effects shots (Ling, "Other Voices" 2001).

For The Terminator Cameron's plans were, from the start, to do all the endoskeleton work as stop frame animation using a miniature model. Stan Winston, head of makeup and special effects, had to convince director James Cameron to build a full-size endoskeleton using puppetry and animatronics. Since Cameron wanted the most realistic result possible he was prepared to listen to Winston's suggestions that they use a combination of shots of the various puppets for the best effect (Ling, "Other Voices" 2001).

Winston described the puppets needed for the scenes as including:

1. An upper torso puppet with animatronic eye and head movement, worn on the shoulders of the puppeteer, Shane Mayhan.
2. A full head-to-toe puppet with the top of the robotic torso blown in half. This was for full body shots and would be pulled along from beneath the floor.
3. A pair of feet for close ups.
4. Mechanical arms for close ups.
5. A chromed polyurethane robot to be blown up.
6. An enlarged model of the eye socket area for closeups of the eye operation.
7. Lastly, to really sell the endoskeleton to the audience, puppets of Arnold's head and

hand had to be made to show the metal skeleton underneath.


Fig. 22.


Fig. 23.

**Fig. 22.** Stop frame animation of the T-101 minature. The model is repositioned by hand for every frame.

**Fig. 23.** The T-101 Terminator life size puppet designed to be worn on the shoulders of the puppeteer.

**Fig. 22-23.** McQueen, Jeff. Prod. and dir. "The Making of The Terminator: A Retrospective". Prod. Patty Matlen. 1992. The Terminator. MGM Home Entertainment. 2001. DVD.

At the climax of the action in The Terminator, the point when the robot finally catches up with its human counterparts and hand-to-hand combat is inevitable, the film lapses into the surreal world of stop frame animation. The fluid motion of the main human character, Reese, fighting the jerky Terminator robot, is strongly reminiscent of Ray Harryhausen's famous scene of Jason in Jason and the Argonauts (1963) fighting the skeleton army. Although this is very conspicuous, the most notable contrast between the live action and the stop frame animation in often not that the model seems jerky but that it is too crisp and sharp against the live action. This is due to the absence of motion blur in the stop frame animation. Motion blur is an artefact of the camera and film caused when the action happens faster than the speed of the film passing by the lens of the camera, which causes the image to blur.

Many techniques have been tried over the years to simulate motion blur in stop frame animation. For the Terminator model T-101 a sheet of glass smeared with petroleum jelly placed between the camera and the animation subject created an artificial area of blur. Although fairly effective this method is also time consuming, since the blurring effect is required more in the areas of the model which are moving faster, such as the hands and feet, than slower moving areas like the torso. For this reason the grease needs to be cleaned off and reapplied for each new movement of the subject (Rickett 161).

In Terminator 2 the problem of motion blur was tackled by using **Go-Motion** animation, a technique developed by animator Phil Tippet in Star Wars V: The Empire Strikes Back (1980). The moving of a model during filming to create a motion blur is refined in Go-Motion by using computerised joints in the model. When the animator poses the model for each frame a computer records its joint positions. After the posing for the sequence is completed, the recorded positions are played back moving the model in real time and creating a realistic motion blur on film. Although effective, Go-Motion is seldom used because it is time consuming and expensive (Rickett 161).

In contrast to the previous films, Terminator 3 has an almost excessive amount of motion blur in its fight sequences, where digital doubles of its actors are used. Looking at the final fight sequence between the two Terminators, the T-101 played by Schwarzenegger and the T-X played by Kristanna Loken, it is difficult to see the moment the real actor is replaced with a computer-generated actor because of the excessive blur. Motion blur is a standard controllable parameter within effects software and is activated when the final image is rendered. The decision to incorporate motion blur indicates the ongoing desire for visual effects to simulate the camera rather than reality. The large amounts of blur may have been used to hide the fact that the actors are computer models, but it can also be attributed to their moving unusually fast because of their inhuman nature.

Apart from the digitally created T-1000 in Terminator 2, at some point in the film every principal adult actor had to be replaced by a physically created artificial model. Schwarzenegger's character, the Terminator T-101, never loses its external human flesh covering as it does in the first film, but the reason for this is most likely a narrative one. The plot distinctly humanised the T-101 character to be a father figure for the young male character, John Conner, and there needed to be a strong contrast between him and the T-1000. There were a few shots in which Schwarzenegger was replaced by a puppet, most significantly one hour and twenty minutes into the film when he walks out into a barrage of bullets from a police squadron which rips his skin and clothes to shreds. The

full-scale walking animatronics puppet is used for the visual effects of the bullets penetrating the skin. The puppet walked in a strange mechanical way and Schwarzenegger was required to imitate the puppet's walk for that particular scene in Terminator 2. Similar to the use of models in the first film, there are many quick cuts between the puppet and the real Schwarzenegger. Once again this style of editing stands in stark contrast, not only to the rest of the film, but also to the fluid continuous camera moves associated with digital effects films today.


**Fig. 24-26.** Some of the T-1000 physically created puppets which are digitally morphed seamlessly back into the live action footage of actor Robert Patrik. Terminator 2: Judgment Day, Dir. and writ. James Cameron. 1991. Momentum Pictures. 2001. DVD.

The most elaborate physical models created to replace an actor in Terminator 2 and perhaps the Trilogy as a whole were those for Robert Patrick when the T1000 gets shot at or blown apart. Puppets named Saucer Head, Pretzel Head and Doughnut Head, nicknames given to the puppets by their creators, illustrate the extremeness of the poses. Although these models are arguably not the most realistic in the trilogy they are so extreme that without digital technology to morph them back into Robert Patrick they may not have been successful. The very obvious contrast in editing between the scenes of the Schwarzenegger puppet, which cut from shot to shot, and the 3D morphing shots, which linger on the effect, serve to emphasize the differences between the analogue and the digital effects (see figs. 24-26).

In the CG realm, once the actor has been digitally scanned into the computer, the model can be duplicated and re-used indefinitely. It is also common that the same virtual model, as in the case with Arnold Schwarzenegger in Terminator 3, is shared collaboratively amongst the various effects houses, the game developers, toy manufacturers and anyone else involved with the Terminator franchise (Meadows and

Taubin).

Michael Allen comments on the strategy, used to give the impression that models and CGI are more realistic, of inter-cutting shots of them with live action shots. Allen argues that real life models at least have a physical reality and therefore need fewer strategies of confirmation than CGI shots, because "CGI is pure immaterial illusion" (115).

One could argue that Michael is incorrect in this regard, especially concerning the simulation of human actors. As already established in Chapter One, the goal of visual effects is to simulate the photographic image, not reality. CGI is one step closer to the photographic than the puppets which attempt simulation through physical means. For example the artificial skin on the Schwarzenegger head puppet in Terminator 2 is created using physical materials imitating skin, but they do not look specifically like Schwarzenegger's skin. The CGI model on the other hand uses a high resolution photographic scan of Arnold's actual skin, which is a **texture mapped** onto the 3D model of his face. But human skin is made up of many layers and is influenced by the blood beneath the skin's surface, and is therefore in a constant state of flux. Thus for heightened photographic realism, the skin can be filmed while the actor's face forms specific expressions which cause blood to rush to different areas of the skin. The sequence of images can then be used as a moving texture on the 3D model, thereby enhancing the realism of the simulation of the actor in a way that could never be achieved with a physical puppet.

The other area in which the realism of the computer-generated model is superior to a real-life model is the method of animation. Movements and actions differ from person to person in very subtle ways that are difficult to simulate but are noticeable to the human eye. Animatronic technology and stop frame animation, even when expertly executed, are seldom successful in imitating organic motion in general, never mind the motion of a specific individual. As mentioned earlier, in Terminator 2 Arnold was required to match his walk to that of the puppet rather than the other way around. Films using computer-

generated characters, like Terminator 3, employ motion capture technology to record the actual motion of the real-life actor in a three-dimensional space. This motion data is transferred onto the digital character for accurate and realistic animation. For the finale of Terminator 3 the villain Terminatrix, the T-X (Kristanna Loken), loses her human-looking exterior and only the robot underneath remains. Even though all visual reference to Loken has disappeared, it was still essential to get her motions into the character's animation and her expressions into the facial animation.

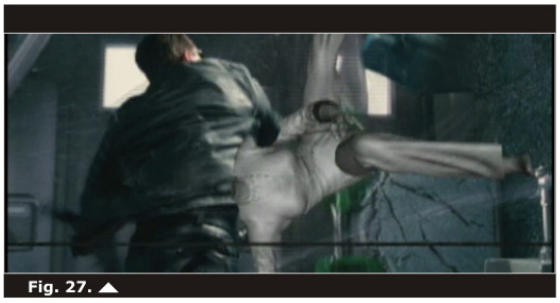


**Fig. 27.** Digital model of Kristana Loken before realistic textures have been applied . "T3 Visual Effects Lab", Terminator 3: Rise of the Machines. Prod. Michael Meadows, and Mitchell Taubin . Columbia TriStar Home Entertainment, 2003. DVD.


**Fig. 28.** Digital model of Arnold Schwarzenegger and Kristana Loken. "T3 Visual Effects Lab", Terminator 3: Rise of the Machines. Prod. Michael Meadows, and Mitchell Taubin . Columbia TriStar Home Entertainment, 2003. DVD.

In analogue film production the only means of recording information were sound (tape) and film. In the digital era other methods of capturing data, such as motion capture, are incorporated into the digital cinema mix. Digital extras and stunt doubles, also called synthespians, are a fixture in current effects-based films. They are not only more affordable but also safer than the human equivalent, and are frequently used instead of stunt doubles. It has become common practice in effects films to digitally scan in all the principal actors at the outset of filmmaking. Often during editing and postproduction it is realised that small shots not captured during filming are needed. These can be artificially created using the digital double, rather than having to spend money on bringing the actor in for another shoot (Rickitt 243).

**3.4 Morphing**

The subject of morphing has received a lot of attention from both the academy and the industry in recent years. Most academic works on special effects, such as Norman M. Klein's The Vatican to Vegas: A History of Special Effects, include sections about morphing. Vivian Sobchack's book Meta-Morphing; Visual Transformations and the Culture of Quick Change, consists of essays about aspects of morphing.

Although The Terminator contained no elements of digital morphing, the earliest morphing software had been used in the film Tron (Lisberger 1982) two years earlier, as mentioned in Chapter One. However the credit for bringing computerised morphing to the attention of a wide audience is generally given to Terminator 2.

The metamorphosis of the mercurial T-1000 was approached by the ILM team as a transformation through five metamorphic stages: The first a blob, then three chrome men in various degrees of human likeness, and finally the realistic human, usually performed by Robert Patrick. For the stages closest to the actual human shape of Patrick, extremely accurate data was obtained by observing him, filming him, rotoscoping him and scanning him. By painting his body with gridlines the filmmakers were able to achieve fairly accurate rotoscoping of his walk and run cycle. This included a barely noticeable limp from an old athletic knee injury (Ling, "The Ultimate T2" 2001).

Special software had also been created to assist with the T-1000 effects. One was Body Sock Software, designed to make completely unrelated pieces of CGI geometry look as if they were in actuality one single mesh. Another was Make Sticky software, which enabled two-dimensional background plates to assume three-dimensional form as they were animated. This was used extensively in the scene where a security guard in the mental institution is getting some coffee from a vending machine. The checkerboard floor behind him rises up into the form of the T1000, at first dragging the chequered pattern with it before becoming metallic. Make Sticky was also used in the scene where Robert Patrick walks straight through the security bars (Wolf 92).

The scene in Terminator 2 where the T-1000 acquires a helicopter, illustrates the five smooth mercurial movements of the morph used by ILM (see figs. 29 and 30). At the time of the making of Terminator 2 this motion seemed extremely fluid, but the technique used could be compared to modelling with a soft pliable substance like clay. Terminator 3, having to outdo its predecessor, used an even more fluid-looking effect requiring particle simulation running over a metal endoskeleton before morphing into specific shapes. The filmmakers felt that combining the solid metal endoskeleton seen in the first Terminator with the morphing ability of the T-1000 in Terminator 2 made the T-X the ultimate killing machine. It also gave ILM the opportunity to demonstrate new fluid simulation techniques created especially for the film.

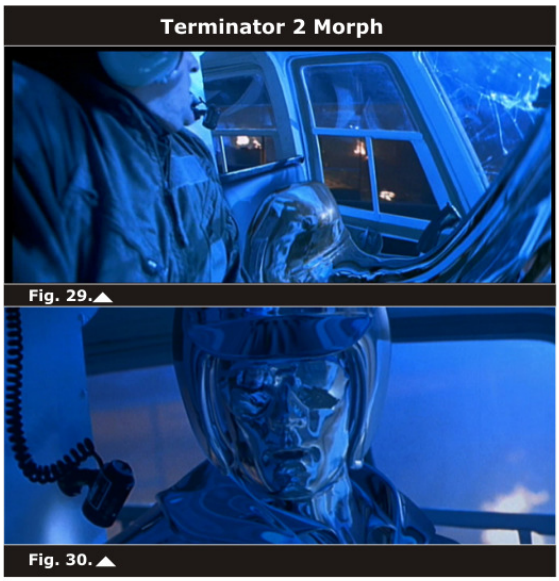


**Fig. 29-30.** The T-1000 morph using digital geometry shapes. Terminator 2: Judgment Day, Dir. and writ. James Cameron. 1991. Momentum Pictures. 2001. DVD.


**Fig. 31-32.** T-X Liquid simulation used for morphing. Terminator 3: Rise of the Machines. Dir. Jonathan Moston. 2003. Columbia Tri Star Home Entertainment, 2003. DVD.

Certain sequences could only be visualised on a computer. An example is the climactic sequence in which the T-X's skin literally melts away from her endoskeleton (see figs. 31-32). Helman knew that fluid simulation would be the focus of their research after reading the script for Terminator 3. The effect was accomplished after working for eight months with a team from Stanford University who had written fluid simulation engines. It required a combination of motion capture, bluescreen photography, and matchimation

of Kristanna Loken's actions and facial expressions to create a digital double of her face. The virtual model of the face geometry was filled with digital particles which were put through a fluid simulation. Fluid simulations are generally unpredictable, but the T-X effects required control over the viscosity and mass of every little strand of liquid metal.

Another morphing sequence in Terminator 3 allows the viewer to see the entire transformation over some time. The morphing of the T-X in the graveyard scene as she walks, from the heroine's boyfriend, into the robot figure and finally back into her usual shape of Loken, happens in an elaborate 180 degree camera rotation which simultaneously tracks her motion.

As already explored in the above examples, camera movement has been affected by technological limitations and technological advances. Allen notes that early digital effects in films like Willow and The Abyss usually used still cameras or very slow tracking shots, and featured the digital imagery either in shots separate from the shots containing the actors, or kept the effect and the actors on separate sides of the frame. This is very similar to analogue effects. In Terminator 2 the digital animation is often tracked; the implication is that, as only real objects in front of the camera can be tracked, what one is witnessing must be real. While there is more camera motion in Terminator 2, there is still the tendency to keep the motion frontal to the digital image (Allen 111).

In Terminator 3, however, as illustrated by the T-X morphing in the graveyard, the camera motions are overt and draw attention to themselves. The sweeping 180 degree movement, displaying a continuous live action environment, helps to reinforce the apparent reality of the digital effect situated within it. Once again a dual purpose is served: while reinforcing the spatial reality of the image the camera movement also draws attention to itself as something special and out of the ordinary.

The tension between the real and the illusionary is central to the appeal that Baroque and Neo-Baroque art forms have for their spectators. Ndalianis comments that the

relationship of the spectator to the image requires a simultaneous acceptance of the fantastic illusion both as a technological achievement and as an alternative reality (214).[11]

The audience and its expectations are a significant driving force behind the evolution of digital cinema. So while the new technology provides new possibilities in cinematic expression and language, as described above, the way in which these are visualised is also influenced by the audience. This will be discussed in the next chapter.

11 With reference to Baroque artist,Andrea Pozzo's painting on the S. Ignazio Church ceiling (Rome, 1691-1694), Ndalianis explains how the advancement in mathematical systems and understanding of perspective enabled the artist to achieve the illusion of artificial space in an illusionist style of paintings called *trompe l' oeil* in French or translated into English, "deceive the eye". "Embodied in this ambivalence for spectacle is a clash of opposites that connect the rational and technological with irrational and emotional in a union configured by special effects" (214).

# CHAPTER 4: TERMINATOR AESTHETIC ANALYSIS

The previous chapter explored the production techniques used to create the effects in the Terminator films. This chapter will examine the aesthetic presentation of the effects, the audience's reception of these, as well as the significance of the actors and creators of the films. It will be argued that changes in film construction (such as story changes, cinematic pace, framing and cinematography), made specifically to enhance the visual effects, have affected the language of cinema.

## Role of the Audience

As discussed in the previous chapter, the presentation of digital effects often serves the dual purpose of grounding the effect in reality and offering it to the audience as something new. Thus the length of the shots depicting the morphing Terminators in Terminator 2 and Terminator 3 are much longer and stand out against the quick, flaw-concealing cuts used with physical models. In The Terminator scene in which Schwarzenegger removes his damaged eye, the camera continuously cuts back and forth between the real actor and the model to reinforce the reality of the model for the audience. In Terminator 2 a single lingering shot stays focused as the strange Stan Winston model of the T-1000 with its head blown open, the so-called "saucer head" model, is morphed, via digital imaging, back to a real image of actor Robert Patrick. The shot length serves the dual purpose of reinforcing the reality of the image for the audience and highlighting it as a new spectacle presented overtly for the gaze of the spectator.

A similar duality is apparent in the case of a camera moving ostentatiously around the digital effect, because this functions both to reinforce the spatial reality of the effect and to draw attention to itself so as to be admired by the audience. This is illustrated by the shot in Terminator 3, when the camera pans around the morphing T-X in the graveyard

scene; or the future scene, where the camera rises up out of the water to focus on the hovercraft. It could be argued that the complexity and elaborateness of the shot draws viewers in and helps suspend their disbelief (see figs. 33 -36).

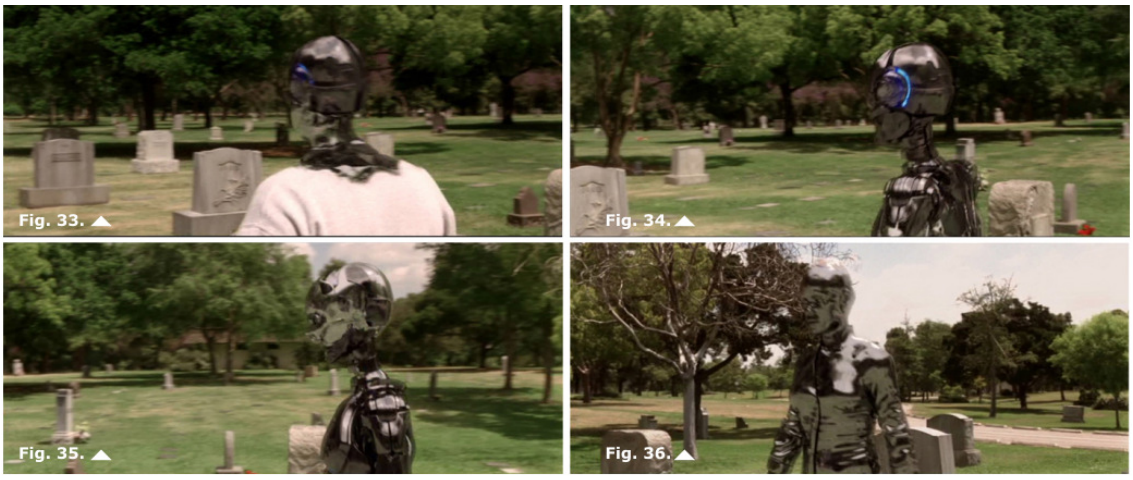


**Fig. 33 - 36.** Digital morph with 180 degree camera rotation. Terminator 3: Rise of the Machines. Dir. Jonathan Moston. Columbia Tri Star Home Entertainment. 2003.

This duality is not only obvious to audiences but has become an expected characteristic of an effects-driven film; as Cubitt puts it: "Audiences have a clear idea in their minds when offered digital entertainment: a certain seamlessness, an expectation of something new, a willingness to sever connections with the fundamental laws of nature" (The Cinema 246).

This is supported by the fact that many of the highest grossing films since Terminator 2, including Jurassic Park, Forrest Gump and Independence Day, represent a transformed role for the digital effect and narrative (Beebe 171). These films all have stories that depend on the believability and success of digital effects. Beebe notes that the actors in Jurassic Park are subordinate as "stars" to the outstanding digital effects; Forrest Gump relies on the successful compositing and digital integration of actor Tom Hanks into old footage of historical events, while Independence Day has an uncomplicated narrative focusing on the destruction of prominent historical landmarks (171).

With the success of his film, Independence Day, director Roland Emmerich made the special effects a primary focal point in the marketing material for The Day After Tomorrow (Emmerich 2004). "People didn't go to The Day After Tomorrow because of acting, directing and writing", says Scott Ross of effects house Digital Domain, "they went to see New York flooded and LA ripped apart by a twister" (Thompson 84.)

While many of the special effects in the Terminator films occur in high action sequences there are other scenes, such as that of the future war sequence in Terminator 3, which spends some time showing various scenarios from the future. Although one such scene would have been sufficient for narrative purposes, as illustrated in The Terminator and Terminator 2, Terminator 3 uses highly detailed digital creations and elaborate camera work to give the audience an in depth tour of the imaginary world. Cubitt suggests that shock and surprise are not the only non-narrative functions of the spectacle, the other is allowing the audience to contemplate and wander around the world on the screen. The attention to detail is critical because if it is convincing, there is a desire by the audience to complete a picture of that which is not actually shown. Although narrative is still essential to the success of a film, audiences watching effects driven films want to be able to project themselves into the world of the story (The Cinema 282). Cubitt proposes that "Many science fiction buffs are disappointed when a sci-fi film concludes without a shot or two contemplating the star fields of outer space (Cubitt, The Cinema 279)".

The continuing development of CGI and its increasing incorporation into film have received a mixed response of anticipation and trepidation. On the one hand there are critics who endorse the creative possibilities of digital technology, while on the other hand many critics view it as a descent into spectacular superficiality where meaning is lost in favour of visual spectacle (Lister et al. 137).

Andrew Darley (102) maintains that traditional concerns with the narrative of the story are being overwhelmed by the computing imaging techniques which have assumed a central authority in cinema. He believes that this will not cause narrative content to

disappear, but rather that this new dimension of visual display has become so distinctive that it requires recognition and analysis as a formal aesthetic element in its own right. George Lucas disagrees that digital technology voids the medium of content. He argues that the technology allows a much broader scope for the telling of stories that were previously reserved for print media (Parisi 1997). This is evidenced by the return of epic tales comparable to Lawrence of Arabia or Gone With The Wind, which had largely ceased during the 1960s due to the expense of large crowd scenes and sets (Parisi 1999).

If one reconsiders Beebe's comment that many of the highest grossing films since Terminator 2 are also films that make extensive use of digital effects, it becomes clear that there is a strong relationship between film profits and the development of digital film technology (171). Almost 50% of Hollywood films made today contain a significant number of effects, and in many cases the success of the film depends on them (Thompson 84).

As mentioned before, as was the case with Terminator 2, changes will sometimes be made to the script specifically for the purpose of displaying new visual effects. Such changes are designed to show off the technology to the audience by making the images as visually seductive as possible. The audience appreciates not only the spectacular images but also the technology behind the effect.

Since success at the box office depends on the public's reaction to a film, and since there is clearly public appreciation and demand for digital effects films, it can be argued that the audience is a major driving force behind the continuing development of digital technology in cinema. As became evident in the production analysis of the Terminator films, the technology used improved markedly from film to film. There also seemed to be an intention in each of the latter films to outdo the one preceding it, and to make this obvious to the audience by the deliberate repetition of certain sequences. For example, the chase scenes involving heavy-duty vehicles are so similar in all three films that they

invite comparison from the audience. The deliberate juxtaposition of the older robot against the newer robot in Terminator 2 and Terminator 3 can also be seen as a deliberate demonstration to the audience that the special effects are superior to those in the preceding films. The following section deals with the desire on the part of the filmmakers of the Terminator Trilogy to "show off" their special effects.

## Showing Off Technology

Heavy-Duty Vehicle Chase Sequences

Featured in all three films is a chase sequence involving a heavy-duty vehicle driven by the antagonist in pursuit of the protagonists, which ends in the crashing and destruction of the vehicle. For the climactic chase at the end of The Terminator, an oil tanker driven by the Terminator character crashes and explodes (see fig. 37). The live action sequence of the chase and crash is followed by a shot of complex miniatures of the environment and tanker, modelled to match exactly the film footage preceding it. Joe Viskocil, pyrotechnician and specialist in exploding miniatures, designed the explosives used to blow up the three-metre-long tanker model in The Terminator. Since the bomb was placed behind the real truck in the live action scene, Viskocil used forty-three explosives to animate the explosion, moving from the back to the front of the miniature (Pinteau 82). During filming the miniature tanker came apart in the first take, but for safety reasons the explosives had to be detonated anyway, destroying the miniature truck and its environment. The entire set had to be rebuilt from scratch. This illustrates the lack of control filmmakers have over physical variables in creating an analogue effect, as compared to a computer simulation which can be re-done over and over until the desired result is achieved (Meadows and Taubin).

**Fig. 37.** Miniature oil Tanker and miniature phyrotechics. The Terminator, Dir. and writ. James Cameron. Perf. Arnold Schwarzenegger, Linda Hamilton and Michael Biehn. 1984. MGM Home Entertainment, 2001. DVD.

**Fig. 38.** A digital model of a crane used in the chase sequence. As it flips its as if parts of it become unglued for dramatic effect. Terminator 3: Rise of the Machines. Dir. Jonathan Moston. 2003. Columbia Tri Star Home Entertainment, 2003. DVD.

A similar chase sequence in Terminator 2 features the antagonist chasing the protagonists in a tanker containing liquid nitrogen. Once again miniatures of the tanker and the environment were built to match the live-action footage. The final footage of the miniature tanker capsizing and sliding would later be used as a rear projection with live action in the foreground. The spilling liquid consisted of liquid nitrogen and alcohol combined to create the desired effect.

For the equivalent chase sequence in Terminator 3 (see fig. 38), the villain Terminatrix (T-X) commandeers a large construction crane in pursuit of Connor. Following the structure of the first two films, the crane is eventually destroyed in an elaborate crash. Since the sequence would require more than a thousand shots, which included the destruction of buildings and roads, a full-scale model of a three-block stretch of suburban streets and buildings was built outside the production facility. The Terminator 3 production team also purchased a crane with the intention of crashing it in the end (Holben 2).

It was later realised that physically crashing the crane was logistically impossible; it was also dangerous and could cause damage to the location in LA city. It was therefore decided that the crane would be created and crashed digitally by the 500 animators at ILM (Meadows and Taubin).

The animators were given background plates of the required empty street scene which

contained an upward camera movement to follow the flipping crane. They started with a simple model animated by hand in order to obtain client approval of the crane's motion, before beginning primary animation. This model was then placed in the background and more and more detail added until it blended photo-realistically into the background plates. Dennis Turner, technical animation supervisor, points out that there is more crash debris than one would have if a real vehicle flipped. It is as if all the parts suddenly become "unglued". If one were to count them, there would probably be more wheels flying through the air than the crane started with. Turner concludes: "it's just way over the top, but it looks so much better because of it" (Meadows and Taubin).

While Terminator 3 director Moston states that "the aim of special effects is to make the audience forget that it's an effect they're watching and [believe] that it really happened", Turner's comment emphasises the desire to astound audiences with imagery that is "over the top". While computer-generated imagery tries to veil its virtual nature through photo-realism, it simultaneously has to announce its amazing presence as illusion. Allen believes that this tension between the real and the illusionary lies at the heart of the impact computer-generated images have on spectators (Allen 114).

Atom Bombs

The foreshadowing of the predicted destruction of the planet by the simultaneous detonation of many nuclear bombs accounts for the primary motives and actions of both the protagonists and antagonists of all three Terminator films. Scenes of destruction and fighting are revealed to viewers in the first moments of the films so that they can identify what would be at stake if the protagonists fail. With the lowest budget, The Terminator does not actually expound on this initial image, but does show various instances of it through the movie. The other films do show the atomic explosions, one created physically and the other digitally. In comparing the way in which these shots are rendered in Terminator 2 and Terminator 3 one notices that there is a very different aesthetic involved. In the script of Terminator 2 the character Sarah has a dream about

the destruction of the world by atomic bomb, which is visualised in a very sensationalistic way and in great detail in the film.

The bomb in Terminator 2 is an analogue effect, constructed by Joe Viskocil with Bob Skotak of 4-Ward Productions using air guns and imploding miniatures with pyrotechnics to show the shockwave sweeping through the city. This complex shot was carefully planned since any mistakes would have meant starting from scratch (Pinteau 84).

The initial explosion is a blinding white light, followed by the shock wave and then an incinerating fire which turns the city to ash. The disintegration of the buildings is achieved with computer imaging, by Electric Image Inc., composited over the city miniatures set. The mushroom plume of the bomb is made with backlit Dacron Fibre fill pillow stuffing layered into the explosive scene on screen for only a few seconds. This is accompanied by graphic scenes of children in a playground and Sarah Connor behind a fence. They are all replaced by puppets which get incinerated by the blast. Sarah turns to ash which blows away leaving her skeletal remains behind still hanging onto the fence. It is a fast-paced and gruesome scene.

Atomic Bomb sequence: Terminator 2

Fig. 39. ▲

Fig. 40. ▲

Fig. 41. ▲

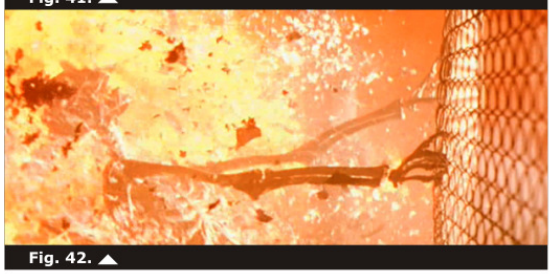

Fig. 42. ▲

**Fig. 39.** The atomic mushroom cloud created with pillow stuffing, is only shown briefly. **Fig. 40.** The atomic bomb destruction, created with models, miniatures and optically generated computer simulation. **Fig. 41.** Linda Hamilton's replica animatronic model. **Fig. 42.** Animatronic skeleton revealed after the exterior is incinerated.

**Fig. 39-42.** Terminator 2: Judgment Day, Dir. and writ. James Cameron. 1991. Momentum Pictures. 2001. DVD.

Atomic Bomb sequence: Terminator 3

Fig. 43. ▲

Fig. 44. ▲

Fig. 45. ▲

Fig. 46. ▲

**Fig. 43.** The atomic mushroom cloud created with digitally generated particle effects. **Fig. 44.** The atomic bomb launch in a pristine farm landscape. **Fig.45.** The detonation of the atomic bomb seems out of place in the tranquil landscape. **Fig. 46.** The elaborate end of the world as seen from outer space.

**Fig. 43-46.** Terminator 3: Rise of the Machines. Dir. Jonathan Moston. 2003. Columbia Tri Star Home Entertainment, 2003. DVD.

In contrast, the digital imagery in Terminator 3 is slow paced and ethereal. The first atomic explosion, early in the film, is depicted in a dream sequence of John Connor. ILM's lead artist Willi Geiger explains that a **fluid dynamics** system was used to simulate the motion for the explosion (Derakhshani 1).

The explosion effects needed a high level of detail so Geiger first worked on generating a system to avoid the memory usage problems inherent in using massive amounts of particles. Creating a 2D fluid simulation method that provided the animators with almost real-time feedback for the explosion's motion enabled them to design and tweak the flow of the explosion to get the desired result (Derakhshani 2).

The first shot consisted of the mushroom cloud, animated **volumetric** cloud rings moving out from the epicentre, and a shockwave rippling through the city. For more control during compositing all the renders were output into different lighting passes using the three inherent colour channels of the image files. The key light used on the explosions was output through the red channel, the bounce light through the green channel and the self-illumination glow of the explosion through the blue channel (Derakhshani 2). Each of these elements could then be manipulated independently.

At the end of the film, as the machines take over, dozens of bombs detonate simultaneously. Unlike the first bomb which was part of a dream sequence, this is not, yet it retains a dreamlike quality. First there are scenes of pristine landscapes in which the atomic bombs are detonated. Not cityscapes but beautiful country scenes, farmlands and open landscapes with a rich lighting reminiscent of painted landscapes.

These concluding shots from Terminator 3 are the compositions of artists who have complete control of every element on screen, the polar opposite of the harsh immediacy of the shots in Terminator 2. The bombs rise up into the sky almost gracefully. They do not really seem out of place in the scene. Perhaps this approach ie meant to emphasise that the destruction of the earth is inevitable. Perhaps the very ability of digital

technology to achieve such sensational imagery makes it difficult to resist its appeal. These landscape shots are followed by a shot from outer space looking down at the planet. Over twenty bombs are detonated simultaneously, and like a celebratory fireworks display they fill the screen in a finale of digital bombardment. The voice over by actor Nick Stahl playing John Connor is calmly announcing that Judgement Day, the day the machines take over, is inevitable. This all serves to emphasise that the world really is about to end, while simultaneously underlining the fact that digital imagery can make anything possible and aesthetically spectacular.

Moston says that each visual effects shot is like its own mini movie: it requires pre-production, production and postproduction, and forms a massive part of an action movie. It is becoming more and more common for certain digital effects shots to be undertaken by effects houses that specialise in those types of shots. Some of these companies are listed in the credits of Terminator 3 (Appendix 3). These companies will have their own storyboards, directors, digital lighters and hundreds of their own staff, who will work on a single shot independent of the rest of the film. For this reason the effects director for the film has also to oversee the work of all the effects houses commissioned to work on the film in order to maintain consistency throughout. One such company is Riot Studios, which created the scene of the bomb shelter (see fig. 47).

**Fig. 47.** Computer generated shot for the bomb shelter in Terminator 3. Terminator 3: Rise of the Machines. Dir. Jonathan Moston. 2003. Columbia Tri Star Home Entertainment, 2003. DVD.

## The Decline of the Actor as Icon

Part of the aim of this chapter is to lead discussion away from the purely technical aspects of visual effects in order to explore the changing ideology behind their cinematic use. Using as a framework the popular Action Hero film genre of the 1980s, personified by body-sculpted actors such as Arnold Schwarzenegger and Sylvester Stallone, the discussion will compare and contrast the three Terminator films in order to explore changes occurring in the period 1984-2004. It will illustrate how the displacement of the Action Hero by visual effects has brought about new cinematic narrative forms. This section builds on the essay "After Arnold", in which Rodger Beebe argues that digital technology has transformed the action genre of the 1980s, typified by actors like Arnold Schwarzenegger and in many ways has replaced them.

The Terminator Trilogy is arguably associated more with Arnold Schwarzenegger than with any other actor or even the director James Cameron. In a review of Aliens (1986), Pauline Kael described James Cameron as "the man who directed the Schwarzenegger film, The Terminator, and wrote the script for Rambo: First Blood Part II before Stallone reshaped it" (French 30), thus revealingly attesting the status of action hero superstars of the 80s like Schwarzenegger and Stallone.

Although The Terminator was neither conceived nor executed as a typical action hero film, French regards it as the film which more than any other turned Arnold Schwarzenegger into both a cult and international film star (French 30). (French notes that Schwarzenegger was already 36 years old when he was cast as the Terminator, and at the time poised for a career in the straight-to-video market or Rodger Waters style campery [34].)

Schwarzenegger was the villain in the show; the hero, Kyle Reese, was played by actor Michael Biehn, yet Schwarzenegger rose to stardom while Biehn remained virtually unknown. It is hard to make sense of Schwarzenegger's success, considering that his

role was that of a robot and therefore supposedly devoid of character development and any other human qualities (something further signalled by his very distinctive and out-of-place Austrian accent). The final climactic sequence did not even include him, featuring only the stop frame and puppet endoskeleton. Cameron explained that the role originally allocated to Schwarzenegger was the hero role of Kyle Reese. After their initial meeting, both parties decided that Arnold would be better suited playing the role of the Terminator. But when Schwarzenegger was cast as the Terminator character, the plot took a significant turn away from the original visual concept.

In "The Making of The Terminator" director James Cameron describes how in the original story the Terminator was depicted as an ordinary-looking fellow, just another face in the crowd who might at any moment step out and kill you for no apparent reason other than what you would do in the future. Co-writer William Whisher, who originally conceived of the Terminator as more of a stalking mantis-type character, comments: "Casting a 6.3 foot 220lb ripped Austrian guy is not your best under-the-radar infiltration unit" (McQueen).

The original Terminator character would most likely have been far closer to the T-1000 character played by Robert Patrick in Terminator 2, but with Arnold Schwarzenegger in tow the film took on what Cameron describes as a "larger than life hyperbolic style", (McQueen).

From the outset, The Terminator created a definite distinction between the Schwarzenegger and Biehn characters. Two minutes into The Terminator, amidst wind and lightning effects, the camera pans left to reveal a naked Arnold in the smoke. An introductory shot of Schwarzenegger is a worm's eye view of him as he stands up, emphasizing his size. His first line, "Your clothes, give them to me, now", said as he pulls the heart out of a gangster, sums up his character in under two minutes.

The story's protagonist, Reese, enters present time in the following scene. Starting with

a white frame he drops from some height, landing painfully on his side in a vulnerable foetal position. As opposed to the Terminator who lands on his feet, Reese, clearly in pain, struggles to stand and limps down the ally. For the rest of the film this impression of Reese's weakness stands in contrast to Schwarzenegger's no-nonsense character.

The Reese character played by Michael Bien has more implied interiority and there is a certain vulnerability about him. In a complex story like The Terminator, where a lot of the plot happens in a future which will not be shown to the audience, yet still has to be exposed in some way, one has to be sure not to interrupt the pace as the missing bits of the story get filled in, in this case by the character Reese. What helps to keep the pace going in The Terminator is that the story is told on the run, mixed in with the action sequences. This further reinforces the difference between the characters of Reese and Schwarzenegger. The former talks a lot about his past, while the latter, The Terminator T-101, has a specific goal and nothing stands in his way of attaining it.

Perhaps one of Cameron's motives for casting Arnold Schwarzenegger may have been technical, as is implied in this statement by Gale Hurd, the co-producer of The Terminator: "It created the idea of this unstoppable terminator and you didn't need to believe initially that there was metal under that body … the body was enough to convince people he was lethal. With the low budget of the film there was very little money for the visual effects." She also suggests that, besides Reese, Cameron wanted to make the hero a woman, the character of Sarah Connor played by Linda Hamilton. Her character could also transcend the drama as the mother who saves humanity (The Terminator 1984).

French describes how Cameron, standing just off camera, directed Schwarzenegger's every move in one particular scene, from opening his eyes to raising himself off the ground, "as if he were another of Stan Winston's stop motion models" (French 32). This indicates that there is much in common between the action hero and the effects film genres. The priority of the actor's own intuition and sensitivity to his role as the

character is less important than the spectacle of the choreography: the physical action is much like the visual spectacle of special effects.

The Terminator 2: Judgment Day, with a budget almost twenty times greater than that of The Terminator, had to do much more than just carry on the story of the original. Not only does it stand as a story on its own, it recapitulates and comments on its predecessor in a subtle and slyly comic way (French 64). In contrast to the more mechanical T-101 the T-1000 is a liquid metal robot with the ability to morph into various objects, including humans. James Cameron has remarked: "I call him a mimetic poly alloy, meaning that he's made of a substance that can imitate anything. There is a deliberate contrast to the Arnold Terminator, like a Tank versus a Porsche" (Hudson and March).

Cameron, by repeating the caption and imagery of The Terminator for Terminator 2, demonstrates his faith in the original but at the same time promises the audience more than they got before. The scene introducing the arrival of the Terminator character is a conscious reconstruction of the original, right down to the wind disturbing newspapers in the street, but thereafter we are treated to effects that supersede those in the first film. The fluid morphing of the T-1000 stands in stark contrast to the heavy bulkiness and comparative laboriousness of Arnold Schwarzenegger's movements as the old mechanical T-101. The T-1000, in its human form, is extremely slight of build. It appears that the film is deliberately making direct comparisons between old and new technology by setting them up against one another, and in this way celebrating the ground-breaking visual effects (French 66). Beebe states that "T2 was explicitly (if not exclusively) a showcase for morphing (and, by extension, for the technologies that produced it)" (Beebe 165).

This digital mutability is demonstrated, for example, in the scenes of the Pescadero State Hospital, a mental asylum where Sarah Connor is held captive. Once again Cameron is consciously raising the stakes between the first Terminator film and the second. Where

the T-101 blasted his way through a police station in The Terminator, the T-1000 has to get into the high security mental asylum. The events are almost parallel in the two films. The same psychiatrist will once again, infuriatingly, not believe the protagonists of the film, and then seem, once more, to be leaving just as the murderous Terminator arrives. This time however he is taken captive by Sarah as she tries to escape, and gratifyingly becomes a witness to the reality of the Terminators.

In contrast to Arnold Schwarzenegger's violent bombardment of the police station, the T-1000's entrance into the asylum is slick and methodically menacing. At one point he emerges from his guise as a chequered floor, rising up behind a security guard and assuming his identity. This silent, almost elegant transformation in one continuous shot displays the power of digital visual effects compared to the frequent cuts needed between puppets, models and jerky stop frame animation.[12]

For Terminator 2, many of the cast and crew from the original Terminator film returned. These included Arnold Schwarzenegger, Michael Biehn, Linda Hamilton, Director James Cameron, Director of Photography Adam Greenburg and Makeup Effects Supervisor Stan Winston, as well as all the effects houses from the first film. In Terminator 3 the only principal actor to return was Arnold Schwarzenegger. As can be observed in the credits of the films (Appendix II), the number of effects houses involved increased significantly from four in Terminator 2 to eleven in Terminator 3. The only two effects studios to return from the previous film were those which employed digital technology, namely ILM and Stan Winston Studios.

Once again the older robot T-101 played by Arnold Schwarzenegger is contrasted with a new and improved Terminator, the T-X. As all attempts were made to keep the Terminator character the same as the T-101 from the 1984 film, it still represents older

12 On another level this morph from floor to human functions as an in-house joke to CGI practitioners who are aware of the check pattern used as a mathematically generated procedural texture applied to 3D animated models in order to test the success of surface rendering and warping of textures.

technology and Schwarzenegger is still representative of the Action Hero from that time. To emphasise the power of the new Terminator against the old one she is represented as a woman strong enough to pick up Schwarzenegger and ram him through a urinal.

Synthespians more sophisticated than the disappearing human in Hollowman[13] are still prohibitive in cost, and there are ongoing debates as to whether realistic digital humans will ever be achieved. Other high-end digital effects, though diminishing in cost, are still too expensive for independent filmmakers, and can only be used extensively if the huge budget of a Hollywood blockbuster is available (Pescovitz 153).

Beebe describes this shift away from the 1980s star system as "Hollywood's attempt to overcome its reliance on the troublesome human labour of stars" (173). While this may or may not be the case, a number of "F/X Gods", to quote Thompson (84), have emerged who have acquired the same status as film stars. Cameron estimates that it costs more per second of screen time to cast the digital T-1000 than to hire Arnold Schwarzenegger.

For many years, animators and special effects artists were classified in the industry as craftspeople and not thought capable of making a movie 90 minutes long (Klein 269). Film director John Waters, in an interview about the influence of digital technology on his recent movie A Dirty Shame (2004), remarked that the "big difference I have also noticed is that digital effects people dress better than optical house people." (Kehr). This comment reinforces the notion that while until recently effects artists had been relegated to the background in the movie-making process, they were now gaining status and recognition in the film industry.

To understand the new status of effects creators, one must bear in mind that the

13 Hollowman has an elaborate shot of actor Kevin Bacon disappearing layer by layer, starting from his skin and ending at his bones. For a few seconds the whole actor is computer generated but the disappearing begins quickly before the audience has much time to focus on the CG model.

average budget for the effects on a film has risen from $5 million to $40 million in the last decade (Thompson 84). The first person approached when production started on The Day After Tomorrow was Visual Effects Supervisor, Karen Goulekas. Thompson notes that the focus of attention and the selling point of the film The Day After Tomorrow was to be the destruction of major cities such as the flooding of New York rather than the actors or actresses featuring in the film (84). In a film such as this the performance centres not on the actor but on the special effects technology's ability to create illusions. So the credit goes to "the directors and the technicians of the film studios and effects houses who orchestrate these 'theatres of the world' for the delight of the audience" (Ndalianis 190).

Effects supervisors like Dennis Muren with nine Oscars, John Dykstra with two and Ken Ralston with five, have equal status to Oscar-winning actors and actresses like Tom Hanks and Julia Roberts (Thompson 84). It could be said that visual effects have become a star in their own right, bringing status and recognition to their creators. Cubitt suggests that the creators of digital effects are not only driven to impress the audience but also their peers. Even the creators of digitally animated children's films, such as Pixar, continue to push the limits of the technology in each new film they produce (283)

From these observations it is clear that the hierarchy within the film industry has been shifting. In the twenty-year period represented by the Terminator Trilogy the changes have been significant. Whereas once actors and directors were perceived as the most important assets to a film, in the digital era the visual effects supervisors and the visual effects themselves are moving up the chain. Where photography in the form of live action was dominant in the film industry for almost one hundred years, in the short time period spanned by the Terminator Trilogy, digitally created imagery began to supersede it.

These significant changes have brought about changes in the critical understanding of cinema, as exemplified in Manovich's insights. As he has suggested, it has become

necessary to adjust previous assumptions regarding the fundamental nature of cinema. This will be discussed in the Conclusion.

# CONCLUSION

Manovich has argued that the advent of the new media means that the very concept of cinema should be reconsidered, while Cubitt insists that digital technology only expands the existing possibilities of cinema. This study was therefore undertaken to investigate how and to what extent the New Media revolution has transformed the identity of cinema, and to establish whether it has indeed altered the basic language of cinema. These aims have been achieved through technical and aesthetic analysis of the Terminator Trilogy over the period of the integration of digital technology into the film-making process.

## Digital Magic

To conclude, this section returns to the magicians of the 19th century described by Barnouw as the pioneers of early cinema, who saw beyond the physical technology of the cinematograph to the magic it was capable of delivering to an audience willing to suspend disbelief (3-9). The spectacular demonstrations of technical mastery and the incorporation of cinema in the magic shows seem to be mirrored by the increasing incorporation of digital visual effects into film, as illustrated above in respect of the Terminator Trilogy. The magicians' role in early cinema as described by Barnouw (85–105) can be broadly divided into three phases. In the beginning the magicians' repertoires contained no cinematic elements, although other new technologies were frequently incorporated into the show in the form of magic tricks. As soon as the novelty wore off the tricks were replaced with new ones. In the second phase, film was added as a novelty to enhance the show. It appeared first in the form of short documentaries, but later magicians recorded their tricks onto film and used optical effects to create a new type of entertainment called the trick film. It was during this time that the medium began to evolve a language of its own, bypassing the tricks of the magicians which were no longer necessary. In this third phase the cinematic show replaced the regular magic performance and started to develop into the popular form we know today. The images,

once viewed as something spectacular and magical, had become transparent to the audience, and the film began to perform a new function, the function of a language. Many factors contributed to this change, including the incorporation of new technology, the demands of the audience, and the artistic and aesthetic decisions made by the filmmakers.

The development between the three Terminator films can be equated to the three phases of the magicians' history. The first film, The Terminator, uses traditional analogue effects at the peak of their development. It even makes innovations, such as the use of Vaseline on glass to simulate motion blur in the stop-frame animation of the Terminator model. This can be likened to the use of new technology in the magic shows of the past.

Similar to the cinematic elements of the magicians' second phase, Terminator 2 employs digital visual effects as well as analogue effects, yet the purpose of the digital effects is not to replace the analogue effects but to enhance them. The elaborate analogue puppets created by Stan Winston of the T-1000 (such as the saucer head puppet), which are blown apart when shot at by Schwarzenegger, would visually have stood out significantly in relation to the live action in pre-digital cinema. Before digital technology the nature of the model's origin would have been betrayed by the necessity to employ a stationary camera for creating stop-frame animation. Alternatively, cutting between a puppet and a live-action scene, as was done in The Terminator and Terminator 2 (specifically in scenes with duplicate models of Arnold Schwarzenegger), make the sequences stand out from the rest of the live action. As described previously, Manovich has indicated that such cuts or montages have been used purposefully to juxtapose elements for aesthetic and emotional reasons (158). In Terminator 2 the digital effects were incorporated into the analogue special effects rather than replacing them. The digital morph of the T-1000, between the puppet and the live action, bridges the artificial to the real through digital simulation rather than cutting the shot. In this way the analogue effect is enhanced in a similar way to that in which the magicians enhanced

their shows by showcasing moving images. In this respect Cubitt's argument that digital technology expands the existing possibilities of cinema is valid, because Terminator 2 used all the old analogue techniques and enhanced them by incorporating the digital into the shots.

In the last film, the technology, like early cinema in the third phase of its development, replaces what has come before. As illustrated in the analysis of the Terminator films, the incorporation of digital technology increased throughout the period 1984–2003. Terminator 3 employs large quantities of digital effects that have replaced analogue methods of effects creation, stuntmen and on some occasions even the actors themselves. Although the capabilities of the new technology are, as Manovich observes, used mostly to "solve technical problems while traditional cinematic language is preserved unchanged" (309), it is significant that the analogue technology is being replaced by digital technology. If we continue the comparison of the Terminator Trilogy to the development of early cinema language, the replacement of analogue film techniques with digital technology opens the way to the development of a new language.

Although the digital effects in Terminator 2 had achieved a convincing level of realism, they were still depicting fantastical subject matter and could therefore still be identified as artificial images. Terminator 3 also contained many overtly fantastical images, but there were also some artificially created shots that did not draw attention to themselves, such as the scene showing the exterior of the bomb shelter. This set, which looks like a photograph, is completely computer generated and has no referent in reality as a photograph would have. The switch between live action and CGI is almost imperceptible within many shots: it does not necessarily happen from one frame to the next, but can occur in different regions of the frame at different times within the sequence, as is demonstrated in the bathroom fight sequence between the T-101 and the T-X in Terminator 3. In consequence, the malleability of the data in the digital realm results in the live action not being clearly distinguishable from the animation. In this respect Manovich seems correct in his argument that cinema can be redefined as a particular

case of animation that uses live-action footage as one of its many elements (302). Therefore it can be said that the identity of cinema has indeed changed.

For many years cinema has been understood and analysed as a "filmed medium", something created on film in front of a camera. The word "film" has become synonymous with the words "cinema" and "movie" and the three terms can be used interchangeably. Before digital technology, even hand-drawn animation was at some point photographed onto film in order to be displayed as a continuous body to an audience. So film, as a medium, whether used for live action or animation, has, for almost a hundred years, been an integral part of the cinematic process. All the visual elements of The Terminator – the live action, stop-frame animation, puppets and miniatures – were essentially captured in front of a camera onto film. Terminator 2, on the other hand, incorporated the T-1000 images as data created on a computer along with the filmed images created in the traditional way. But Terminator 3 as a cinematic form is better described as a 'data captured' entity than as a 'filmed' entity. Data gathered from many sources included filmed elements such as the live action, computer-generated elements like the Terminators, scanned elements such as the 3-D scans of the actors, and photographic stills used to texture the 3-D models. The ease of manipulation of digital photography has weakened its value as a documenter of reality. Mitchell has argued that the inherent mutability of a digital image invites modification by its creator, as a painter would alter his painting until it conveys the desired message (7). In the aesthetic analysis of Terminator 2 and 3 it has been demonstrated that Mitchell's argument applies to cinema as well. In the scenes such as the atomic explosions and the future war sequences, the digital manipulation of detail, composition and even live action has become the norm rather than the exception. With the increased flexibility of the cinematic medium the Terminator directors, Cameron of Terminator 2 and Moston of Terminator 3, had the opportunity to elaborate on the visual imagery of the films, in a way consistent with a Neo-Baroque aesthetic as discussed by Nadalianis (187). As illustrated in the previous chapter, many shots in Terminator 3, although maintaining a photo-realistic look, were concerned more with the aesthetic of the digital image than with the imitation of reality.

This supports Manovich's view that as cinema enters a digital age it is no longer an indexical media technology, but rather a sub-genre of painting (Manovich 295).

However, the question of whether a new language of cinema has developed remains to be answered. The phrase "language of cinema" is used in this paper to mean the various conventions used by the director of a film to organise data and structure the audience's experience. It has been established in the study that the formal parameters of film such as shot length, framing and camera movement changed during the making of the Trilogy for technological as well as aesthetic reasons. So while the digital effects are set apart in terms of what can be depicted, the goal has been to achieve a seamlessness between the animation and live action, digital and real, so that the flow of the film is uninterrupted.

As mentioned before, digital effects have always strived to mimic the photographic image, and this is apparent throughout the Trilogy. Even though the images have become aesthetically more spectacular, they still strive to maintain a foothold in photographic reality by following the fundamental laws of nature such as gravity, momentum, velocity and even motion blur. They also establish themselves as a part of the live action by affecting and being affected by the environment, in terms of reflections and shadows as well as the simulation of atmospheric perspective and depth of field, all of which help them to appear to inhabit a real three-dimensional space. On the surface, then, it would appear that Cubitt is correct that digital technology only expands the possibilities available to cinema because the focus has been on creating spectacular visual imagery while emulating classical film language (The Cinema 8). In both Terminator 2 and Terminator 3 the digital special effects are highlighted as magical and spectacular in two ways identified by Cubitt ("Observations" 282). The first is the capacity for digital effects to shock and awe, such as the morphing T-1000 or the crashing of the crane in Terminator 3. The second is the result of the elaborate details of the scenes, such as the atomic bombs detonating at the end of Terminator 3, which invite viewers to lose themselves in the artificial world.

In the comparison of the three Terminator films it emerged that there are many instances where digital cinema technology has achieved a more accurate emulation of the established language of classical cinema and live action, rather than something new. This is consistent with Manovich's comment that commercial cinema tries to simulate the classical realist style in which images act as photographic shots which took place in front a real camera (Manovich 309). Various analogue special effects in The Terminator and Terminator 2 had placed limitations on the camera, such as stop-frame animation's requiring a static camera, or the necessity of keeping the camera on one focal plane for front or rear screen projection and optical compositing techniques. There was also the need to hide the fact that models were being used by cutting between shots of the model and shots of live action. Cameron and Moston both used the capabilities of digital imaging to imitate live-action cinematography, but at the expense of some well-established characteristics of classical cinema. Some of the limitations, such as the necessity to have cuts between shots, have become a part of the language, for instance a series of quick cuts is associated with action and suspense. In some digital shots this aspect of the language is foregone in favour of having the camera focusing on the effect for a long period of time.

Digital cinema has given directors the freedom to move the camera as they wish in order to achieve the shots they desire, and in the Terminator Trilogy this freedom is used largely to maintain consistency with the language of classical cinema. As classical cinema aims to position the spectator in terms of the best viewpoint in each shot (Manovich 108), digital cinema attempts to do the same. However there are now new possibilities beyond the scope of classical live-action cinema, and a few of these were illustrated in Terminator 3. The shot of the future war, where the camera starts underwater and emerges without a drop of water on the lens, moves in one smooth motion without the necessity to cut at any point, to change lenses or to refocus, is unique in that it has abandoned the simulation of a real camera in favour of positioning the spectator at an optimum viewpoint. The other shot of the future war, where the camera spirals up

unnaturally rapidly and smoothly, seems to be influenced more by a computer game environment than a real camera. There are also shots which deliberately abandon the simulation of reality in favour of the visual appeal of the image, such as the crashing of the crane where the wheels and debris flying through the air outnumber those on the crane. Subtle changes of this nature in the way films are being constructed could point towards the beginnings of the development of a new cinematic language.

The narrative in the Terminator Trilogy functions, as it does in many other effects-driven films, to motivate the use of elaborate effects and at the same time, as Cubitt argues, to explain the uncanny away ("Observations" 282). Cubitt points out that the motivation behind the creation of digital effects like those in the Trilogy is the need to be 'cutting edge', to push the technology to its limits and to keep offering something new to the audience. This suggests that in time viewers will no longer be thrilled and amazed by the images they are seeing, but – again like the third phase of the magicians' use of cinema – this does not mean that the elements concerned will disappear. It may be that the images which now seem spectacular will become ordinary, and unexplored possibilities of the digital medium may form a new language. Although old characteristics such as the jerky stop frame or the motion blur could be returned to, these elements may also fade away into history, like the Trick Films did as cinematic language established its classical form.

Manovich suggests that the history of cinema may not be a linear march towards one language or a progression toward increasingly accurate verisimilitude. There may be a succession of distinct and equally expressive languages, each with its own aesthetic variables, and each closing off some of the possibilities of its predecessor (314). As was demonstrated by the analysis of the Terminator Trilogy, the introduction of digital technology has not only made available new visual possibilities, but has also influenced the formal elements and structure of the film. Some distinctive characteristics of classical film have been rendered obsolete or optional, such as motion blur and miniature pyrotechnics and even (in Terminator 3) stunt men. Although digital films still cling to

the language of classical cinema, the way is open for the development of a new language because digital technology has already replaced the older technology. As the magical and spectacular edge of the technology wears off and becomes commonplace, these new digital characteristics will not only become more common, but will also form the foundation for new potential languages. Until then it remains to be seen whether digital effects will give birth to a new language, in the way that magic shows gave birth to cinema.

# APPENDIX I

## Glossary

**Analogue** special effects include any physically created special effects, effects filmed on camera and optical effects created by using the properties of light sensitive photochemical film. This is in contrast to data stored digitally in numerical values.

**Animation.** This is the process of photographing models, puppets or artwork in such a way that it appears to move. A series of images are made and each shows a slight change to the one before. When these images are displayed or projected in rapid succession the figures appear to move.

**Animatronic.** Objects and models which are controlled pneumatically, hydraulically or with rods, cables or motors which appear to give a life like movement to inanimate objects.

**Bluescreen.** A screen is carefully prepared to be placed behind performers or actors when they are filmed to produce digital or optical travelling mattes. This enables the background to be removed and another to be put in its place. Some screens used translucent blue material which was lit from behind with fluorescent tubes to intensify the colour. Recently other monochromatic colours, such as green, have been used.

**Blue Spill.** This is any blue light, which is reflected of the screen during the blue screen process. This must be corrected otherwise during the compositing process this area becomes transparent.

**CGI (Computer-generated/graphic Imagery).** This is any two or three dimensional images created entirely by computer.

**Composite**. This refers to the actual process of combining various images, digital or analogue, into a final image. This can be done in-camera, in an optical printer or on a computer.

**Cubic reflection environment.** Six images representing six views of the live action are arranged into a cube around the object so that the reflections and refractions on the 3D object are consistent with the set and appear to have been filmed there.

**Depth of Field.** The distance behind the camera which appears to be in focus. The depth of field is affected by the focal point of the camera. When objects near to the camera are in focus but those a few feet behind are not, this considered to be a 'short' ('narrow' or 'shallow') depth of field. A 'deep' field is when objects near and far are in focus.

**Digital.** This is a method of recording storing and transmitting sounds, images and data in a binary form (a combination zeros and ones) without loss of quality in spite of being copied several times. For the creation of visual effects by computer it has proved very effective and efficient.

**Digitise.** This is the process of converting information or images so that it can be used or changed on a computer.

**Fluid Dynamics.** The study of fluid motion. The scientific study of the forces acting on liquids and gasses and the resulting movements of these fluids in order to simulate them by computer using the mathematical rules.

**Forced perspective.** This is a deliberate attempt to alter the perspective of the depth or size of a scene for example to make objects smaller in relation to the objects around them so that they appear to be further from the camera than they really are.

**Front screen projection.** This is a method of simultaneously filming performers in a studio and pre-filmed background images. By using the correct angles these can be projected on to mattes. This can also be used to combine live action and mattes paintings.

**Ghosting.** This occurs because the two images, which, due to the nature of celluloid film are transparent and are therefore visible through one another giving a ghostlike appearance.

**Go-Motion.** A sophisticated variation of stop-motion animation in which the puppet is pre-programmed to perform each incremental move while the shutter of the camera is open. This creates a life-like motion blur.

**Greenscreen.** See Blue Screen.

**In-camera Effects.** This is any visual effect which can be achieved during filming without using an optical printer or any other process at a later stage.

**Matchimation.** A newly developed 3-D rotoscoping technique.

**Matte line.** This is the line where separately created and composited images meet. Matte lines also called 'minus' lines, occur if the composited elements are misaligned by a mere thousandth of an inch resulting in a fine black outline around the image making it seem pasted into the environment.

**Mattes.** This is any form of mask which prevents light reaching a particular portion of a film. This unexposed area of film will usually receive have another image from a different source at a later stage. A travelling matte is a matte which follows the motion of an object. A hand drawn matte is a matte which cannot be created optically and is therefore created manually for every frame.

**Motion Blur.** This is the blurring which occurs when an object moves while it is being filmed if its speed exceeds that of the film moving in the camera.

**Motion capture.** This is the digitally recorded or captured movement of particular defined points on the body of an actor in relation to real three-dimensional space. This data can then be used for the animation of computer-generated characters.

**Motion control.** This is the digitally recorded movement of a robotic model or camera which can be reused so that the model or camera repeats the same motion indefinitely. When CG effects need to be placed together with filmed action, the images need to be 'filmed' with identical camera movements to get a realistic result.

**The "normal".** A computer graphics term referring to the value of the perpendicular to a surface point on the surface of digital object

Optical Effects.

**Physical Effects.** Any effects that are physically achieved on set during filming, including the use of pyrotechnics, atmospherics and large-scale mechanical props. Also known as 'mechanical effects'.

**Prosthetics.** False limbs, noses, or other appendages which are seamlessly fixed on to the face or body of a performer.

**Pyrotechnician.** The person who creates explosions and bullet hits by using real explosives and other highly flammable materials.

**Raytracing.** A resource intensive render technique calculating, amongst other values, those of bounced light and reflection throughout the entire scene. The result is a realistic simulation of light, shadows and reflections.

**Rear Screen Projection.** A method of combining live-action foregrounds with pre-filmed background scenery. Actors perform in front of a translucent screen which has still or moving images projected on to it from behind. A camera films the composite image.

**Rendering (render passes).** The final process in the production of computer-generated images. During rendering every instructional aspect of a 3-D scene (lighting, camera, geometry, texture, maps, animation, etc.) is studied by rendering software in order to calculate the final 2-D image. Diffuse pass, Shadow Pass, Reflectivity Pass, Specular Pass (Highlight Pass) Depth pass (Z-Depth or Depth Map), and Occlusion Pass

**Resolution.** The quality of a digital image expressed in terms of pixels or pixels per unit area.

**Rotoscoping.** A photographic/projection device simply projects the film image downwards, frame by frame allowing specific elements to be traced by hand. If generating a matte painting the traced area will be painted a solid black. The rotoscope locked in exactly the same position is loaded with high contrast film and converted into a camera which photographs the artwork a frame at a time.

**Stop Frame Animation.** A method of animating models by physically altering their position in between the photography of each frame. When the resulting images are projected at the normal speed, there is the illusion of autonomous movement. Also called 'stop-action' or 'stop motion'.

**Texture map.** A method of adding colour or surface detail to digital models. To create texture maps, photographs or artwork of surfaces and patterns can be scanned into the computer, or created using digital paint software. Texture maps are then applied to the model using mapping co-ordinates to ensure that they fit correctly. As well as adding 2-

D detail to a model, certain texture maps can change the appearance of a model's shape.

# APPENDIX II

**Terminator Film Credits**

**The Terminator (1984)**

Terminator T-101 Series 850: Arnold Schwarzenegger

Kyle Reese: Michael Biehn

Sarah Connor: Linda Hamilton

Director: James Cameron.

Special Make-up and Terminator Effects: Stan Winston.

Special Visual Effects: Fantasy II Film Effects, Supervisor: Gene Warren Jnr. Terminator

Stop Motion: Peter Kleinow

Optical Effects: Image 3

Special Effects: Rodger George and Frank DeMarco

Terminator Special Effects: Shane Mahan, Tom Woodruff, John Rosengrant, Richard Landon, Brian Wade, David Miller, Jack Bricker

Terminator Mechanical Effects: Ellis Burman, Jr., Bob Williams, Ron MacInnes (assistant)

Special Effects Coordinator/Graphic Animation Effects/ Main Title Design: Ernest D. Farino

**Terminator 2: Judgment Day (1991)**

Terminator T-101 Series 850: Arnold Schwarzenegger

Kyle Reese: Michael Biehn

Sarah Connor: Linda Hamilton

John Connor: Edward Furlong

T-1000: Robert Patrick

Director: James Cameron.

Visual Effects Supervisors: Dennis Muren and Robert Skotak.

Special Make-up and Terminator Effects: Stan Winston.

Computer Graphics: Industrial Light and Magic.

Optical Photography Supervisor: Bruce Vecchitto.

Special Visual Effects: Fantasy II Film Effects, Supervisor: Gene Warren Jnr.

Special Visual Effects: 4ward Productions, Supervisor: Robert Skotak.

Terminator POV/Graphics Displays: Video Image.

Digital I\mage processing: Pacific Data Imaging

Academy Awards: Best Visual Effects, Make-up, Sound and Sound Effects Editing.

**Terminator 3: Rise of the Machines (2003)**

Terminator T-101 Series 850: Arnold Schwarzenegger

TX: Kristanna Loken

John Connor: Nick Stahl

Kate Brewster: Clair Danes

Director: Jonathan Moston

Visual Effects Supervisor: Pablo Helman

Digital Animation Supervisor: Dan Taylor

Production Supervisor: Greg Alpert

Production Designer: Jeff Mann

Animatronic and Make-Up Effects: Stan Winston

Animatronic and Make-Up Effects Supervised: John Rosengrant

Special Visual Effects and Animation: Industrial Light and Magic.ILM

*Visual Effects Producer: Gretchen Libby*

*Visual Effects Art Director: Peter Rubin*

*Visual Effects Associate Supervisor: Samir Hoon*

*Computer Graphics Supervisor: David Meny*

*Technical Animation Supervisor: Dennis Turner*

*Digital Compositing Supervisor: Jeff Doran*

*Digital Model Supervisor: Russell Paul*

Visual Effects: Digiscope. Supervisor: Dion Hatch

Visual Effects: Riot. Supervisor: Kenneth Nakada

Visual Effects: Giant Killer Robots. Supervisor: Rich McBride

Visual Effects Photography and Model: New Deal Studios. Supervisor: Ian Hunter

Visual Effects: Sand Box Pictures: Supervisor John P. Nugent

Visual Effects: Beau LLC. Supervisor: Beau Cameron

Visual Effects: Digic Pictures Hungary. Supervisor: Gabor Marinov

Visual Effects: Hydraulx. Supervisor: Greg Strause

Computer Graphics: The Useful Companies, Inc. Supervisor: Justin Owen

Digital Intermediate: Efilm

## WORKS CITED

A.I. Artificial Intelligence, Special Edition. Dir. Steven Spielberg. Warner Bros., 2001. DreamWorks Video, 2002. DVD.

Allen, Michael. "The Impact of Digital Technologies on Film Aesthetics". The New Media Book. Harries, Dan, ed. London, British Film Institute. 2002. 109 -118.

Babe (Widescreen Special Edition). Dir. Chris Noonan. 1995. Universal Studios, 2003. DVD.

Barnouw, Erik. The Magician and the Cinema. New York, Oxford: Oxford University Press, 1981.

Bazin, André. "Cinematic Realism". The Philosophy of Film: Introductory Text and Readings. Curran, A. and Wartenberg, TE (eds). Oxford: Blackwell Publishing. 2005. 59 – 69.

Beebe, Rodger Warren. "After Arnold", Visual Transformation Meta Morphing and the Culture of Quick-Change. Minneapolis. University of Minnesota Press, 2000. 159 – 179.

Blade Runner. Dir. Ridley Scott. Perf. Harrison Ford. Warner Bros., 1982. Warner Home Video, 2007. DVD.

Block, Bruce. The Visual Story: Seeing the Structure of Film, TV, and New Media. Boston: Focal Press, 2001.

Burni, Robert. Dir. "Making of Tron". Tron, 1982. Buena Vista Home Entertainment. 2002.

Buckland, Warren. "Between Science Fiction Fact and Science Fiction." Screen 40.2. London: Society for Education in Film and Television. Summer 1999. 177-192.

Cameron, James. Dir. and writ. The Terminator. Perf. Arnold Schwarzenegger, Linda Hamilton and Michael Biehn. 1984. MGM Home Entertainment. 2001. DVD.

Cameron, James. Dir. and writ. Terminator 2: Judgment Day. (The Ultimate Edition DVD). Perf. Linda Hamilton, Robert Patrick and Arnold Schwarzenegger, 1991. Momentum Pictures, 2001. DVD.

Close Encounters of the Third Kind (Two-Disc Collector's Edition). Dir. Steven Spielberg. Columbia Pictures, 1977. Sony Pictures, 2001. DVD.

Cotta Vaz, M and Duignan, P R. Industrial Light & Magic: Into the Digital Realm. London. Virgin. 1996.

Cubitt, Sean. The Cinema Effect. London: The MIT Press, 2004.

---."Observations on the History and Uses of Animation Occasioned by the Exhibition Eyes, Lies and Illusions Selected from Works in the Werner Nekes Collection." Animation: An Interdisciplinary Journal. Vol 2(3). 2007. 49 – 66. Accessed on: 11 July 2008. < http://anm.sagepub.com>

---."The Cinema of Attractions." Animation: An Interdisciplinary Journal. Vol 2(3). 2008. 275–286. Accessed on: 11 July 2008. < http://anm.sagepub.com>

Curran, Angela. and Wartenberg,Thomas E (eds). Introduction. The Philosophy of Film: Introductory Text and Readings. Oxford. Blackwell Publishing. 2005.

Darley, Andrew. Visual Digital Culture: Surface Play and Spectacle in New Media Genre. New York: Routledge. 2000.

Derakhshani, Dariush. "Terminator 3: Rise of the Explosions". VFX World. 10 July 2003. 1-2. 4 July 2008 <http://vfxworld.com/?sa=adv&code=f9c2669f&atype=articles&id=1797>

Forrest Gump (Two-Disc Special Collector's Edition). Dir. Robert Zemeckis. Perf. Tom Hanks. 1994. Paramount Pictures, 2001. DVD.

French, Sean. The Terminator. London: British Film Institute. 1996.

Holben, J. "Heavy Metal: The Unstoppable Cyborg Returns in Terminator 3," American Cinematographer 5.11 Aug 2003:Vol 84, Number8. 1-3. 20 Nov. 2007 <http://www.theasc.com/magazine/aug03/cover/index.html >

Hudson, David and March, Ed. Dir. "The Making of Terminator 2: Judgement Day". Prod. Larry Kusanoff. 1991. Carolco Pictures. Terminator 2: Judgment Day. The Ultimate Edition DVD. Momentum Pictures, 2001. DVD.

Independence Day. Dir. Roland Emmerich. Perf. Will Smith, 1996. 20th Century Fox, 2003. DVD.

Indiana Jones and the Last Crusade (Special Edition). Dir. Steven Spielberg. Perf. Harrison Ford and Sean Connery, 1989. Paramount, 2008. DVD.

"Industrial Light and Magic: A Lucas Film Company", 2005. Paramount Pictures and Dream Works. Accessed on: 2 May 2008. <http://www.ilm.com/awards_academy.html>

Jason and the Argonauts. Dir. Don Chaffey. Columbia Pictures, 1963. Sony Pictures Home Entertainment, 2005. DVD.

Jurassic Park. Dir. Steven Spielberg. Perf. Sam Neill and Laura Dern, 1993. Universal Studios, 2000. DVD.

Kehr Dave. "A Face That Launched a Thousand Chips." The New York Times. Oct 4 2004. Accessed on: 05 March 2007 <http://query.nytimes.com/gst/abstract.html?res=F40614F7385E0C778EDDA90994D404482&incamp=archive:search>

Klein, Norman M. The Vatican to Vegas: A History of Special Effects. New York: The New Press. 2004.

Lerner, Jeffrey, dir. and prod. "Toys in Action". Terminator 3: Rise of the Machines. Columbia TriStar Home Entertainment. 2003. DVD.

Ling, Van. Prod., and dir. "Other Voices, Back Through Time, Creating the Terminator: Cast and Crew Recollections". The Terminator. MGM Home Entertainment. 2001. DVD.

Ling, Van. Dir., writ., and ed. "T2: More than meets the eye: 22 minute special discussing omitted scenes and the special edition". Terminator 2: Judgment Day. The Ultimate Edition DVD. Momentum Pictures, 2001. DVD.

Ling, Van. Prod., and writ. "The Ultimate T2". Terminator 2: Judgment Day. The Ultimate Edition DVD. Momentum Pictures, 2001. DVD.

Lister, Martin, ed. The Photographic Image in Digital Culture. London and New York : Routledge, 1995.

---. New Media :A Critical Introduction. London and New York: Routledge, 2003.

Magid, R. "Building a Believable Blockbuster: The Unique Collaboration Behind T3**".** American Cinematographer 5.11 Aug 2003:Vol 84, Number8. 20 Nov 2007. <http://www.theasc.com/magazine/aug03/sub/index.html>

Manovich, L. The Language of New Media. Massachusetts: MIT Press, 2002.

McQueen, Jeff. Prod. and dir. "The Making of The Terminator: A Retrospective". Prod. Patty Matlen. 1992. The Terminator. MGM Home Entertainment. 2001. DVD.

Meadows, Michael and Taubin, Mitchell. Prods. "T3 Visual Effects Lab". Terminator 3: Rise of the Machines. Columbia TriStar Home Entertainment. 2003. DVD.

Meadows, Michael and Taubin, Mitchell. Prods. "Inside Terminator 3: Rise of the Machines". Terminator 3: Rise of the Machines. Columbia TriStar Home Entertainment. 2003. DVD.

Mitchell, William. The Reconfigured Eye. London. MIT Press, Cambridge, Massachusetts, 2001.

Moston, Jonathan. Dir. Terminator 3: Rise of the Machines. Perf. Arnold Schwarzenegger, Kristanna Loken, Nick Stahl and Clair Danes. 2003. Columbia TriStar Home Entertainment. 2003. DVD.

Mourão, Maria Dora and Yamaji, Joel. "Cilect Project Report: The Influence Of New Tools On Contemporary Conceptions Of Film Language As A Mode Of Expression". Cilect. 29 April 2004. Accessed on: < http://161.58.124.223/archives/MDFINAL1.htm >

Ndalianis, Angela. Neo-Baroque Aesthetics and Contemporary Entertainment. Massachusetts: The MIT Press, 2004.

Parisi, Paula. "Cameron Angle: The Abyss, Terminator 2, True Lies - Jim Cameron's films are the milestones by which we measure the development of Silicon Cinema." Wired 4.04. 1996:1-3 Accessed on: 12 April 2007 <http://www.wired.com/wired/archive/4.04/cameron.html?topic=&topic_set>

---. "Grand Illusion: The Master Of Myth Rewrites History." Wired 7.05. 1999:1-3. Accessed on: 12 April 2004 <http://www.wired.com/wired/archive/7.05/illusion.html >.

---."The New Hollywood" Wired 3.12. 1995: 1-7. Accessed on: 12 April 2007 <http://www.wired.com/wired/archive/3.12/new.hollywood.html?topic=&topic_se>

Pescovitz, D. Starmaker. Wired 6.10. October 1998. pg 153. 15June2004 <http://www.wired.com/wired/archive/6.10/hollywood.html?pg=8>

Pinteau, Pascal. Special Effects: An Oral History. New York. Harry N. Abrams, Inc. 2003.

Prince, Stephen. "True Lies: Perceptual Realism, Digital Images and Film Theory." Film Quarterly, Fall, vol. 41 no1. Berkeley. University of California Press. 1988.

Quart, Alissa. "Rumble in the Academy." Film Comment Vol.37, No.6 (2001) The Film Society of Lincoln Center. 30-34.

Rickitt R. Special Effects: The History and Technique. London. Virgin Books, 2000.

Silberman, Steve. "G Force :George Lucas fires up the next generation of Star Warriors". Wired.7.05 . May 1999. Accessed on: 24 April 2007 <http://www.wired.com/wired/archive/7.05/lucas.html?pg=1&topic=&topic_set >.

---. "Matrix ²:F/x guru John Gaeta reinvents cinematography with the Matrix. Reloaded." Wired 11.05. May 2003. 1-5. Accessed on: 15 June 2007 <http://www.wired.com/wired/archive/11.05/matrix2.html>.

Silent Running. Dir. Douglas Trumbull. Perf. Bruce Dern, 1972. Universal Studios Home Video, 2002. DVD.

Smith, Thomas G. Industrial Light and Magic: the Art of Special Effects. New York. Ballantine Books, 1986.

Sobchack, Vivian. Visual Transformation Meta Morphing and the Culture of Quick-Change. Minneapoilis. 2000. University of Minnesota Press.

Star Wars - Episode I, The Phantom Menace (Widescreen Edition). Dir. George Lucas. 1999. 20th Century Fox, 2005. DVD.

Star Wars - Episode IV, A New Hope. Dir. George Lucas. Lucasfilm/Twentieth Century-Fox, 1977. Twentieth Century Fox Home Entertainment, 2006.

Star Wars Episode V: The Empire Strikes Back (Full Screen Edition). Dir. Irvin Kershner. Lucasfilm/Twentieth Century-Fox, 1980.Twentieth Century Fox Home Entertainment, 2006. DVD

The Abyss, Special Edition. Dir. James Cameron. Perf. Ed Harris, Mary Elizabeth Mastrantonio and Michael Biehn. 1989. Twentieth Century-Fox, 2000. DVD.

The Lost World. Dir. Hoyt. Writ. Arthur Conan Doyle. First National Pictures, 1952. Eureka Video Release, 2001. DVD.

The Matrix. Dir. Andy Wachowski and Larry Wachowski. Warner Brothers. 1999

The Matrix Reloaded. Dir. Andy Wachowski and Larry Wachowski. Village Roadshow Films. 2003

The Thing. Dir. John Carpenter. 1982. Universal Studios, 2004. DVD.

The Sarah Connor Chronicles. Dir. Jeffrey G. Hunt and David Nutter. Perf. Lena Headey, Thomas Dekker, Summer Glau. Prod. Warner Bros. 2008. Broadcast in South Africa on May 6, 2008, airing at 08:30 pm, on M-Net. Series.

The Wolf Man. Dir George Wagner. Universal Pictures, (1941).

Thompson, Anne. "F/X Gods: Meet the 10 Visual Effects Wizards Who Rule Hollywood" Wired.13.02. February 2005.

Tron. Lisberger, Steven, Dir. Disney, 1982. Buena Vista Home Entertainment. 2002.

Toy Story. Dir. John Lasseter. Perf. Tom Hanks and Tim Allen. Disney, 1995. Walt Disney Video, 2001. DVD.

Watson, Paul. "There's No Accounting for Taste: Exploitation Cinema and the Limits of Film Theory". Trash Aesthetics: Popular Culture and its Audience. Cartmell, D (et al), ed. London, Pluto Press. 1997.

Wells, Liz.(ed). The Photography Reader. New York: Routledge, 2003.

Willow (Special Edition). Dir, Ron Howard. Lucasfilm/MGM, 1988. 20th Century Fox, 2001. DVD.

Wolf, Mark P.J. "A Brief History of Morphing". Meta-Morphing: Visual Transformation and the Culture of Quick-Change. Vivian Sobchack, ed. Minneapolis: The University of Minnesota Press. 2000. 83 -102.